THE IMPACT OF OIL PRICE SHOCKS ON AN OIL EXPORTING COUNTRY: A MIXED METHODS APPROACH

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A thesis submitted in partial fulfilment of the requirements of the University of Northumbria at Newcastle for the degree of Doctor of Philosophy

May 2016

Abstract

Since the advent of exporting oil in 1999, Sudan's economy became more reliant on the proceeds of crude oil export. This situation exposed the economy to the negative effect of crude oil price shocks. In general, oil price increase positively impacts the economy of oil exporting countries, while oil importing economies suffer. That is, oil price increase boosts economic activities in oil exporting countries while it retards economic growth in oil importing countries. Unlike developed economies, there is a paucity of research in the relationship between oil Price shocks and the macroeconomy in developing countries. In this context, Sudan lacks appropriate fundamental economic knowledge and understanding of the complex relationship between its macroeconomy and oil price shocks. This research contributed towards filling this gap. To this end, the overall objective of this thesis was to examine the impact of crude oil price shocks on Sudan's macroeconomy over the period 2000 – 2011. In doing so, this research answered the following question: what was the impact of oil price shocks on the public budget, Gross Domestic Product (GDP) growth and unemployment rates, sectors' growth rate and current account.

The research employs the Convergent Parallel Mixed Methods Design, in which the Vector Auto-Regression (VAR) model and Delphi method are used. The main findings show that negative real crude oil price shocks have a greater influence on the majority of the macroeconomic variables compared to positive shocks. Findings from the public budget VAR model suggests that real crude oil price shocks have asymmetric effect on the public budget. This is attributable to the use of a predetermined crude oil price in the annual public budget. This finding is consistent with those of Jbir and Zouri-Ghorbel (2009) and Ibrahim and Mohamed (2012) in the Tunisian and Iranian economies,

respectively. Therefore, adoption of a conservative approach in determining the benchmark price in the public budget is very crucial to avoid persistent withdrawals from the Central Bank. Results obtained from the current account VAR model indicate that negative and positive real oil price shocks have symmetrical effects on the trade and current account balances. This finding is in line with those of Le and Chang (2013) and Allegret et al (2014) in Malaysia and some African oil exporting countries, respectively. However, oil increase improves the trade and current account balance, but at the expense of the non-oil exports. Therefore, there is a need for export restructure, diversification and support for non-oil exports. Furthermore, the GDP growth and unemployment VAR model shows that real crude oil price shocks symmetrically affect the GDP growth rates. Similar results of the negative effect on GDP growth is reported in Nigeria and Iran by Akin and Babajide (2011a) and Farzanegan and Markwardt (2009), respectively. However, negative real crude oil price significantly impacted the unemployment rate. Finally, the sectors' growth VAR model shows that increase in crude oil price positively affected agricultural and service sector growth rates, while it negatively impacted industrial sector growth. Decrease in real crude oil price influenced agricultural sector to increase, whereas industrial and services sectors growth rates suffer. These findings are consistent with those obtained by Binuomote and Odeniyi (2013) and Ahmed and Wadud (2011) in the in Nigerian Malaysian economies, respectively.

The significance of this research is its contribution to the existing body of knowledge on the relationship between crude oil price shocks and the macroeconomy in oil exporting developing countries, mainly Sudan, and the use of the mixed method approach in this research investigation. This research addressed the dynamic interrelationship between the crude oil price shocks and the macroeconomy. The outcome of this research provides key decision makers with the relevant information to design appropriate economic policies to mitigate the negative effects of crude oil price shocks.

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List of published and conference papers

1. A research paper entitled "Impact of Oil Price Shocks on Sudan's Government Budget" published in the International Journal of Energy Economics and Policy, 2016, volume 6, issue 2, pp. 243-248. Available from http://econjournals.com

2. Conference paper entitled "Oil Price Shocks and their Consequences on Sudan's GDP Growth and Unemployment Rates" *Presented in the 21st. International Academic Conference, 9-12 Feb-2016, Miami, Florida, United states.* Available from http://www.iises.net/past-conferences/academic/21st-international-academic-conference-miami

3. Conference paper entitled "Oil Price Shocks and Sudan's Current Account Nexus" *Presented in the 4th IBESRA Conference, 27-28 February 2016, Istanbul, Turkey.* Available at

   http://ibesra.com/content/4th-ibesra-international-business-economics-social-sciences-research-association-0

Acknowledgement

At the outset, I would like to thank the almighty God "*Allah*" for helping me to finish this thesis on time, for easing things and giving me the power to continue without suffering from loneliness. Big thank you goes to Dr. Noel Perera, my principal supervisor for his guidance and encouragement during the Ph.D. journey. He provided an exceptional assistance and gave me full freedom to manage my time. He also meticulously reviewed the first draft of the thesis and has pinpointed the holes and guided me to fill those gaps in an intelligent manner. I extend my gratitude and appreciation to Dr. Kian Tan, the second supervisor for his critical feedbacks and comments on my work, which helped me to prepare for similar critiques and to feel confident to answer them. Furthermore, I owe great thanks to Dr. Lual Deng, the former minister of the Ministry of Petroleum in Sudan for his invaluable support and encouragement to let me go back to school and continue my higher studies after a long period of professional experiences. Without his keen support, I would not have made my way to the Ph.D. program in the United Kingdom. Likewise, thanks go to my friends Sheikh Elnoor Jabralla, Ahamed Eltyb Salih, Mohamed Ahmed Aljaali, Abdelmajid Alkadro, Sheikh Salah Abdalla, Alhadi Bakhit, Sheikh Suliman, among others, who kept praying for me. I'm grateful to my colleagues at the Ministry of Finance and National Economy, and Central Bank of Sudan for providing assistance in collecting the required information and data. Furthermore, I highly indebted to anonymous individuals for availing their time and took part in the experts' panel of the Delphi method. I am highly grateful to my extended family, especially my mother, sisters and brothers for their continued support and prayers. Special thanks and appreciations go to my wife Amira, sons (Ahmed and Mohamed) and daughters

(Tasabeeh, Fatima Alzahara and Khadija) for their understanding of being away from them and for their passionate and love that gave me the strength to keep on in my studies. Last and not least, I would like to extend my thanks and gratitude to the African Educational Trust (AET) for financing my Ph.D. programme and outstandingly managed all financial arrangements with the University and regularly furnishing me with the monthly allowances, which helped me to focus on my studies and finish on time.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee on the 7th of April 2014 [Research Project: RE-EE-13-131115-5285f4352d6d9].

I declare that the Word Count of this thesis is 70,323.

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Chapter one: Introduction

The impact of oil price shocks on economic activities has been extensively researched, since the crude oil shock of the 1970s. Earlier studies have established the negative relationship between the oil price shocks and economic growth in the United States (Hamilton, 1983; Gisser and Goodwin, 1986; Darby, 1982, Mork and Hall, 1980, among others). Moreover, other researchers had documented the negative relationship between oil price shocks and the macroeconomy in other countries (Burbidge and Harrison, 1984). However, after 1985, it was observed that the linear relationship between oil price and the Gross National Product (GNP) in the United States started to lose its significance. That is, the effect of oil price decrease had shown smaller effect on economic activities (Lardic and Mignon, 2008). As a result of that, researchers started to consider the asymmetric effects of oil price shocks. Accordingly, a number of oil price specifications were proposed to assess the consequences of oil price going up and down (Hamilton, 1996, Mork, 1989, Lee et al., 1995, Ferderer, 1996, Hamilton, 2003). In this regard, Hamilton (2011) confirmed the non-linearity of the relationship between the United States GNP growth rate and oil prices. It is apparent that most of these studies were carried out in the economy of the United States, which is a net oil importer. One the other hand, there is a paucity of research in developing countries in general and in oil exporting countries in particular.

From the literature, oil price boom has an adverse effect on the economies of oil importing countries, while it affects net oil exporting countries positively, the reverse is expected when oil prices plummet (Le and Chang, 2013; Jimenez-Rodriguez and Sanchez, 2005). However, the generalization of the effect is misleading as some countries from oil importers group such as Japan exhibited a positive response to oil price shocks (Jimenez-Rodriquez and Sanchez, 2005). In the same manner, few oil exporters are negatively affected by oil price increase (Lorde et al., 2009; Iwayemi and Fowowe, 2011a). This why it is important to understand the structure of the economy and how monetary and fiscal policies react to oil price shocks. In this respect, Kilian (2009) emphasised the importance of understanding the source of oil price shock in order to design the appropriate counter policy. However, Segal (2011) criticized Kilian's approach of differentiating between the sources of the oil price shocks and their impact, claiming that the supply shock and the demand shock are two facets of one coin.

The relationship between oil price shocks and the macroeconomy gained momentum due to the importance of oil as a source of energy for a wide spectrum of economic activities. In this context, understanding the effect of oil price shocks on economic activities would help the government to adopt the appropriate economic policy to mitigate their adverse impacts. Although in some industries there are other energy alternatives that can substitute it, still some industries such as transport depend entirely on oil. To assess the impact of oil price shocks on the macroeconomy, researchers used various methods and techniques, for example, bivariate regression, production function (Cobweb production function), General Equilibrium model, VAR models (unrestricted Vector Regression model, Error Correction Model, Structural Vector Auto Regression model, etc.).

In this respect, this thesis will investigate the impact of oil price shocks on the economy of Sudan, a small oil producer and exporter in Africa. It is worth noting that Sudan was a unified state during the period under study (2000:q1 – 2011:q2). Before the exploration of the crude oil in 1999, Sudan's economy was dominated by agricultural activities. The agriculture sector employed approximately 80 per cent of the labour force and had a higher share in the Gross Domestic Product (BBC, 2013). However, the discovery of the crude oil and the advent of its exportation in the third quarter of 1999 caused a notable change in Sudan's economic structure. Crude oil export earnings constituted over 90 per cent of the total export proceeds in 2008, leading to oil revenues contributing more than 50 per cent of the total government revenues (Abuldrahman, 2013; International Monetary Fund, 2009).

Since then, Sudan's economy has depended on oil revenues to finance its budget and pay its import bill. This has led to a higher growth rate of the GDP, driven mainly by the oil sector (World Bank, 2009). Sudan's proven oil reserve is estimated at 6.4 billion barrels (BP, 2011). Oil production was 15.9 million barrels per annum in 1999, however, it increased steadily to 176.3 million barrels/year in 2007 (Sudanese Petroleum Corporation, 2013). It's worth noting that Sudan during the period under investigation was a net crude oil exporter as its oil production surpassed its consumption. This situation puts Sudan at economic risk due to the fluctuation of crude oil prices in the international markets.

Although the contribution of the oil sector to the Gross Domestic Product (GDP) is around 12 per cent, it constitutes on average 65 per cent of the export proceeds. Having that in mind the government has established an Oil Revenues Stabilization Fund (ORSF) to cater for drop in crude oil prices. However, the amount of crude oil revenues available in ORSF has been poorly managed and fail to serve its intended purpose. Most of the resources of that fund are utilized in financing the growing government current expenditure (Abdulwahab, 2012). According to Omojolaibi and Egwaikhide (2014), different studies found that oil exporting countries increase public expenditure during the oil boom in non-productive activities.

From the above discussion, it is clear that Sudan has been heavily dependent on revenue revenues, this situation puts the economy at risk of crude oil price shocks as a considerable amount of the total revenues come from crude oil revenues. Furthermore, the continued interventions of the Central Bank of Sudan to stabilize the exchange rate in the foreign exchange market accelerated the depletion of the ORSF resources and foreign reserve in general. Despite the high dependency on crude oil revenues and given that Sudan is a price taker, as it cannot influence the crude oil prices in the global market, no effort was exerted to study the relationship between the movements of crude oil prices and the key macroeconomic variables. This showed a lack of knowledge and understanding of the impact of global crude oil price shocks and its consequences on the macroeconomy. That is, the focus was on the oil revenue side rather than looking at the effect of instability in the global crude oil markets and how that could affect the economy and how the impact pass through to the economy. Therefore, this is the main motivating factor behind undertaking this piece of research to enable the government to clearly understand the effect on macroeconomic variables as a result of fluctuations of crude oil price in the global market. By so doing, the government will be in a better position to prudently adopt the appropriate economic policy response to further enhance the positive effects and to put in place precautionary measures to mitigate the negative effects of the crude oil price fluctuations. Hence for this reason it was pertinent to examine the effects of crude oil price shocks on Sudan which was a developing oil producing country over the period 2000: q1-2011: q2.

1.1 Research questions

This research attempted to answer how is crude oil price shocks transmitted to the Sudanese economy as measured by:

a) The public budget?
b) Key macroeconomic variables?
c) The current account?
d) Real GDP growth and unemployment rates?
e) The growth rate of agricultural, industrial and services sectors?

1.2 Research aim and objectives

This research is aimed at assessing the impact of crude oil price shocks on eighteen selected macroeconomic variables in Sudan, during the period 2000: q1 – 2011: q2. To achieve this, aim the following objectives are fulfilled:

1. The investigation of the effect of crude oil price shocks on the government public budget, key selected macroeconomic variables, current account, GDP growth and

unemployment rates, and growth rates of the agricultural, industrial and services sectors.

2. A thorough review of relevant literature to deeply understand the body of knowledge in the area of oil price shocks macroeconomy nexus and to identify potential gap in the research methodologies and techniques.

1.3 Research methodology:

This research used the Convergent Parallel Mixed Method Design, in which quantitative and qualitative data were collected concurrently, analysed separately and then compared to each other (Creswell & Plano Clark, 2011). The rationale of using the mixed methods approach was to corroborate and validate the findings of the research (Bryman, 2006). According to Gillham (2011), using more than one method creates more confidence of the research findings as each method has its own limitations. The quantitative data were collected from secondary sources and analysed using the VAR mode, while the qualitative data were collected directly from respondents (primary sources) using the Delphi method and then the descriptive statistical analysis was performed.

1.4 Significance of the research:

This thesis attempts to contribute to existing knowledge from different perspectives: exploring a research in new geographical area or a new setting, applying an existing technique in a new context, combining two techniques that have not been used together before and finally complement existing knowledge with regard to crude oil price shocks and macroeconomy relationship in developing economies. These elements of contribution to knowledge are explained as follows:

1. Since the start of oil production and up to the secession of South Sudan in July 2011, the government tended to deal with economic instabilities with discrete policies. Thus, no consideration was given for the dynamic effects of oil price shocks on other

macroeconomic variables within the economic system. This research has investigated thoroughly the impact of crude oil price shocks on Sudan's economy over the period 2000: q1 – 2011: q2. In doing so, five VAR models were developed to carefully assess the relationship between the crude oil price shocks and macroeconomic variables under the framework of the mixed methods. To the best of my knowledge, this is the first comprehensive empirical study to assess the entire period when Sudan was a net crude oil exporter.

2. All previous studies conducted elsewhere have used quantitative methods only to assess the relationship between crude oil price shocks and macro-economic variables. This research, however employed the convergent parallel mixed method design (quantitative and qualitative approach) to investigate the research questions using the VAR model and Delphi method.
3. This research also complemented and contributed to the expansion of the existing knowledge on the impact of crude oil price shocks on developing countries and specifically in crude oil producing and exporting countries. Generally speaking, there is a paucity of research in the relationship between crude oil price shocks and the macroeconomy in developing exporting countries compared to developed crude oil importing countries such as the US and OECD countries.

1.5 Research organization

The research is organized as follows: Chapter two discusses the literature in a manner that distinguished between the different characteristics of countries. Countries classified into developed and developing countries based on the IMF criteria (International Monetary Fund, 2014). These countries further sub-grouped into oil importing and oil exporting countries, in order to capture similarities and differences in their responses to oil shocks. Then, the pass through of oil price shocks to the economy discussed.

Chapter three provides background about the national economy and the evolution of the oil sector in Sudan. It discusses the management of oil sectors and stages of crude oil exploration is provided. Then, the chapter displays the crude oil types, crude oil production and consumption, distribution of oil fields and existing oil facilities and infrastructure. It also analyses the behaviour of the macroeconomy by discussing the GDP growth, performance of the public budget, balance of payments and its main components, and external debt position. Finally, the chapter ends with some reflections on the economic performance in post sample period, that is, the period after 2011.

In chapter four begins with an overview of the world crude oil proven reserves by region over the last fifteen years. Then, a thorough discussion of peak oil theory is carried out to reflect the different views for and against the theory. The chapter then turns to the crude oil market by discussing the world crude oil supply and demand. Next, a brief glimpse of crude oil pricing mechanism is explained, followed by an elaboration of the main factors behind crude oil price fluctuations. Finally, a series of historical crude oil price shocks and the recent plunge in oil prices are reviewed and discussed.

Chapter five discusses the philosophical framework of the mixed research methodology. It also presents the process of Delphi method, including the structure of the semi-structured questionnaire and criteria used in selecting the experts. The Vector Auto Regression (VAR) Model and its various tests were discussed as well as data definition and sources. The VAR adequacy tests and how to use the Delphi results for external validation were explained as well.

Chapter six discusses the empirical findings of the impact of crude oil price shocks on macroeconomic variables, using five VAR models and Delphi method. The purpose of using mixed method was to corroborate and validate the findings of this research. The five VAR models are estimated using an ordinary least square method. The outcomes were internally validated using serial correlation, normality, heteroscedasticity and stability tests. For external validation, the coefficients sign of the VAR models were compared to those obtained from the Delphi method before examining the relationship between oil price shocks and the macroeconomy using the Granger causality test, Impulse Response Functions and Variance decomposition analysis. There were some contradictions between the signs of the coefficients of the estimated VAR model and the Delphi method, therefore, a historical simulation method was applied and evaluated.

Chapter two: Literature Review

2.1 Introduction

The oil price shocks and the macroeconomy relationship gained recognition from the early 1970s, when the first oil price shock took place after the OPEC countries stopped supplying crude oil to the market as a punishment against western countries for supporting the Israeli army in its war against Egypt. Since then, a huge number of studies were carried out to understand the relationship between the oil shocks and the macroeconomy. In this chapter, the previous studies will be reviewed in a manner that distinguishes between the different economic characteristics of countries. Studies were classified as to whether they relate to developed or developing countries based on IMF criteria (International Monetary Fund, 2014). Studies were sub-grouped further into those relating to oil importing and oil exporting countries to capture similarities and differences in their responses to oil price shocks. The review also examines the pass-through of oil price shocks will be discussed.

2.2 Developed countries

2.2.1 Exporting countries

Using a Vector Auto-Regression (VAR) model, Mork, et al. (1994) examined the effect of oil price shocks on the GDP growth rate in seven countries of the Organization for Economic Cooperation and Development (OECD) during the period 1967: q3-1992: q4. They included increase and decrease in oil price as separate variables in the VAR model as proposed by Mork (1989). The lag length of the VAR model was five. Their findings revealed that the sign of the increase in oil price was negative for the first and second lags and statistically significant in the case of the United States. The summation of all coefficients of the oil increase variable was -0.54. That is, increase in oil prices cause Gross National Product (GNP) to retard in the United States. On the other hand, the third and fourth lags of price increase variable were positive and statistically significant. Likewise, the other six countries, excluding Norway, had shown somewhat similar patterns of coefficients. For the case of Norway, the response of the GDP growth was positive for both increase and decrease in oil prices. This might be attributed to the large share of the oil sector in Norwegian economy.

Jimenez-Rodriguez and Sanchez (2005) employ the VAR model to explore the relationship between the oil price shock and the GDP growth in some OECD countries over the period 1972: q3-2001: q4. They report mixed results for oil exporting countries, namely Norway and the UK. They find that an increase in oil price has a significant positive impact on the GDP growth in Norway, while in UK its effect on the GDP growth is negative and statistically significant. This unexpected result is due to the appreciation of the UK exchange rate, which harms its exporting sector (Dutch disease effects). On the other hand, a decrease in oil price has positively affected the GDP growth in the UK and Norway. The positive result in the case of Norway is attributable to the prudent economic policy and management of the oil windfalls. They also report the effect of increase and decrease in oil price on the GDP growth in Canada. Their results show that the GDP growth response was negative in the two countries. The negative response in Canada may be due to the long sample period, where Canada was a net oil importer until 1980 and since then Canada became a net oil exporter. However, in another study that covers other European countries besides the United Kingdom, Jimenez-Rodriguez and Sanchez (2009) examine the impact of oil price on real GDP and inflation using quarterly data from 1970:q3 to 2003:q4 and employing a VAR model with linear and non-linear oil price specification. They find that an increase in oil price has a positive effect on the real GDP in the UK. This study reported only results related to increase in oil price and kept silent about the effect of the decrease in oil price.

Cologne and Manera (2008) studied the effect of the oil price shocks on economic activities in Canada and the UK using quarterly data during the period 1980: q1 to 2003: q4, by applying the structural co-integrated VAR model. In the case of Canada, the findings from the impulse response function suggested that oil price shocks caused monetary stock, interest rate, the GDP growth, inflation rate to increase, with an appreciation in the exchange rate. On the other hand, for the UK, the oil price shock appeared to have a different effect, where the exchange and inflation rates reacted positively, while the remaining variables were impacted negatively. Although the UK was a net oil exporter during the study period, the effect on its economic activities seems to be quite odd, compared to Canada. Despite these facts, the researchers did not provide a justification for such unexpected findings on the impact of oil price shocks on net oil exporting countries.

In an attempt to assess the impact of oil price shocks on the UK services and manufacturing sectors, Guidi (2009) used three sets of VAR models. Each model included seven quarterly variables, covering the period 1970: q1 to 2005: q4. These variables are the real oil price, consumer price index, real wages in sectors, index production of the manufacturing and services sector, long-term interest rate, short-term interest rate, and the real effective exchange rate. He adopted different oil price specifications, namely linear approach, an asymmetric specification proposed by Mork (1989) and Net Oil Price Increase (NROI) specification introduced by Hamilton (1996). His results showed that, for the linear oil price specification, oil price shocks have a positive effect on all variables in the two sectors, but not the real wages. For the non-linear specification, an increase in oil prices caused a negative effect on manufacturing output, short-term and long-term interest rates, while triggering a positive impact on services output, real effective exchange rate, inflation rate and real wages. Decrease in oil price affected manufacturing output, services output, real effective exchange rate, inflation and real wages negatively, while impacting the short-term and long-term rates positively. Finally, the net oil price increase (NOPI) impacted the manufacturing output, real effective exchange rate, and inflation rate positively, but affected services output, short-term and long-term rates negatively. It was clear from the analysis above that some differences may be attributed to the selection of the oil price specification. Therefore, selection of the right specification is very important to accurately estimate the effect of oil price shocks on the macroeconomic variables.

In studying the impact of oil price shocks on the real Gross Domestic Product (GDP) in Canada, Korhonen and Ledyaeva (2010) employed simultaneous equations developed by Abeyysinghe (2001), and used quarterly data from 1995:q1 to 2006:q3. Their results suggested that Canada had experienced a positive effect on the GDP growth rate as a result of oil price increase. The impulse response function showed that the cumulative response of the real GDP growth rate to a 50 per cent increase in oil price is a 1.5 and 0.9 percentage points increase in the short and long terms, respectively. The result showed that the economy was less dependent on oil revenues.

Bashar et al. (2013) examined the relationship between the oil price uncertainty and the macroeconomic variables in Canada using monthly data over the period January 1986 – April 2011. They used a seven-variable structural VAR model. The model included industrial production index as a proxy for the economic output, consumer price index, money stock, overnight market rate, nominal exchange rate, and the Federal Fund rate and oil price. They used two types of oil price specifications, the oil price level and oil price uncertainty. The oil price uncertainty was simply the standard deviation of the daily oil prices during a span of one month. According to their findings, oil price shock influenced general prices and the exchange rate significantly. Likewise, output and money stock were positively affected by the oil price shock, but the effect was insignificant. On the other hand, they used oil price uncertainty instead of the oil price shock to investigate its effect on the same macroeconomic variables. Their findings suggested that the output and the general price level declined as a result of an increase in oil price uncertainty. The response of the interest rate appeared to be negative, whereas monetary stock increased significantly. Furthermore, the exchange rate depreciated significantly due to the increase in oil price uncertainty. From the above-mentioned analysis, it seems that oil price uncertainty had a greater effect on the Canadian economy compared to the oil price shock; this might be attributed to its negative impact on the investment and monetary policy.

2.2.2 Importing countries

In a pioneering work, Hamilton (1983) studied the relation between the oil price shocks and the macroeconomic activities in the United States during the period 1948-1972, using VAR model of seven macroeconomic variables, namely real GNP, unemployment rate, the price deflator for nonfarm business income, import prices, money supply (M1), hourly compensation per worker and the nominal oil price. He explored the relationship between the oil price shock and the real GNP by testing three hypotheses, namely that oil increase preceded the US recession as a matter of coincidence, there were a set of third endogenous variables that were responsible for the recession, and finally, the recession was due to an exogenous factor which was the increase in oil price. Using linear oil price specification, he concluded that increase in oil price had negatively influenced the real GNP in the United States. However, Bernanke et al. (1997) claimed that the US recession in the 1970s was not due to the oil price shock, but to the response of the Federal Reserve by increasing the interest rate following the oil price spike. In return, Hamilton and Herrera (2004) criticised Bernanke et al. (1997) on the ground that the estimates of their VAR model were sensitive to the lag length used in the model. They claimed that econometric model favours longer lag length, similar to those used by other researchers. When the simulation was carried out using the longer lag length, the monetary policy role proposed by Bernanke et al. (1997) showed no effect on the output recession. Furthermore, Kilian and Lewis (2011) re-estimated the Bernanke et al. (1997) model by changing the assumption of asymmetry to symmetry. Their results showed that monetary policy had no effect on the US recession of the 1970s and early 1980s. That is, their results supported those of Hamilton (1983) and Hamilton and Herrera (2004).

A similar study was carried out in the U.S. by Gisser and Goodwin (1986) using four quarterly macroeconomic variables, namely real GNP, inflation, unemployment and real investment in St. Louis-type equations over the period 1961: q1-1982: q4 to investigate their response to oil price shocks. Their findings showed that oil price had a significant positive impact on inflation and unemployment rate, while its effect on investment and real GNP was negative and statistically significant.

In his research, Mork (1989) criticised Hamilton's (1983) results regarding the negative correlation between the oil price changes and growth of the GNP in the US. He claimed that the oil price was on the upward trend during the period that had been studied by Hamilton. This situation had left the effect of the decline in oil prices untouched. Like Hamilton, Mork followed Sims (1980) VAR model, to investigate - after correcting the distortion on prices due to price control during 1970s - whether the findings obtained by Hamilton (1983) were valid when extending the sample period to encompass the new trend of the oil price changes after 1986. He found that the model did not maintain the same results as before. This had led Mork to think of the probability of asymmetrical effects of the oil price. The symmetric effect means increase in oil prices have significant impact on economic activities, while drop in oil prices have no significant effects. Therefore, he included increase and decrease in oil price as separate variables in the model to capture the presumed asymmetric effect of oil price movements. He studied the effect of the real oil price on six macroeconomic variables: GNP, inflation, Treasury bills, unemployment, wages, and import price during the period 1949: q1-1988: q2. Unlike Hamilton, Mork (1989) used refinery acquisition cost instead of producer price index. This index reflects the controlled prices of crude oil that was produced domestically during 1970s. He confirmed that all coefficients for oil price increase were negative and the sum of the four lags was around -0.144 and statistically significant. That is, negative correlation between the increase in oil prices and the GNP growth. On the other hand, the coefficients of the oil price decrease were smaller and of different signs, with a sum slightly positive (0.017), but not significant. That is, no significant effect on the GNP growth was observed as a result of a decrease in oil price. Therefore, he concluded that the effect of oil decrease is different from oil price increase. A few years later, Mory, (1993) examined and confirmed the asymmetric effects of oil price shocks on the aggregate activities in the US economy. In this regard, some researchers have claimed that the asymmetric effect can be attributed to the way the monetary authorities responded to oil price shocks, adjustment cost and the impact of uncertainty on the investment environment (Hamilton, 1988; Pindyck, 1991; Bernanke et. al., 1997; Ferderer, 1996, Hooker, 1999)

Lee et al. (1995) employed eight macroeconomic variables in a VAR model, namely the real GNP, GNP deflator, the unemployment rate, three months Treasury bill rate, import, price inflation and real wage inflation over the period 1950: q3-1992: q3, to estimate the effect of oil price on the U.S economy. They used the same variables as in the Mork (1989) model. They found that increase in real oil price had a significant negative effect on GNP during the period 1949: q1-1988: q2, consistent with the results of Mork (1989). However, when the sample period extended to the 1992: q3; the real oil price shock was found to be statistically insignificant. Furthermore, they introduced a new oil price transformation, which was real oil price change normalized by their conditional standard deviation. Their results suggested that positive normalized oil price had a significant negative impact on the real GNP and significant positive effect on the unemployment. That is, they only reported the business cycle indicators. It is clear from the above studies that researchers have attempted to explore the relationship between the oil price shocks and the occurrence of series of economic recessions in the U.S. using different oil price specifications to establish stable relationship.

Using monthly data for the period 1970:1-1990:12, Ferderer (1996) used an unrestricted VAR model to assess the effect of the real oil price (the monthly mean) and volatility of real oil prices (the monthly standard deviation) on the industrial output growth, non-borrowed reserves and the Federal Funds rate in the U.S (monetary policy indicators). Fereder used an oil price volatility specification, which was defined as the monthly standard deviation of the daily real oil prices. Unlike previous studies (such as Hamilton, 1983; Mork, 1989; Lee et al., 1995) Ferderer used daily spot market bulk prices for the refined oil products that shipped from Rotterdam port in Netherland. He employed two VAR models, the first model included federal fund, both oil price specifications and output. In the second VAR model, he just replaced the Federal funds rate by non-borrowed reserves. His overall findings showed that the oil price shocks and monetary policy variable had impact on the industrial output. However, the novelty of his research was that oil price volatility had a significant negative effect on the industrial production growth while the real oil price showed a significant effect after 12 months. He further claimed that oil price variables had greater influence on the growth of the industrial production compared to the two monetary policy variables (non-borrowed reserves growth and Federal Fund rate). Moreover, he examined the existence of asymmetric effect by including increase and decrease in real oil price as separate variables in the VAR model. His results revealed that increase in real oil prices had a greater negative effect on the industrial production growth than the decrease in oil price. By this he confirmed the existence of asymmetric effects on the US economy.

Hooker (1996a) used a VAR model with different oil price specifications to examine the relationship between the oil price shocks and the macroeconomic variables in the U.S. over the period 1948:q1-1994:q2. His findings showed that an increase in oil price had a significant negative effect on the GNP growth and unemployment rate in the early sub-sample (1948: q1-1973: q3), while a decrease in oil price failed to reject the Granger causality null hypothesis. That is, the decrease in oil price had no significant effect on the GNP growth and the unemployment rates. However, in the late sub-sample, 1973: q4-

1994: q2 and the full sample, 1948: q1-1994: q2, both the increase and decrease in oil prices showed no significant effects on the GDP growth and unemployment rates. In an attempt to find an explanation for the weak relationship between the oil price and the macroeconomic variables from the 1973 to 1994, he investigated the stability of the model, indigeneity of the oil price and the VAR misspecification. He tested these three hypotheses, but the results were insignificant. For the model stability, he found that there was a structural break around 1973 not captured by Hamilton (1983). Second, before 1973 oil price was treated as exogenous variable in the model which is no longer true in the case of US economy. Finally, the misspecification issue was due to the assumption of symmetrical effects of changes in oil prices.

Hamilton (1996) criticised the oil price specification used by Mork (1989), pointing out that an increase is just a correction of the decrease in oil price in the previous quarters. He claimed that oil price should be compared with previous year price instead of previous quarter as Mork (1989) did. Based on that argument, Hamilton introduced a new oil price measure called Net Oil Price Increase (NOPI), which was defined as the difference between the current level of oil price and the maximum value in the last year. If the difference was positive, the result was said to be a net oil price increase, otherwise oil price was considered to be zero. He used quarterly time series data over the period 1948: q1-1994: q2 in the context of the VAR model to assess the impact of oil price shock on the U.S. He used a net oil price increase and compared his results with those obtained by Hooker (1996). He concluded that the net oil price increase Granger caused the GNP growth in the early sub-sample (1948: q1-1973: q3), late sub-sample and full sample (1948: q1-1994: q2), while Hooker results showed that the nominal oil price change Granger caused the GNP in the early sub-sample. In a reply to Hamilton's outcomes, Hooker (1996b) claimed that NOPI fails to Granger cause other macroeconomic variables in the period 1973: q4-1994: q2. He further argued that the significant effect over the full sample might be driven by the early sub-sample and not from the fluctuating data after 1986. He also criticized the definition of the net oil price increase as an *ad hoc* and not based on any theoretical grounds. In the same line of critique, Kilian (2009) suggested that the oil price shock in 1973 was due to correction of the market disequilibrium, but not as a result of geopolitical events. He further criticized the notion of the net oil price increase proposed by Hamilton (1996) because it depended on the untested postulation that individual consumers and firms would actively respond to the oil price shock when the current oil price was greater than its maximum in the last four quarters. There is no scientific based behind this postulation, it is an attempt by Hamilton to re-establish the negative relationship between oil price shocks and the UN' GNP as before 1984.

Dayong (2008) examined the effect of oil price shocks on the GDP growth in Japan over the period 1975:q1 to 2006:q4, using regression model. According to his finding, which was based on different oil price specifications proposed by Hamilton (1996), Lee et al. (1995) and Mork (1989), negative oil price shock (increase) had a greater and significant impact on the GDP growth compared to positive oil price shock (decrease). This finding was in line with other researchers that confirmed the asymmetric effects of oil price shocks. However, the negative effect of oil price shocks on GDP contradicted the findings obtained by Blanchard and Gali (2007).

In an investigation of the relationship between real oil price shocks in domestic currency and set of the output of selected manufacturing industries in Germany, France, Italy, United States, Spain and United Kingdom over the period 1975: 1 to 1998: 12, Jimenez-Rodriguez (2008) used bivariate VAR model. However, the time series data for Spain and France started from 1980: 1. All countries are net-oil importers, except United Kingdom. The impulse response functions showed that the aggregate manufacturing output was negatively affected by oil price increase in all countries, including the United Kingdom. However, the magnitude of the effect was greater in the two Anglo-Saxon countries (US and UK). Then, she examined the real oil price shocks at eight industrial manufacturing groups as follows: (food, beverage and tobacco), (textile, wearing apparel and leather), (wood and wood products), (paper and paper products), (chemical industry), (non-metallic mineral products), (basic metals), and (metal products, machinery and equipment). The overall response of these industries to oil price shocks was negative, but heterogeneity was observed in France, Spain, Germany and Italy (European Manufacturing Union countries). These disparities in the response of these countries might be attributed to the unique structure of each industry. Therefore, any future counter economic policy to mitigate the adverse effect of oil price shocks in the European Manufacturing Union countries must consider these differences to avoid any further adverse effects.

Jimenez-Rodriguez and Sanchez (2009) examined the impact of oil price on the real GDP and inflation rate in the US, Italy, France, and Germany, in addition to the Eurozone economy in general. Using quarterly data from 1970: q3 to 2003: q4 and employing VAR model with linear and non-linear oil price specifications, they found that an increase in oil price has a negative impact on the real GDP growth and inflation rates. This study reported only the effect of the increase in oil price and left the effect of the decrease in oil price unexplained.

Blanchard and Gali (2007) looked at the changing effects of oil price shocks on economic activities over the time. They assumed that four factors were behind the milder effects of oil price shocks in recent years. These are lower share of oil consumption and production, favourable conditions (no coincidence of adverse shocks), flexible or less rigidity in labour markets, and finally more credible and improved in monetary policy. They used structural VAR model and allowed to break in the sample in mid of 1980s. That is, the sample period was divided into two sub-sample: before and after 1984. The significant about this date is that oil price before 1984 was trending upward while beyond 1984 oil prices witnessed frequent fluctuations. The VAR model comprised of six variables, namely the consumer price index, GDP deflator, GDP growth, employment, nominal oil price and wages. Six countries were studies based the six-variable VAR model, which were the United States, Germany, United Kingdom, France, Italy and Japan. In the United States, the impulse response functions in the pre-1984 period suggested that the response of Consumer price index, GDP deflator and wages were positive. However, GDP and employment responded negatively to oil price shocks. On the other hand, in the post-1984 period, the responses of the above-mentioned variables were similar to those in pre-1984 period (with exception of consumer price index), but somewhat milder. Thus, the analysis indicated weaker effects of oil price shocks on economic activities. For France and United Kingdom, the responses of the six variables to oil price shocks were almost similar to the results obtained in the United States. However, the for United Kingdom, the response of consumer price index was very mild. For Germany, the response of the consumer price index was similar in two periods. But, the influence of oil price shocks on employment and GDP were stronger in the pre-1984 period, which was consistent with conventional wisdom, while the response of GDP and employment post-1984 period was weaker. For Japan, the response of the six variables to oil price shocks showed odd results. For example, GDP increased in both periods, while the consumer price index was weaker in the both periods. They concluded that the response of the six variables to oil price shocks was in accord with conventional wisdom, with exception of Japan and to some extent Germany. That is, oil price increase resulted in increase of wages, inflation, and decreased GDP and employment. However, in all countries, the response of inflation and GDP was substantially weaker in the post-1984 period. They also used the variance decomposition analysis to understand the importance of oil price shocks on the variations in the other variables in the United States. The variance decomposition results suggested that the explanatory power of oil price shocks declined over time. This finding reinforced the earlier impulse response function results. They further used bivariate model (in the United States), which included the oil price and one variable at a time. The dynamic responses of variable due to oil price shocks were similar to the finding obtained from the multivariate model. Again, they developed a simple macroeconomic model to estimate the effect of oil price shocks in 1970s and 2000s. The two periods were selected based on the followings: First, in 1970s, labour unions were very influential and stronger compared to the situation 2000s. Second, the reaction of the central bank to oil shocks was on ad-hoc basis and there was a lack of experience to deal with oil shocks. However, in 2000s monetary policy was prudent and had greater credibility. Third, oil share in consumption and production was less in the 2000s compared to the situation in 1970s. They concluded that there were adverse events that was at work during the 1970s, for example increase in food commodity prices. Also, the oil shock effect became milder in the 2000s, especially in the consumer price index, wages, GDP and employment. The response of wages was smaller in the 2000s, due to weaker labour unions. Moreover, the increase in the monetary policy credibility in 2000s played significant role in lowering the effects of oil shocks on the inflation rate. Finally, there was a notable decline in oil consumption in 2000s. Despite these important results, the assumption of other adverse shocks in 1970 were not modelled and had been taken granted as key events. Also, the inflation variable was misleading in the analysis, as authors used consumer price index and GDP deflator to refer to inflation, but in the analysis they reported the effect on inflation only. Furthermore, the odd results obtained in Japan went without explaining the unexpected responses of the macroeconomic variables. In a similar study in the United States, Nordhaus (2007) attributed the weak response of the macroeconomic variables to oil price shocks during the period 2002 – 2006 for three reasons: first, the oil price shocks in the 2000s were different from the earlier episodes as they were less of a surprise and happened gradually. The second reason was that the pass through from oil price to GDP changed from negative to neutral during the last three decades. He claimed that the declining of macroeconomic sensitivity to oil price shocks was not fully understood. Finally, the other offsetting forces which aggravated the situation in the earlier episodes were almost neutral over the period 2002 – 2006.

Kilian (2009) suggested a new approach to assess the impact of oil price shocks on the U.S. economy. He split the oil price shocks into three components based on its source. These were crude oil supply shocks, global demand shocks for all industrial commodities (index of single-voyage freight rates), and specific demand shocks for crude oil in the global market (precautionary demand). Using the structured VAR model based on monthly data for the period 1973:1 – 2007:12, he claimed that crude oil supply shocks led to a decline in the US real GDP, while positive global demand shock boosted the economic activity. For the increase of precautionary demand shocks, a negative impact on GDP and consumer price index was observed. His approach has been criticised on the ground that demand and supply are two facets of the same coin. For example, if a country has increased its demand by 300,000 barrels/day, it has the same effect of the decrease in the aggregate supply of the same amount (Segal, 2011). Moreover, such decomposition of crude oil price shocks is over-simplification of reality in the crude oil markets. For example, there might be overlap between the three components, and they might occur concurrently, in this case, it will be difficult to distinguish the source of each shock. Therefore, the effect oil price shocks are said to be the same in general, irrespective of their sources. Furthermore, Hammels (2007) claimed that freight rates were significantly correlated to oil prices, thus the exogeneity of the aggregate demand was questionable. That is, oil price shocks affect and is affected by aggregate demand.

Ozlale and Pekkurnaz (2010) examined the impact of oil price shocks on the current account balance in Turkish economy. They used monthly data covering the period 1999: 1 – 2008: 9. In constructing the structural relationship between the oil current account balance and the oil price, they controlled the main determinants of the current account, which were output gap and exchange rate misalignment. The rational for selecting these variables was to capture their impacts on the current account balance as control variables. Moreover, to capture the other factors or variables that were not included in the model, they added lagged value of the current account balance as independent or regressor variable. They further imposed the following restrictions: first, variable in the model does not affect oil prices. That is, oil price was exogenous variable. Second, exchange rate misalignment is affected only by the oil price shocks. Third, the output gap was assumed to be influenced by the oil price shocks and exchange rate misalignment. Fourth, all variables affected current account balance, whereas current account did not cause those variables. That is, current account represented the most endogenous variable in the model. The impulse response functions findings suggested that current account balance responded negatively to oil price shocks in the short run. On the other hand, the variance decomposition analyses showed that most of the variations in the current account balance emanated from the shock to itself, while oil price shocks accounted for 9.8 per cent of current account balance variation. They also tested the relationship using simple linear regression. Using the ordinary least squares, the coefficient of the oil price shocks was negative and statistically significant. That is, oil price shock worsened the current account balance. The result was plausible as Turkey was a net oil importer.

In assessing the impact of oil price shocks on Turkey's economy, Erkan et al. (2010) employed four macroeconomic variables VAR model, using annual time series data from 1991 to 2008. Their findings showed that increase in oil price had a significant negative effect on the unemployment and export-import ratio, but influenced inflation rate positively. However, the effect of increase in oil price on the economic output was moderate and statistically insignificant. The negative effect of oil price shock on the unemployment rate was confirmed by Dogrul and Ugur (2010). The latter scholars investigated the relation between crude oil price and the unemployment rate in Turkey over the period 2005:1 to 2008:8. They used monthly data and employed Toda Yamamato (1995) procedure in the context of the VAR model. They found that crude oil price shock had a significant negative effect on the unemployment rate, while the effect on the interest rate was positive.

Weiwen (2012) examined the relation between the oil price volatility and the Singaporean economy over the period 1983: q2 to 2009: q2, using six variables Vector Error Correction model, namely oil price volatility, real oil price, unemployment rate, gross fixed capital formation, consumer price index and real GDP growth. He used a realized oil price volatility proposed by Andersen et al. (2001, 2003). The realized volatility specification could be defined as the squared summation of the changes in daily oil prices over the quarter. His results showed that an increase in oil price volatility caused the real GDP to slow-down, investment to drop, the unemployment rate to increase and inflation to decline. The latter effect was explained by the fact that a surge in oil price volatility had increased uncertainty, which in turn led to a decline in the aggregate demand, thus resulting less pressure on the general level of prices. He also concluded that the impact of oil price volatility was not statistically significant, attributing that to the declining of the oil intensity in the Singaporean economy.

Guney and Hasanov (2013) studied the impact of oil price changes as proposed by Hamilton (1996) on the GDP growth and inflation in Turkey, using monthly data spanning the period 1990:1 to 2012:3, and adopting regression equations and Granger causality test. Their results suggested that increase in oil price has a significant negative effect on the GDP growth and a significant positive effect on inflation. On the other hand, they found that decrease in oil price had no effect on the GDP growth and inflation. Their results confirmed the existence of the asymmetric effect of oil price shocks. It is worth noting that the authors used the oil price measure proposed by Mork (1989), but they referred to Hamilton (1996) oil price shock transformation, which was quite confusing.

In assessing the impact of oil price shocks on the economic activities in the United States, Katayama (2013) used VAR model including seven quarterly macroeconomic variables, namely, real GDP, real consumption, inflation rate, real investment, real wages, labour productivity and interest rate. He divided the sample period into two subsamples: the first sub-sample spanning from 1951: q1 to 1983: q4, while the second subsample covering the period 1984: q1 to 2007: q3. Two oil price shocks were used, namely net oil price increase, which had been proposed by Hamilton (2003) and exogenous shocks introduced by Kilian (2008). From the impulse response functions for the pre-1984 sub sample, 10% shock to the net real oil price had significantly decreased GDP, real consumption, real investment, labour productivity, with an exception of the real wage. However, inflation and interest rate were positively impacted. Looking at the post-1984 period, all variables had shown mild response to oil price shocks. He found that the response of the GDP in the pre-1984 to oil price shocks occurred in quarter five with a magnitude of 1.52%, while in post-1984 trough of 0.38 was observed in quarter 2. These findings were consistent with those obtained by Hooker (1999), Blanchard and Gali (2007). From this result, he concluded that the effect of oil price shocks in terms of the persistence and the magnitude after 1984 was weakened. To check the robustness of his findings, he employed exogenous shocks in the world crude oil supply. His results revealed that the response in the two sub-sample were similar.

In investigating the impact of oil price shocks on the trade balances and their oil and non-oil components in three Asian countries, namely Japan (an oil importing country) Malaysia (an oil exporting countries) and Singapore (an oil refining country), Le and Chang (2013) used Granger causality approach in addition to generalized impulse response function. Their data covered the period January 1999 – November 2011. The results from the Granger causality test showed that oil price significantly caused trade balance and the oil trade balance in Malaysia. This result was expected as Malaysia was a major crude oil producer and exporter in the region. With regard to Japan, oil price shocks significantly Granger caused oil and non-oil components of its trade balance. However, oil price did not

Granger cause the overall trade balance. They attributed that result to the difference in the sign of the oil trade balance and the non-oil trade balance. In Singapore, oil price shocks did not Granger cause the three overall trade balance and its components. This might be attributable to the unique case of Singapore as a crude oil importer and refined oil products exporter, thus in the long run negative and positive effects cancelled out each other. For the impulse response function results, oil and non-oil trade balances of Malaysia had significantly and positively responded to oil price shocks. For Singapore, oil price shocks negatively influenced the overall trade balance and their two components in the short run. With regard to Japan, non-oil trade responded positively to oil price shocks, which was in line with the results obtained from the Granger causality test. However, the oil-trade balance negatively responded to oil price shocks. One the other hand, Le and Chang (2013) also checked the stability of the model and found a structural break in the time series data, therefore, they divided the entire sample into three sub-samples: first sub-sample (January 1999 – December 2003), second sub-sample (January 2003 to July 2008), and last sub-sample (August 2008 to November 2011). The break point of December 2002 was based on the aggregate demand pressure on 2002 and civil unrest and the Iraq War. The second break point of July 2008 was based on the speculative demand shocks. Then they retested the Granger causality test and impulse response functions for each sub-sample period. The Granger causality in the three sub-samples relatively shows slightly different results compared to those of the entire sample period. For the impulse response functions, the response of the overall trade balance and their oil and non-oil trade balances components in three sub-samples has different magnitudes. Thus, they attributed the difference in the results to sources of the oil shocks.

Ratti and Vespignani (2013a) examined the relationship between the global money supply and crude oil prices. They used structural auto regression model with monthly data over the period 1970 – 2011. To calculate the global monetary supply, they aggregated the money supply in US dollars from China, United States, Japan and Euro zone. In addition to the money supply, the model included real aggregate demand, real oil price, and the global oil production. The real aggregate demand was calculated as in Kilian (2009), which was based on the equal-weighted dry cargo freight rate. The accumulative impulse response functions showed that a shock to global oil production (oil supply) influenced real oil price positively, but insignificantly. On the other hand, the response of real oil price to real aggregate demand shock was significantly positive. In response to the real oil price shock, significant positive effects were observed on global oil production, aggregate demand, while money supply responded negatively and statistically significant. Furthermore, the response of real oil prices, global oil production and global real aggregate demand were positive and statistically significant. They concluded that money supply has influential impact on increasing real oil prices. Hence, they were in line with other researchers who claimed the importance of monetary policy in determining the oil price increase (Barskey and Kilian; Gillman and Nakov, 2009). In similar study, Ratti and Vespignani (2013b) investigated the impact of real money supply on crude oil prices, using money supply of China, US, Swiss, Euro zone and UK over the period 1996: 1 to 2011: 12. Their main finding suggested that increase in money supply of China influenced crude oil prices significantly compared to the effect of money supply of other countries in the sample.

Brahmasrene et al. (2014) studied the relationship between the imported oil prices in the United States and the exchange rate. Monthly data from 1990: 1 to 2009: 12 were used. Granger causality test, impulse response functions and forecast error decomposition analysis were employed to understand the relationship under the framework of the VAR model. The Granger causality test finding suggested that the exchange rate Granger caused crude oil price in the short run, while crude oil price Granger caused the exchange rate in the long run. For the forecast error decomposition analysis, the exchange rate explained small portion of variation in the crude oil price in the short and long run, for example its contribution on average 4.2 per cent. This result contradicted their Granger causality test findings. On the other hand, shock to crude oil price was responsible for more than 44 per cent of the variation in the exchange rate in the long run. Looking at the impulse response functions, the response of crude oil price to exchange rate shock was negative and statistically significant. However, the exchange rate responded positively to oil price shock, but it was not significant. They concluded that, in the short run, fluctuation in crude oil price generally appeared after fluctuation in the exchange rate, whereas changes in in the exchange rate followed crude oil price shocks in the long run.

Lian et al. (2014) used quarterly data from 1959:q1 to 2006:q4 to assess the asymmetric effect of oil price shocks on the US macroeconomy following oil price specification of Hamilton (1996). They employed factor-augmented VAR model and included oil price as an exogenous independent variable in the VAR system. Their finding showed that increase in oil price had a negative effect on the output, saving, CPI and a positive effect on the Fed Fund rate. On the other hand, a decrease in oil price had a less significant effect on the macroeconomic variables. Their results confirmed the existence of the asymmetric effect of the oil price shock.

Tantatape et al. (2014) examined the correlation between imported crude oil price and the exchange rate in the short and long terms in the US. They used monthly data over the period 1996 - 2009, employing impulse response function, Granger causality test and variance decomposition analysis, based on unrestricted VAR model. The Granger causality test suggested that exchange rate significantly caused crude oil price in the short term while oil price influenced the exchange rate in the long term. Results from the variance decomposition analysis showed that oil price was significantly responsible for variation in the exchange rate. Furthermore, the response of the exchange rate to oil price shock was negative during the first five months, but it was not statistically significant. However, the response of oil price to exchange rate shock was significantly negative in the second month. This result support those obtained from Granger causality test.

George and Ioannis (2014) examined the response of inflation rate and interest rate to oil price shocks, by using the impulse response function in the context of structural VAR model. The study covered nine industrialized countries; two are net oil exporters (Norway and Russia) and seven net oil importers (United Kingdom, Italy, Netherland, Germany, Portugal and Spain), using monthly data with different timeframes based on the availability of the data. Their findings suggested that inflation rate response in the two groups was positive. Their results were not consistent with other similar studies carried out by Blanchard and Gali (2007) and Lian et al. (2014). The latter studies claimed that the oil price shock had less inflationary effects. They also concluded that the response of interest rate to oil price shocks depends on the monetary policy in each country.

2.3 Emerging and developing countries

2.3.1 Exporting countries

Eltony and Al-Awadi (2001) examined the effect of oil price fluctuations on six macroeconomic variables in Kuwait, using quarterly time series data over the period 1984 - 1998. They used VAR model and Vector Error Correction model (VECM) to investigate the effect of oil price fluctuations on the Kuwaiti economy. The selected seven key macroeconomic variables, namely, oil price of Kuwaiti blend crude, oil revenues, government expenditure, government development expenditure, consumer price index, money supply and value of imports of goods and services. For the VAR model, the variance decomposition analysis showed that variations in macroeconomic variables were substantially explained by the variables own shocks. Furthermore, oil price responsible for almost 45 per cent of the variance in oil revenue, government current and development expenditure. Turning to the impulse response function, shock to oil price had resulted in an increase in oil revenue, government development and expenditure over the first three quarters; while money supply, value of imports and consumer price index exhibit negative response. The decrease in money supply and consumer price index was questionable as oil exporting country tends to increase their expenditure as a result of increase in oil revenue. With regard to the vector error correction model, the variance decomposition analysis suggested the same result obtained by the VAR model, but the significance was relatively higher. The responses of the variables to the oil price shocks were similar to those obtained under the VAR model. They concluded that VECM demonstrated a higher significant impact of oil price shocks on the macroeconomic variables compared to the VAR model. Moreover, they emphasised that oil revenue was the main channel through which oil price shocks have impacted the economy.

Employing the VAR model, Farzanegan and Markwardt (2009) investigated the impact of oil price changes on some macroeconomic variables over the period 1975:q2 – 2006:q4, through three transmission mechanisms namely, supply side, demand side and terms of trade. They reported the effect of the oil price shocks during the period 1989:q1 – 2006:q4 and compared the outcomes of their analysis to those of the period before 1989. They used asymmetric definition of the oil price as suggested by Mork (1989). They reported that real exchange rate, the real GDP per capita, inflation and real import had responded positively to the increase in oil price. However, the decrease in oil price had a negative impact on the real GDP per capita, real exchange rate, real import and real government expenditure. Interestingly, the inflation rate response was again positive, similar to the effect of positive oil price change. The latter effect on the inflation rate was attributed to the increase of the money supply to finance budget deficit when oil price drop. Accordingly, they confirmed that Iranian economy had been impacted through supply-side effect, demand side effect and terms of trade.

Olusegun (2008) investigated the impact of oil price shocks in Nigeria over the period 1970 – 2005, employing a VAR model. Seven macroeconomic variable were included in the VAR model, namely, consumer price index (CPI), real government current expenditure, real government capital expenditure, gross domestic product (GDP), real money supply, real oil revenues and real oil price. The forecast error variance decomposition analysis showed that oil price shocks were significantly responsible for the variation in oil revenues and GDP. However, real oil price shocks accounted for minimal effects on the other variables. For example, the real oil price shock was, on average, responsible for 3.3 per cent, 1.9 per cent and 2.1 per cent of the variation in real money supply, consumer price index and government current expenditure, respectively. The impact of oil price shocks on oil revenue was in line with findings obtained in Kuwait by Eltony and Al-Awadi (2001), but contradicted the findings related to the effect on real government current and development expenditure.

Aliyu (2009) investigated the effect of oil price shocks on the GDP growth in Nigeria, using monthly data from January 1980 to December 2007. He employed the VAR model with linear and non-linear specifications of oil prices following Hamilton (1996), Lee et al. (1995) and Mork (1989) measures. The multivariate Granger causality test suggested that net oil price increase and asymmetric oil price decrease, but not the linear and the asymmetric oil price increase, had significantly impacted economic activities in Nigeria. Moreover, the accumulated impulse response functions for the linear specification showed that oil price shocks positively influenced real GDP growth. Furthermore, the response of real GDP growth rate to the net oil price specification was positive in the first eighteen months and became negative thereafter. The negative effect of Nigeria real GDP growth might be attributed to counter negative effect of increasing fuel import bill as the country suffered from low refining capacity that hinder it to meet the domestic fuel consumption. For the asymmetric specification, the accumulative response of the real GDP growth was positive for oil price increase, while it was negative for price decrease. He claimed that the increase in oil price affected real GDP growth positively, while a decrease affected it negatively. However, the positive increase outweighed the negative effect of oil price drop. Interestingly, he found that oil price shock depreciated the exchange rate. This unexpected result explained by embarking of Nigeria in deregulating the foreign exchange market as part of its Structural Adjustment Programme (SAP). On the other hand, the variance decomposition analysis showed that all oil price shocks, except the linear specification, was substantially responsible for the variation in real GDP growth. He concluded that the magnitude of the effect was greater in the case of an increase in oil price than that of decrease. Accordingly, he confirmed the existence of the asymmetric effect of oil price shocks on the real GDP growth rate.

Gunu and Kilishi (2010) studied the impact of oil price shocks on the Nigerian economy, using four macroeconomic variables (real Gross Domestic Product, unemployment arte, consumer price index and money supply) under the VAR framework. They found that oil price shock Granger cause real GDP growth at 10 per cent level of significance. According to their VAR estimates oil price shock had a positive effect on real GDP growth and a negative impact on unemployment rate and money supply. Impulse response function showed that oil price shock negatively influenced money supply and unemployment rate. Impact on Consumer Price Index (CPI) was insignificant, claiming that oil price was not included in the calculation of the CPI in Nigeria. This study suffered from a technical shortfall. They used pairwise Granger causality test, which normally used in the bivariate models, but not in the multivariate models. Despite that, the influence of oil price on the money supply was contradicting other researchers' findings in oil exporting developing countries, including previous studies carried out in this country itself (Mehrara and Mohaghegh, 2011; Farzanegan and Markwardt, 2009; Olusegun, 2008)

Lorde et al. (2009) examined the impact of oil price fluctuations on Trinidad and Tobago from 1966 to 2005 using the Vector Error Correction Model (VECM). Their model comprised of the following variables: Gross Domestic Product, government revenue, government consumption, gross investment, net exports and the level of prices. They employed linear and volatility oil price specifications. Based on the impulse response functions, oil price increase found to have a positive effect on the government revenue, gross investment, net export (for the first two years), government consumption and average prices, while the output response was negative only for the first two years. The negative response of the output was explained by the fears of investors from the uncertainty environment brought up by the sudden increase in oil price, which postponed their decision to invest. They explained the negative impact of net exports on the ground of appreciation of the exchange rate, which drive imports to increase and reduce non-oil exports. On the other hand, the response of the macroeconomic variables to the oil price volatility was smaller compared to increase in oil price. Their variance decomposition analysis confirmed the results of impulse response function.

In studying the oil price and the macroeconomy relationship in Tunisia over the period 1993: q1-2007: q3, Jbir and Zouri-Ghorbel (2009) employed the VAR model with six variables (real oil price, government expenditure, real effective exchange rate, inflation rate and industrial production index). Using linear and non-linear oil price specification, they found indirect effect of the oil price changes on the macroeconomic variables in general. However, they reported a significant impact on the government spending. This mainly attributed to the subsidy policy adopted by the government during the period under study. On the other hand, they stated that the effect of all price specification was almost the same, thus they argued that the relationship between oil price and the macroeconomic variable was not asymmetric.

Berument et al. (2010) examined the effect of oil price shocks on some of the Middle East and North Africa countries over the period 1952-2005 using SVAR model. They found that oil price shocks have a positive impact on GDP growth of the following countries: United Arab Emirates (UAE), Syria, Qatar, Oman, Libya, Kuwait, Iraq, Iran and Algeria. They also claimed that in oil exporting countries, output increase in association with the oil price shocks regardless of the source of the shocks, whether it is oil supply shock or oil demand shock.

In an attempt to assess the impact of price shocks on some oil-exporting African countries, Iwayemi and Fowowe (2011a) examined the effects of oil price shocks on selected African oil exporting countries (Egypt, Algeria, Libya and Nigeria), using five variables VAR model, over the period 1970 to 2006. The five macroeconomic variables were consumer price index, inflation rate, gross domestic product deflator, real gross domestic product growth rate, industrial value added growth rate, and growth fixed capital formation growth rate. They used linear oil price specification proposed by Bachmeier (2008)[1] in addition to three non-linear oil price specification proposed by Mork (1989) and oil volatility suggested by Lee et al. (1995). They further defined the oil price specification of Lee et al (1995) as follows: oil volatility for all oil shocks, negative volatility and positive volatility oil shocks. For Algeria, all oil price measures Granger caused the real gross domestic product growth rate, except negative oil shock of Mork (1989). The impulse response functions showed that the initial response of gross domestic product deflator and the consumer price index to oil price volatility, increase and decrease in oil price were positive. However, the initial response of the real gross domestic product growth rate and industrial value added were negative. For Egypt, all oil price measures did not Granger cause consumer price index, real gross domestic product growth rate and the industrial value added. On the other hand, the response function showed that all oil price shocks specifications had resulted in negative effects on consumer price index and real gross domestic product growth rate, with exception of negative volatility measure. With regard to Libya, oil price shocks Granger caused consumer price index in the short run, while other macroeconomic variables did not exhibit significant causality with oil price shocks.

[1] Bachmeier (2008) defines linear specification as per centage change in the nominal crude oil price.

The impulse response functions depicted that real gross product growth rate responded positively to the two of the oil price specifications. Other variables showed a volatile response to oil price shocks. For Nigeria, oil price shock Granger cause consumer price index and gross domestic product deflator in the short run. The impulse response function revealed that the initial response consumer price index and industrial value added to oil price volatility measures influence was positive. Surprisingly, the real gross domestic product growth rate response was negative to oil price increase and positive to decrease. They explained this counter intuitive behaviour of gross domestic product in oil producing country by the expansionary policy during oil price boom and contractionary fiscal policy during oil bust periods. These results on Nigeria and Libya seem to be contradicting the behaviour of the GDP response in oil producing countries. Although they came up with justification for that, this might be attributed to the high dependency on imports. That is, increases in oil price inflate the import bill, which in turn affect the GDP negatively through the trade balance (net exports). Interestingly, in another similar study using the same approach to assess the impact of oil price shock on the macroeconomic variables in Nigeria, they reported that the oil price shock had no effects on the GDP growth and the real exchange rates (Iwayemi and Fowowe, 2011b). This could be attributed to the employment of different data frequency, time frame and oil price specifications. However, the impact on exchange rate was not in line with those results obtained by Olomola and Adejumo (2006), who studied the impact of oil price shocks on Nigerian economy over the period 1970 – 2003, using linear oil price specification.

Iwayemi and Fowowe (2011b) examined the effect of oil price shocks on selected macroeconomic variables in Nigeria, using quarterly data from 1985:q1 to 2007:q4, employing a VAR model. They used three specifications, of the oil price shocks, namely, net oil price increase proposed by Hamilton (1996), positive and negative real oil price shocks introduced by Mork (1989), and oil price volatility proposed by Lee et al. (1995) to test their effects on the real gross domestic product growth, real exchange rate, government expenditure, inflation rate, and net export. The unit root tests showed that the time series were integrated at different orders; therefore, he decided not to conduct an integration test. Furthermore, they used unrestricted VAR model at level following Hamilton (1994) and Farzanegan and Markwardt (2009). Their results from Granger causality test showed insignificant effect of positive real oil price, net oil price increase and volatility measure on real Gross Domestic Product (GDP) growth rate, government expenditure, the real exchange rate and inflation rate. However, they claimed that their results confirmed those of Hooker (1996) and Hamilton (1996) in the United States economy. They also found oil price shocks significantly Granger caused the net exports. On the other hand, negative oil price shocks Granger caused the real GDP growth rate and the real exchange rate. The impulse response functions of shock to the linear oil price measure showed a negative response of the real GDP growth rate. This result is not in line with similar studies carried out in oil producing countries (Ebrahim and Mohammad, 2012). For the real exchange rate, net export, inflation rate and government expenditure the initial response was positive and negative thereafter. They also observed that inflation was increased as a response to the decrease in oil price. With regard to one unit shock to the net oil price increase, real GDP growth retarded, inflation significantly declines, net exports significantly increased, and government exhibited positive response. Interestingly, the responses macroeconomic variables to the different asymmetric measure were to great extend similar. The response of the real GDP was negative, while others variable responded positively. On the other side of the coin, the variance decomposition analysis suggested that oil price shocks accounted for small portion of variations in macroeconomic variables. It is worth mentioning that the unexpected behaviour of the inflation rate when oil price decreases was explained by the higher dependency on the imported oil refined products in the Nigerian economy. According to Chuku, et al. (2011) Nigeria used to import more than 89 per cent of its refined oil product’s needs.

Employing a panel VAR model, Mehrara and Mohaghegh (2011) studied macroeconomic dynamics in twenty oil exporting countries, twelve OPEC countries in addition to eight non-OPEC countries over the period 1985 to 2009. They tested four macroeconomic variables, namely oil price, money supply, consumer price index, and economic output, applying Impulse Response Function and Variance Decomposition Analysis. They claimed that oil price shock positively and significantly influences consumer price index. Likewise, shock to money supply resulted in a significant positive effect on consumer price index. Their variance composition confirmed importance of money supply in consumer price movements as it contributes by more than 38 per cent of the variations. The dynamic response functions depicted that oil price and monetary shock had appositive effect on real GDP growth. This research concluded that the oil price shocks affected economic output, money supply and consumer price index. However, they emphasised that the money supply had a greater influence on the other macroeconomic variables. In other words, oil price shocks transmitted to the economy through the money supply channel.

Ahamed and Wadud (2011) examined the effect of oil price uncertainty on the Malaysian economy and monetary response over the period 1986-2009, using monthly data and employing structural VAR model. They used two oil price measures: conditional oil price volatility estimated by the Exponential Generalized Autoregressive Conditional Heteroscedasticity model introduced by Nelson (1991) and net oil price increase proposed by Hamilton (1996). The model included six variables, namely, three months Treasury bill rate, consumer price index, industrial production index, net oil price increase, oil price volatility, federal Fund rate, and the exchange rate (Malaysian currency against US dollar). The dynamic impulse response functions based on the shock to oil price volatility cause industrial output to decline for the first three months. They stated that uncertainty reduced investment and thus the aggregate output. This result was consistent with those of Ferderer (1996), who claimed that oil volatility, is more important than oil price changes in explaining the relationship between oil price shocks and economic activities. Moreover, the response of the consumer price index to one standard shock to oil price volatility was significantly negative. Also, the monetary response opts to reduce the interest rate to avoid adverse effect on industrial production. On the other hand, one standard deviation shock to net oil price increase (Hamilton, 1996) resulted in an increase of industrial production for the three months. The monetary policy responded to shock in net oil price increase by increasing the Treasury bill to control inflationary effects on the economy. Further, the exchange rate responded positively to net oil price increase shock. Finally, the variance decomposition analysis suggested that oil price volatility was responsible of substantial variations in the macroeconomic variable compare to net oil price increase measure. To sum up, the findings of the oil price shocks based on the conditional volatility showed a significant negative response of industrial production and consumer price index, while no effect was observed on the interest and the exchange rates. On the other hand, the impact of oil price shocks based on the Hamilton (1996) revealed that industrial production, consumer price index, Treasury bill rate, and the exchange rate have increased. Despite the contradiction in the results obtained from using different oil price measures, the authors left them unexplained and without proposing policies that need to be put in place to waiver such negative effects.

Bouchaour and Al-Zeaud (2012) examined the impact of oil price fluctuations on five macrocosmic variables in Algeria (real gross domestic product, unemployment rate, inflation rate, real exchange rate, money supply) for the period 1980 to 2011. The estimates of the Vector Error Correction Model (VECM) results depicted that the coefficients of oil showed significant positive impact on the inflation rate and significant negative effect on the real exchange rate. However, the coefficients of the oil price in the real GDP, unemployment and money equation were found to be positive but not significant. The variance decomposition analysis suggested that shock to oil price responsible of significant variations in real GDP growth rate, unemployment rate, inflation rate and real exchange rate in the long run, but not the short run. However, oil price accounted for more the 61 per cent to changes in money supply from the first year. Turning to the impulse response functions, oil price shock positively affected money supply and real GDP growth rate, unemployment and inflation rate. The response of the real exchange rate to oil price shock was negative. They concluded that oil price shocks did not have significant impact on the majority of the macroeconomic variables in the short run. In the long-run oil price affected the real GDP and inflation rates positively. On the other hand, oil price shocks negatively impacted the real effective exchange rate. Interestingly, oil price shocks had no positive effect on the money supply, which was inconsistent with other results obtained from similar study in the oil exporting countries (Omojolaibi, 2013). They further proposed and emphasised the importance of diversifying the economy and using oil revenues to develop other economic sectors to minimize the over reliance on the oil sector and to cater for the negative impact of oil price shocks.

Ebrahim and Mohammad (2012) studied the impact of oil price and oil revenues fluctuation on some macroeconomic variables in Iran, using quarterly data for the period 1990:q2 to 2008:q3, employing a Structural VAR model. They used asymmetric price specification proposed by Lee et al. (1995). That is, differentiate between the positive and negative oil price and revenues shocks. Their results showed that increase in oil price influences the GDP growth, inflation rate, government capital expenditure and government current expenditure to increase. However, negative shock to oil prices and revenues showed to have shrunk the GDP growth, decreased inflation rate, and reduced both government capital expenditure and current expenditure.

Omojolaibi (2013) investigated the effect of the oil price volatility on the macroeconomic performance in Nigeria, using quarterly data over the period 1985: q1 to 2010: q4, employing four macroeconomic variables (oil price, money supply, real GDP growth rate, consumer price index) structural VAR model. The accumulated Impulse Response functions depicted that consumer price index responded positively and significantly to money supply shocks. Similar to Mehrara and Mohaghegh (2011), money supply found to have a greater influence in consumer price index, while oil shocks had a negligible effect on consumer price index. The response of real GDP growth and money supply to shock in oil price was positive. The variance decomposition analysis suggested that an increase in oil price had a significant positive impact on the GDP growth, money supply and insignificant effect on the CPI. He also found that the money supply was the main driving force of fluctuations in the other macroeconomic variables. He concluded that the money supply was the key channel through which oil price volatility affected the Nigerian economy. This result corroborated those obtained by Mehrara and Mohaghegh (2011). He further claimed that domestic monetary policy rather than the oil price shocks to be blamed for the increase in the level of prices in Nigeria.

Oriakhi and Iyoha (2013) examined the impact of the oil price volatility on the Nigerian macroeconomy during the period 1970 to 2010. Using quarterly data and employing seven macroeconomic variables VAR model. They claimed that oil price volatility had a significant direct effect on the inflation, the real government expenditure and the real exchange rate, while influenced the real money supply, real import and the real GDP growth indirectly, notably through real government expenditure.

Mehsen and Nooshin (2013) explored the response of some macroeconomic variables to oil price shocks in Iran. They employed structural VAR model, using monthly data over the period 2000-2011. Their findings were based on the impulse response and variance decomposition analysis. Their results suggested that an increase in oil price had a positive impact on the real GDP growth, consumer price index, real money supply, stock price, while negatively impacted the exchange rate on the short run rather than the long run. However, the response of the macroeconomic variables to the decrease in oil price was mixed. The response of the Growth Domestic Product growth, exchange rate and stock price to decrease in oil price was negative and statistically significant. While the response of the consumer price index and the money supply to negative oil price shock was positive. This unexpected response was explained by the fact that during the oil price decrease, the government encountered huge deficit in the public budget. To finance this deficit, the government issued government bonds and borrowed from the central bank. In the two scenarios the money supply and the consumer price index had increased. The findings of this research were in line with those of Farzanegan and Markwardt (2009). One the other hand, the variance decomposition analysis showed that increase in oil prices responsible of substantial variations in the consumer price index and money supply, while decrease in oil prices accounted for significant variance of the stock price and Gross Domestic Product.

Binuomote and Odeniyi (2013) investigated the impact of crude oil price on the agricultural productivity, using annual data over the period 1981-2010 in Nigeria, employing co-integration and error correction model. Their finding revealed that the oil price increase had a significant negative impact on the agricultural production. This result has been accounted for appreciation of the domestic currency in addition to increase in agricultural production inputs costs e.g. fertilizers.

Abbas and Hassan (2013) examined the effect of oil price fluctuations on the inflation rate in Iran during the period 1960-2010. They used the annual data and employed Johansen cointegration test and error correction model. Their finding revealed that the oil price increase had a significant and long-lasting effect on the inflation rate compared to a decrease in oil price. Their result confirmed the asymmetric effect of oil price shocks on the macroeconomic variables.

Ebaidalla (2014) attempted to examine the effect of the oil price volatility on the Sudanese economy, using the VAR model with quarterly five macroeconomic variables, namely the GDP growth rate, inflation rate, exchange rate, government expenditure, real import, over the period 1999: q4 – 2009. He applied unrestricted VAR model with linear and non-linear oil price specifications as proposed by Hamilton (1983) and Mork (1989), respectively. His findings suggested that oil price volatility had a significant effect on the GDP, inflation and exchange rate. This research suffered from different technical flaws. First, although the research aimed to examine the period 1999: q4 – 2009: q4, it actually used data for the period 2000-008. Second, the quarterly data of the GDP and government expenditure were automatically generated, using frequency adjustment tool available in the EViews software, which was by all means not similar to the real data. Including such automatically adjusted variables in a dynamic system of equations jeopardize the reliability and robustness of the model findings. Thirdly, the research used bivariate Granger causality test, which is not recommended in the multivariate VAR model, as it does not consider the effect of other variables in the model. Instead, the multivariate Granger causality test should be used. Also, Granger causality test should be employed on differenced data rather than on data at level, especially when data is not stationary at level (David and Kerstin, 2013).

In a recent research, Dizaji (2014) studied the impact of oil price shocks on some macroeconomic variables in Iran, using three different VAR models and two sets of time series data. He first analysed the effect of oil price shocks on the government revenues and expenditure over the period 1970-2008, using structural VAR model. According to the variance decomposition analysis, shock in oil prices explained 15 per cent and 38 per cent of the variations in the government revenues in the short and the long terms, respectively. On the other hand, in order to avoid omitted variables bias, he used six variables namely, oil revenues (as a proxy for oil price), total government revenue, government current expenditure, government capital expenditure, money supply and consumer price index (CPI). Secondly, he used quarterly data over the period 1990: q2-2009: q1 and employed unrestricted VAR models and a Vector Error Correction Model (VECM) as well. For the findings of the unrestricted VAR model, in the long run, oil revenues accounted for almost 40 per cent, 6.2 per cent, 1.6 per cent, 2.3 per cent and 2.3 per cent of the variations in the total government revenues, current expenditure, capital expenditure, money supply and CPI, respectively. The impulse response function findings suggested that oil revenues had significant positive impact on the total revenue. The effect on the other variables was marginally positive. On the other hand, the results from the VECM showed that the effect of oil revenues on the other macroeconomic variables had become more prominent in the long run. For example, oil revenues accounted for approximately 50 per cent, 8 per cent, 9 per cent, 12 per cent and 9 per cent of the variation in the total revenues, government expenditure, capital expenditure, money supply and the consumer price index, respectively. His results were difficult to compare with those obtained by Farzanegan and Markwardt (2009) because of using different model specification, sample period and variables.

Omojolaibi and Egwaikhide (2014) assessed the response of the economic activities in some African oil exporting countries (Angola, Libya, Egypt, Nigeria and Algeria), employing a panel VAR model and using quarterly data for the period 1990: q1 to 2010: q4. Their model included four macroeconomic variables, namely, fiscal deficit, money supply, gross investment and real Gross Domestic Product (GDP). Based on the impulse response function, they found that oil price volatility significantly and positively influences the fiscal deficit, while significantly and negatively influences the money supply. However, the response of the other macroeconomic variables, the real GDP and gross investment, was insignificant. The Granger causality test results showed that increase in oil price volatility significantly causes fiscal deficit, gross investment and money supply to increase. That is to say, volatility in oil price is the main cause of increasing money supply, fiscal deficit and gross investment in the five selected African countries. The variance decomposition analysis suggested that shock to oil price volatility accounted for 31.5 and 14.8 per cent of the variation in the real GDP growth in Angola and Nigeria, respectively.

Furthermore, oil price volatility responsible for 28.7 and 41.8 per cent of the variance of the fiscal deficit in Algeria and Libya, respectively. Furthermore, increase on oil volatility contributed by 19.3 per cent of the variation in the gross investment in Libya and 12 per cent of the variation in the money supply in Egypt. On the other hand, they reported that fiscal deficit seems to be the main channel through which oil price volatility influence Libya economies. However, Angola and Nigeria were influenced through the real GDP, while Egypt was influenced through the monetary supply channel.

Benhabib et al. (2014) studied the relationship between the oil price shock and the nominal exchange rate in Algeria, using monthly data over the period 2003 to 2013 and applying the VAR model. Their impulse response function results showed that oil price increase had a negative impact on the nominal exchange rate, in other words, oil price increase lead to depreciation on Algerian exchange rate, which was not in line with the established evidences in other oil exporting countries (Adeniyi et al., 2012).

Mendoza and Vera (2010) examined the response of the GDP growth to oil price shocks in Venezuela over the period 1984:1 to 2008:3, using different oil price specifications proposed by Hamilton (2003), Mork (19898) and Lee et al. (1995). Their results suggested that an increase in oil prices using the above mentioned three specifications had a significant positive effect on the GDP growth rate, while the decrease in oil prices had less effect on the GDP growth, which further confirmed the well-documented asymmetric effect of oil price shocks on the economic output.

Allegret et al. (2014) examined the effect of oil price shock on the current account balance in twenty-seven oil exporting countries, covering the OPEC and non-OPEC countries, using annual data over the period 1980-2010. Based on their results that have been obtained from the estimating panel smooth transition regression model, the effect of oil price fluctuations on the current account balance of each oil-exporting country depended on the level of its financial deepness. They concluded that the effect of oil price fluctuation was positive in oil exporting countries with more than 25 per cent financial deepening ratio. The financial deepening can be obtained by dividing the money supply over the GDP. They further classified the oil exporting countries to three groups based on the ratio of the financial deepening to assess the effect of oil price fluctuation on the current account balance. Accordingly, countries with financial deepening ratio of less than 25 per cent were sensitive to oil price changes, countries with the ratio from 23.3 per cent to 28.3 per cent have a weaker response to oil price, and finally, countries with financial deepening ratio above 43.85 encounter limited effects of the oil price changes on their current account balances. Sudan was classified as an oil exporting country with financial deepening ratio less than 25 per cent.

Mehrara and Sarem (2009) investigated the response of the output growth rate to oil price shocks in the Kingdom of Saudi Arabia, Iran and Indonesia, using annual data from 1970 to 2005, employing cointegration, error correction technique and Granger causality test in the context of the bivariate regression model. They used different oil price shock specifications, namely, log difference of the nominal oil price proposed by Hamilton (2003), increase and decrease in oil prices as introduced by Mork (1989), oil price volatility proposed by Lee et al. (1995) and net oil price increase introduced by Hamilton (1996). Their results showed that the decrease in oil price significantly affected output in Iran and Saudi Arabia. The effect of the oil price shock was found to be symmetric, confirming the higher degree of dependency in oil exporting countries on oil and less diversified economic base. However, in the case of Indonesia, the effect of oil price shocks on output was neutral; this was attributable to the adoption of prudent macroeconomic management policies and diversification of its economic base. They concluded that the relationship between the macroeconomic variables and the oil price shocks depend on the economic policies that influence it.

Chuku (2012) examined the impact of oil price shocks on the Nigerian economy using quarterly data over the period 1970:q1- 2008:q4. He used linear and non-linear price measures in the context of the structural VAR model. He primarily focused on the effects of oil price shocks on the supply side (output), real balance (money supply) and inflation. Based on the linear oil price specification, the impulse response results showed that oil price shocks affect output and the money supply positively. On the other hand, interest rate showed positive response in the first ten periods and negative thereafter, while the response of the inflation was not clear as it evolved around the zero line. Turn to the results from using asymmetric oil price specification proposed by Mork (1989), the response as a result of oil price increase was similar to the results obtained from the linear model. Interestingly, the response of the output to oil price decrease was positive, while interest rate, inflation and money supply showed an insignificant response. He concluded by stating that these results could have been different if important fiscal variables were included in the model. This research suffered from having a hypothetical frequency of two variables, namely the output gap and the oil price. This was attributable to transforming the annual data to a quarterly frequency using a mathematical approach (cubic spline approach), which in reality the value of these data might be different. Therefore, the obtained results have to be verified.

Katsuya (2012) studied the effect of oil price volatility on selected macroeconomic variables in Russia. He used quarterly three variables VEC model, covering the period 1995: q1 – 2009: q3. His results showed that an increase in oil prices caused GDP growth and inflation rates to increase, and exchange rate to appreciate. However, decrease of oil price was found to have a negative impact on GDP growth rate, positive effect on the inflation rate and caused the exchange rate to depreciate.

Korhonen and Ledyaeva (2010) examined the effect of oil price shocks on the economic growth of oil exporting and oil importing countries, employing simultaneous equations developed by Abeyysinghe (2001), and using quarterly data from 1995:q1 to 2006:q3. Their results suggested that Russia had experienced a positive effect on GDP growth rate as a result of oil price increase. The impulse response function showed that the cumulative response of real GDP growth rate to 50 per cent increase in oil price resulted in 6.8 and 6.0 percentage points increase in the short and long terms, respectively. They also found that Russia had indirectly negatively affected as its trading partners suffered from the oil price increase. However, the indirect negative effects were smaller compared to the gain from the increase in oil prices.

Almulali and Che Sab (2013) investigated the effect of oil revenues on the economic activities in the OPEC countries (United Arab Emirates, Venezuela, Algeria, Angola, Bahrain, Ecuador, Islamic Republic of Iran, Kuwait, Libya, Nigeria, Qatar, and Kingdom of Saudi Arabia). They used panel model comprised of seven variables, namely GDP, domestic investment, gross domestic savings, government expenditure, consumer price index (CPI), real exchange rate, oil export value as a proxy of oil revenues, and current account balance. Their results showed that oil revenues had significant positive impact on the GDP, investment, government expenditure, exchange rate and current account balance, but had a significant negative effect on the consumer price index and domestic savings.

Youngho et al. (2011) investigated the impact of oil price fluctuations on selected Asian countries. They adopted VEC model with quarterly data over the span of 1990: q1-2010: q3 and 1991: q1-2010: q2 for Indonesia and Malaysia, respectively. Their results showed that increase in oil prices had a significant positive effect on the GDP growth in both countries. However, the impact on the inflation rate was somewhat marginal and statistically insignificant. The small effect on inflation rate was attributed to the domestic pricing policy, which aims at stabilizing the general price level in the economy.

4.3.2 Importing countries

Dawson (2003) studied the impact of oil prices on the exchange rate of the Dominican Republic, applying multivariate regression model on monthly time series data covering the period August 1991 to October 2002. The main finding was that the increase in oil price caused the exchange rate to depreciate against the US dollar. This in turn worsened the trade balance as the Republic of Dominican was a net oil importer.

Weiqi et al. (2010) examined the effect of oil price shocks on the Chinese economy during the period 1998 – 2008, using the SVAR model. They found net that the oil price increase had a negative effect on the output, investment and positive effects on the inflation rate and interest rate as well. Although the research aimed at examining the asymmetric effect following Hamilton (1996), it did not reflect the effects of oil price decrease on the Chinese economy. Likewise, Zhang (2011) investigated the effect of oil price fluctuation on four macroeconomic variables in the Chinese economy, using monthly data over the period 1999:10 - 2008:10. On the basis of the VECM, oil price increase had negatively affected the economic output and money supply, while positively influenced the consumer price index.

Prasad et al. (2007) employed a VAR model to study the effect of the oil price increase on the Fiji Islands. They found that the oil price increase positively affected the GDP growth rate. The result was inconsistent with the findings of similar studies in the oil-importing countries, which had experienced a negative effect on their GDP growth rate as a result of oil price increases. They justified their results on the grounds that the Fiji's GDP did not reach its full potential output; therefore, it was growing despite the increase in oil prices.

Sulaiman (2010) studied the effect of oil price volatility on the export earnings in Pakistani economy; using annual data cover the period 1975 to 2008 and employing the VECM. His research revealed that the oil price increase had a negative effect on the export earnings, the balance of trade and inflation rate. Similar negative effect of oil price shocks on trade balance was observed in Singapore (Le and Chang, 2013).

Cunado and Perez de Gracia (2005) investigated the relation between the oil price shocks and economic activities in six Asian countries during the period 1975:q1 to 2002:q2, employing cointegration and Granger causality test. They used different price specifications for both real prices in the US dollars and in local currency. Their findings showed that the impact is greater on the economic activities when domestic real oil price was used. They pointed out that oil price increase Granger cause the GDP growth in Thailand, South Korea and Japan, while the impact of oil price increase on inflation rate was significant in the six countries. They further emphasised that the asymmetric relationship between the oil price shock and inflation exist in Japan, Malaysia, South Korea and Thailand, while the asymmetric effect of the oil price shock on the GDP growth only found in the case of South Korea.

Jimmy and Jan (2012) used VAR, VECM and panel regressive model to explore the impact of oil price shocks on the economic activities in some Asian countries (Hong Kong, Taiwan, South Korea and Singapore). Their results suggested that the real GDP growth rate was not significantly affected by the oil price shocks in all countries under study, while the unemployment and consumer price index are significantly influenced. Their result regarding the effect of oil price shock on the real GDP was not in line with other studies findings that were carried out in importing countries. This result was quite sceptical, as unemployment was highly affected by the oil price shocks, which considered as a proxy indicator of output performance. The unexpected result might be attributed to applying pairwise Granger causality test to a multiple regression model.

Roseline, Esman and Isaac (2013) examined the effect of oil price shocks on both overall inflation rate, and non-fuel non-food inflation rate in Kenya using quarterly data over the period 1996:q1- 2011:q4, employing Granger causality test and structural VAR model.

They found that the oil price shock had a significant impact on both measures of inflation rates. Moreover, they revealed that the oil price shock immediately depreciates the exchange rate. The results obtained from impulse response function confirm those of Granger test.

Ahmad and Ali (2012) examined the effect of oil price shocks on four Asian oil importing economies (Bangladesh, Sri Lanka, India and Pakistan), using annual data from the period 1985 to 2010 and applying linear regression model. Their results showed that oil price increase lead to a surge in the GDP growth rate, exchange rate and foreign direct investment in the countries under study. However, the inflation response to the oil price increase in India was found to be negative, while the response was positive in the other countries. These results seem to be unreliable as researchers use a very simple regression method which was unable to capture the dynamic relationship between the oil price changes and the macroeconomic variables. This was clear from having conflicting results that were not established in other oil-importing countries.

Chen et al. (2016) investigated the impact of China's crude oil imports, its share in the world crude oil consumption, supply from Oil Producing and Exporting Countries (OPEC) and speculation on world crude oil prices. Similar to Kaufmann (2011), the crude oil inventory was used as a proxy indicator for speculation. They used SVAR model with monthly time series data covering the period 1997: 1 to 2012: 1. The empirical results suggested that the cumulated response of the world crude oil price to China's crude oil consumption was insignificant. However, OPEC supply and speculation influenced world crude oil prices positively and statistically significant in the short run. For the robustness of the results, they tested the period 2003: 1 to 2008: 12 (world crude oil price crisis) and 2009: 1 to 2012: 1 (post crisis period). They found that there was no significant difference between the findings obtained from the entire sample period and the two sub-samples, with exception of the effect of china's crude oil consumption became significant. They concluded that speculation and OPEC supply were the main factors that caused world crude oil price to surge.

2.4 Transmission channels of oil shocks

Misati et al. (2013) identifys three transmission channels of the oil price shocks to the economic activity. These are supply side, demand side and terms of trade. The supply side effect could be explained by increasing the cost of production inputs, which in turn reduce output. The demand side effect works through decreasing the purchasing power of households, thus the aggregate demand falls. Finally, the terms of trade effect are manifested in an increase of the import cost, especially for the net oil importing economies. To explain the inverse response of the U.S. economic activity to the oil price shocks, number of channels were identified (Brown and Yucel, 2002). First, the classic supply-side effect, which increases production cost and accordingly retards output. Moreover, as productivity decreases, unemployment increase and inflation rate as well. Second, the income transfers and demand side effect channel. Through this channel money transfers from the oil importing countries to the oil exporting countries. The increase of foreign exchange resources in the oil exporting countries leads to an increase in consumer demand for goods and services, while in oil importing countries reduces their consuming spending and result in a slowdown of the economic growth. The net effect is that world supply savings increase and interest rate drop, which in turn stimulate investment. The investment offset the consumption reduction in oil importing countries leaving the aggregate demand unchanged. However, if the prices in oil importing countries is sticky downward, fall in consumption will be greater than increase in investment, thus the end result is slowdown of economic growth worldwide. In this respect, Horwich and Weimer (1984) claim that the net effect is mild as fiscal and monetary policies can stimulate the demand in the oil importing countries. The third channel is the real balance effect, which could be illustrated by the increase in money demand as oil price increase. Accordingly, the interest rate surges to curtail the money supply in the economy. As a sequence of the interest increase, investment reduces and output declines as well. Finally, the response of the monetary policies to price shocks, this channel shows how the monetary authority reacts to the oil price increase or decrease, if the monetary authority intends to maintain the nominal GDP growth rate, the inflation will be increased. However, if contractionary policy is adopted as a result of oil price increase, output will be reduced. In this respect, some researchers claim that contractionary monetary policy is responsible for retarding aggregate economic activities when oil prices go up (Bernanke et al., 1997; Bohi, 1991).

Bataa (2010) highlight six transmission channels through which oil price shocks impact the macroeconomy. First, the supply shock which could be interpreted through the production function. If oil price increases, producers tend to reduce the utilization of oil, thus leading to negative short-term effect on the output. Second, the real balance effect, this channel is better explained through increasing of heating bills and goods that are produced using oil products. As oil price increases consumers seek to balance their budget by increasing demand for money, this in turn leads to an increase of interest rate, thus retards investment and the output. Third, monetary policy response, this simply reflects the response of the monetary authorities to an increase of oil price by boosting interest rate, which again slows down the economic performance. Fourth, income transfers from oil importers to oil exporters enhance and improve purchasing power and thus increase the aggregate demand. However, if the increase in oil price is persistent, it affects the aggregate demand in oil importing economies. Therefore, the net effect depends on the rate of recycling of the excess money received by the oil exporters in the global economy. Fifth, adjustment cost, it is generally high in the multi-sector economies to move capital and labour between sectors as a result of changing in the oil prices. Therefore, the capital and labour in the affected sector is most likely to be idle waiting conditions to recover instead of moving out of the sector. The ultimate effect is low output performance. Finally, uncertainty effect, this channel explains the behaviour of firms and individuals regarding their consumption behaviour. When oil price increase consumers tend to postpone the investment decision, hence it holds back the economic output. Similar to this classification of transmission mechanisms have been suggested by Cologni and Manera (2008).

According to Chuku (2010), oil price shock affects economic activities through six channels, four of them similar to those proposed by Brown and Yucel (2002). The six channels are supply-side effect, wealth transfer effect, monetary policy, real sector adjustment, real balance and finally the uncertainty effect. However, Chuku adds new transmission channels, which are real sector adjustment and uncertainty effect. An increase in oil price induces firms to change the combination of production inputs such as capital and labour. Shift from intensive energy machine to lesser consuming ones and moving of labours from the sector that have been affected by the oil price increase to other sectors or might enforce them to be unemployed for some time till conditions improve. This effect results in slowing down the output and increase the unemployment rates. Whereas, the uncertainty effect could be explained in terms of delaying spending by consumers or borrowing from the commercial banks to sustain the same level of consumption.

Again, Weiqi *et al.* (2010) follow the same classification of Brown and Yucel (2002) to define the transmission channels of oil price shocks. However, there are some differences in the name of some transmission channels, for example, instead of uncertainty effect and income transfers; they used unexpected effect and wealth transfer effect, respectively. However, the interpretation of both channels is not changed. They also added inflation effect. According to them, the six transmission channels are supply-side effect, wealth transfer effect, inflation effects, real balance effect, sector adjustment and unexpected effect.

According to Lescaroux and Mignon (2008) claim that the mechanisms of passing through the effect of oil price shocks into macroeconomic activities are classified into two demand and supply side effects. The demand side effect occurs as a result of the transfer of wealth from an oil importer to oil exporter countries, when the oil price goes up, and as a shift in the terms of trade. On the supply side effect, an increase in oil prices invites firms to increase prices of their products to compensate losses in profits or reduces their production. They further suggest that oil price shocks have direct and indirect impacts. General prices increase immediately as a result of the surge in oil prices, then the second round effect occurs when labour ask for a wage increase to compensate the losses in their real wages. However, after 2000, the effects have been weakened due to the quality and credibility of the monetary policies, wages are no longer inflationary adjusted and finally the high competition between firms necessitate firms to minimize their profit rather than passing high energy prices to consumers. They claim that the main transmission channels whereby oil price shocks pass through to economic activities have been under investigation for quite a long period. Though there are substantial studies that are carried out to examine the mechanisms through which oil price shocks influence economic activities, but these are still far from reaching an agreement on them. This statement in not accurate because it is clear from above-mentioned studies that there is consensus on the mechanisms of passing through of the effect of oil shocks to the economic activities. However, the differences are confined to the interpretation and to a lesser extent, to the name of the transmission channels.

2.5 General remarks on the literature

The impact of oil price shocks on macroeconomic variables are to a great extent established in the literature, especially in the developed economies. However, further research needs to be carried out to establish conclusive and clear cut relationships in the developing economies. From the above literature review, it is clear that there are some differences in the outcomes of those studies, which might be attributed to the following reasons:

1. Using stationary versus non-stationary data in the analysis: some researchers had run the VAR model with time series that are not stationary, while others used only time series that proved not to have a unit root.
2. Reporting different type of analysis (Granger causality test, Impulse Response Functions and Forecasting variance decomposition analysis): some researchers used to compare findings of similar studies, but without considering the type of the test that was employed.
3. Using different approaches: researchers had used different methods to analysis the relationship between oil shocks and macroeconomic variables. For instance, (Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH), linear regression, Dynamic Stochastic General Equilibrium (DSGE), structural VAR model, unrestricted VAR model, etc. The factors included in these approaches are certainly different, which raise questions of model identification and misspecification.
4. Classification of countries (oil exporters and oil importers): this is very important as each category has economic characteristics, which do not exist in the other group. Therefore, reporting similarities in results between these different groups are not justifiable.
5. Neglecting fiscal and monetary policies effects: the effect of oil price shocks on the different economic policy environment is misleading, as the counter monetary policies or fiscal policies (e.g. oil price subsidies, oil stabilization fund and rising interest rate) might alter the results. Therefore, giving no attention to these differences will result in meaningless comparisons.
6. Developing and developed countries classification (economic structure): This classification is important as each group has a different level of economic activities. The structure of the economy itself is different in a manner that the composition of

the GDP is different, and pattern of energy consumption (energy intensity) is not similar as well.

7. Using different time spans and frequencies: some researchers used different time frame, which gave unique results when compared to another study that covered longer or less period. Moreover, using different frequencies of the time series had their effect on the outcome of the study. For example, some studies use monthly time series data, while other studies use quarterly and annual time series data.
8. Type of data used in the analysis (real, nominal and percentage change): using different forms of variables will give different findings. Thus, variables used in the model should be checked before making any comparison between studies.
9. Classification of the country regarding oil production: some countries have a unique situation because they are an oil exporter and at the same time oil importer. This uniqueness exists in Nigeria due to its low refinery capacity to meet the domestic demand for oil refined products.
10. Oil price specifications (volatility, net oil price, negative and positive prices, linear): before the 1980s, most of the studies used linear specification, however these oil price specifications failed to stablish the relationship between the oil price shocks and the GNP in the United States. In order to re-establish the relationship different oil price specifications were employed. Accordingly, a researcher has to consider these different specifications when comparing its results to other findings of the studies.
11. The contradiction of terminologies (positive and negative oil price and its effects): some studies use positive oil price shock as an increase of oil price, while others define it as oil price decrease. Some studies report a positive impact on the real exchange rate as appreciation, while other reports it as depreciation. This might be attributed to the definition of real exchange rate by each researcher. Therefore, comparing the effect on real exchange rate should be done with this in mind.

2.6 Summary

In a nut shell, the impact of the oil price shocks on the macroeconomic activities has been relatively well identified and explained in the literature. In general, net oil exporters were found to have positive effects on their economies when oil price went up, whereas net oil importers suffered. On the contrary, net oil importing countries benefitted from a drop in oil prices and their counterparts witnessed negative economic impact. These findings do not hold true all the time due to differences in the development stages, economic structure and counter monetary and fiscal policies to oil price shocks. In some cases, trading of other commodities between net oil exporters and importer relatively offset or mitigate the adverse effects of oil price shocks. However, some variations in the researchers' findings might be attributed to numerous factors, among which oil price specifications, type of data and using different timeframes. Surprisingly, some researchers compared their results, which had been obtained from studies that were carried out in oil exporting developing countries with finding of similar studies conducted in oil importing developed countries. On the other hand, six transmission mechanisms of oil price shock to the economy have been identified in the literature with some differences in the name of the channel and minor variances with regard to their interpretation. However, in developing countries other channel were acknowledged such as money supply and government expenditure. From the above literature it turns out that Sudan has not been comprehensively studied. Also, all studies have used different types econometric models and no attempts were made to use mixed method design. Therefore, this research will attempt to contribute towards filling these gaps.

Chapter three: Overview of Sudan Oil Industry and Economy

3.1 Introduction

In this chapter a historical background on the evolution of the oil sector and the associated oil production activities are thoroughly covered. It also gives an overview of the macroeconomic performance during the period 2000 - 2011. In doing so, it analyses the performance of the public budget, balance of payment, external debt position and the behaviour of selected macroeconomic variables. Finally, a brief review of the post sample period is highlighted, that is, the period after the secession of the South Sudan from Sudan in July 2011.

3.2 General background

Sudan is located in the northeast of Africa and occupies an area of 2.5 million square kilometres. It is bordered by Egypt and Libya to the north and northwest; the Republic of the Central Africa and Chad to the west; Uganda, Democratic Republic of Congo, Kenya to the south and south-west; finally, Eritrea and Ethiopia to the east (Mohsin, 2002). Its geographic climate extends from arid desert in the north, with exceptions along the River Nile, to Savannah in the central regions and tropical woodlands in the south. The administrative structure of the country is composed of 25 states. Sudan witnessed one of the longest civil war in Africa, which lasted for almost 50 years, with some intermittent years of peace in between 1972 to 1983. In 2005, the Comprehensive Peace Agreement (CPA) had been concluded and declaring a new era of peace and development in Sudan.

According to the last national census, which was carried out in 2008, the total population was estimated at 39.2 million, with a growth rate of 3 per cent, of which approximately 70 per cent live in rural areas, while the remainder lives in the urban areas (Central Bureau of Statistics, 2009). Almost 46 per cent of the population live below the poverty line. Since the advent of oil exploration in the last quarter of 1999, Sudan has achieved remarkable growth in its GDP. The GDP increased from approximately US$ 10 billion in

1999 to almost US$ 53 billion in 2008 (World Bank, 2009). The economic structure of the country has changed from being principally reliant on agricultural sector as the main driver of economic growth to the oil sector. However, the agricultural sector still accommodates the majority of the labour force. The service and industrial sectors have grown in tandem with the development of the oil sector. Although the infrastructure has been improved, it is not sufficient to serve such a large country and mitigate the sense of marginalisation among under-developed states.

3.3 Oil sector

3.3.1 Management of the oil Sector

The Ministry of Petroleum in coordination with the Ministry of Finance and National Economy regulates the oil sector, primarily through the Sudanese Petroleum Corporation, which is a public government institution. There are also other government-owned companies working in the areas of oil exploration, production, distribution, refining and other oil related services (Energy Information Administration, 2014). The Ministry of Petroleum setup the general oil sector policies and gives licenses for exploration and production. It also oversees the implementation processes of the Exploration and Production Sharing Agreements (EPSAs). These tasks are undertaken by a number of technical departments within the Ministry of Petroleum. In order to tackle the issue of environmental damage that is generally associated with oil production, the Ministry established a specialized department to set up the prerequisite measures for environmentally safe oil projects to mitigate any negative impacts on local people living around the oil fields or on the environment in general. The equity share of the government in all oil blocks is held by the National Petroleum Company (Sudapet), which is the technical arm of the Sudanese Petroleum Corporation. Sudapet owns shares in oil block licenses ranging from 5 per cent to 30 per cent (World Bank, 2009). It is worth noting that the oil sector is dominated by the Asian companies, in addition to some companies from the region.

3.3.1 Pricing of domestic crude oil and refined products

With regard to pricing of domestic crude oil and refined products, the government (Ministry of Finance and National Economy) sells its share of the crude oil to the Sudanese Petroleum Corporation, as mentioned earlier a government owned institution, at a fixed price far lower than that of the world market. For example, Nile Blend crude oil, which is high quality crude oil is sold at U$$ 49, while a lower quality crude of Fulla Blend is sold at US$ 38 as at 2006. In turn, the Sudanese Petroleum Corporation refines the crude oil in Al-Jali Refinery at the capital, Khartoum, which is a joint venture project between the Chinese National Company and the Sudanese Petroleum Corporation. Refined products are sold to local oil distributing companies (both private and public) at prices regulated by the Ministry of Finance and National Economy (Laura, 2014). It is clear that the government was heavily subsidizing the crude oil and its products. For instance, when the crude oil prices were above US$ 100 in 2008, its price in the domestic market was 50 per cent lower.

3.3.2 Oil exploration

The story of the oil exploration process goes back to 1959, when an Italian company AGIB and British company BP started their operation in the Red Sea area. In 1974, Chevron Company was awarded a license by the government for oil exploration in the Red Sea area. It carried out some studies such as aero-magnetic and gravity surveys. Its exploration was not successful and only resulted in a discovery of dry and condensate gas wells, which were not commercially viable to be extracted. In the same year, Chevron signed a Production Sharing Contract (PSC) to start oil exploration in the central and South Sudan (Muglad basin). Their exploration operations in these areas brought about the first discovery of oil in the country. Furthermore, in 1981 and 1982 Chevron claimed new discoveries of oil fields in Adaryale and Heglig, which are located in the Upper Nile and South Kordofan States, respectively. As a result of the continued fighting in South Sudan, the company suspended all its operations in 1983. Later on, its concession area was divided by the government into smaller units. However, due to political reasons, Chevron sold out its rights in 1992 (European Coalition and Oil in Sudan, 2008). From 1995 onwards Asian companies began to play an increasing pivotal role in the oil exploration operations in the country, especially after the US economic sanction which has been imposed in 1997.

3.3.3 Oil reserves

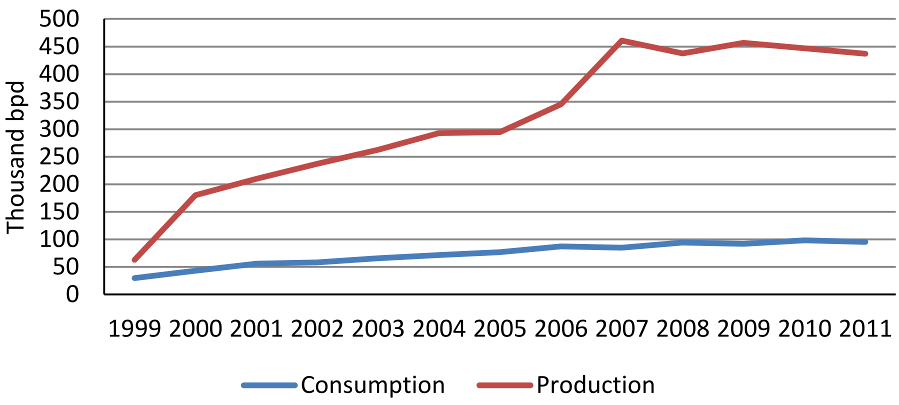
There were different estimates for Sudan's oil reserve. For example, on January 2011, Oil and Gas Journal (OGL) estimated Sudan's proved oil reserves at five billion barrels compared to a previous estimate of 563 million barrels in 2006 (Energy Information Administration, 2012). BP Statistical Review (2012) puts crude oil reserve estimates as high as 6.7 billion barrels as of the end of 2010 (BP, 2012). These two estimates show some degree of uncertainty of proved oil reserves. On the other hand, according to the International Monetary Fund (IMF, 2010), Sudan's proved crude oil reserves are limited and the government could continue to produce oil for 25-30 years in the future, based on the current rate of production (Ali et al., 2010). It is worth noting that the bulk of reserves is positioned in the Melut and Muglad basins (Energy Information Administration, 2014).

3.3.4 Oil production

As a result of civil war, oil exploration processes were limited to the western and south-central parts of Sudan. The government has not used open bid-rounds in allocating petroleum licenses due to the difficulties caused by the conflict. As an alternative, the government directly negotiated with companies that were willing to undertake the work, and ready to operate in Sudan without constraints from US and its allies. Accordingly, companies have signed an Exploration and Production Sharing Agreement (EPSA) with the government for oil blocks concession. The duration of the EPSA contract is 25 years with eligibility for 5-year extension. According to EPSA the, companies receive up to 40% of the crude oil production to cover their exploration, development and production costs (cost oil), while the remaining 60% is shared between the government and companies based on the volume of the production of crude oil. For production to 25 thousand barrel a day, government and companies' shares are 60 per cent and 40 per cent, respectively. Between 25 and 50 thousand barrel a day, government and companies' shares are 70 per cent and 30 per cent, respectively. Finally, for production greater than the 50 thousand barrels a day, government and companies' shares 80 per cent and 20 per cent, respectively (Sidahmed, 2014).

The geological data that have been left by Chevron helped the new international Asian companies to launch their drilling operations soon after signing their contracts. As a result of that Sudan started producing oil in early 1990s with modest rates of production, which gradually began to increase thereafter. The first oil shipment was exported in the third quarter of 1999, after construction of the export pipeline, which links oil producing fields to the Port of Sudan on the Red sea. As can be seen from Figure 1, the production reached its peak in 2007 at a production rate of 461 thousand barrels a day and then started to decline in subsequent years. In 2010, Sudan consumed approximately 98 thousand barrels a day and the remaining 367 thousand barrels a day was exported to Asian markets, especially to China, Malaysia, Japan and India (Energy Information Administration, 2014; Sudanese Petroleum Corporation, 2013).

Figure 1. Oil production and consumption

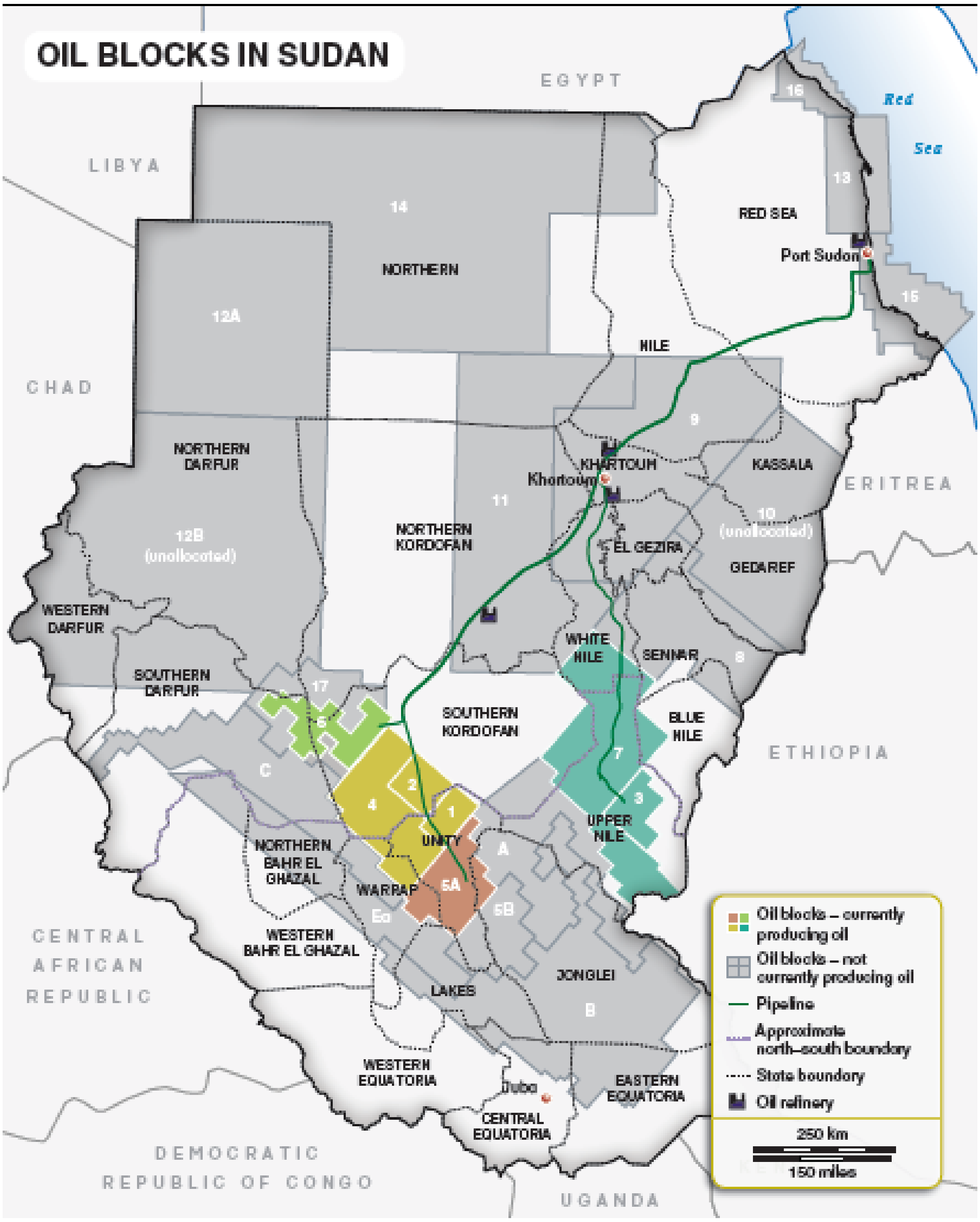


Source: Author's own work adapted from Sudanese Petroleum Corporation statistics

It is worth noting that crude oil is produced from two major oil blocks in addition to output from smaller ones. The major producing fields are in Blocks 1, 2, 4 and Blocks 3 & 7. While the smaller fields found on Block 6, Block 5a. Figure 3 shows the production of each block through the period 2000-2011 (Sudan Petroleum Corporation, 2013). The average block size is around 61,000 square kilometres (European Coalition on Oil in Sudan, 2010). It is worth noting that the number of the drilled oil wells reached 1369 by the end of 2010, but only 1156 wells were active at that time. On the other hand, the oil sector created 4489 jobs, 90.8 per cent were Sudanese and the rest were foreigners (Sidahmed, 2014).

The oil blocks and different consortia are discussed below. Also, Figure 2 shows the location of oil producing blocks, non-producing blocks along with pipeline routes.

Figure 2. Oil blocks in Sudan

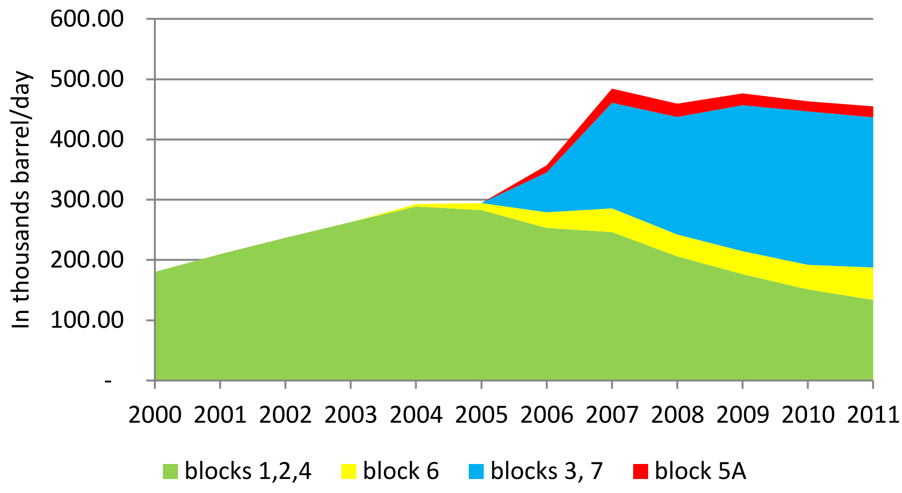


Source: Global Witness Organization

3.3.4.1 Blocks 1, 2 & 4

Blocks 1, 2 and 4 are located in the Mujlad basin and cover an area of 48,000 square kilometres that overlaps the borders of South Kordofan, Unity States and Abyei Region. This area was in dispute for a long time and still the issue is not completely resolved. According to the resolution of the Permanent Court of Arbitration in The Hague, two major oil fields are located in these blocks (namely Heglig and Bamboo) and considered to be part of the North, that is, out of the Abyei region. It is worth noting that Greater Nile Petroleum Operating Company (GNPOC) operates blocks 1, 2, and 4. This consortium comprises of Chinese National Petroleum Company (CNPC), Malaysian Petronas, Indian Oil Natural Gas Corporation (ONGC) and Sudapet with a share contribution of 40 per cent, 30 per cent 25 per cent and 5 per cent, respectively. By the year 1996, development processes of the two main fields (Heglig and Unity) were completed and production was started. Moreover, GNPOC has constructed 1000 mile pipeline linking oil producing fields to the Bashayer terminal, located 15 km south Port Sudan along the Red sea (Energy Information Administration, 2014). In September 1999, the first batch of the Sudanese crude oil exports was from this block (European Coalition on Oil in Sudan, 2010). On the other hand, the average production from Blocks 1, 2, and 4 during the period 2000-2011 amounted to 218.9 thousand barrels a day. This block showed increasing production and reached its peak of 288.8 thousand barrels a day in 2004. After that it started to decline through the rest of the period and the decline expected to continue due to drop of crude oil production from Heglig and Unity fields (Figure 3). However, the production could be increased if the government adopts Enhanced Oil Recovery (EOR) technique to help extract the crude oil trapped in the rock pores. This block produces a crude oil type called Nile blend, which is of medium quality, sweet and with American Petroleum Institute (API) gravity of 34.5 degrees. The Nile blend crude oil type is generally traded at a discount rate of US$ 4 and US$ 1.5 compared to West Texas Intermediate (WTI) and UK Brent blend, respectively (Sidahmed, 2014).

Figure 3. Oil production by block



Source: Author's own work adapted from SPC statistics

3.3.4.2 Blocks 3 and 7

These two blocks are located in the Upper Nile State in the South Sudan, in Melut Basin. Both blocks are operated by Petrodar consortium, which includes CNPC, Petronas, Sudapet, Sinopec and Tri-Ocean Energy of Kuwait with shares of 41 per cent, 40 per cent, 8 per cent, 6 per cent, and 5 per cent, respectively (Sidahmed, 2014). The two main oil fields in these blocks are Adar Yale and Palogue. On the other hand, in November 2005, the CNPC constructed Petrodar pipeline, linking the oil producing fields in these blocks to the marine terminals in Port Sudan. The pipeline has a maximum capacity of 450 thousand barrels a day (Energy Information Administration, 2014). In 2006, the production from these two blocks was almost 66.6 thousand barrels a day of Dar blend crude oil. However, it approximately tripled in the second year and then continued to increase gradually in the subsequent years. As can be seen from Figure 3 the block reached its peak production of 254 thousand barrels a day in 2010. The Dar blend crude oil type is heavy and highly acidic, with API gravity ranges between 28-30 degrees. As a result of the poor quality of crude oil from these blocks, it generally traded at a discount rate to other benchmark crude oil such as Indonesia Minas and UK Brent (Sidahmed, 2014).

3.3.4.3 Block 5a

In April 2005, the government of Sudan contracted White Nile Petroleum Operating Company (WNPOC) to develop oil production in this block. WNPOC is a consortium comprised of three companies Sudapet, Indian ONGC and Malaysian Petronas with equity shares of 8 per cent, 24 per cent and 68 per cent respectively (Sidahmed, 2014). In June 2007, the block started its production with an initial rate of production of 11.9 thousand barrels a day. Although the full capacity of production was estimated at 60 thousand barrels a day, up to 2010 the field production was in the range of 20 to 30 thousand barrels a day (Figure 3). In this block there are two oil producing fields, which are Thar-Jath and Mala. The crude oil from these fields is transported through a 60 miles' pipeline to an existing pump station at Heglig in the south Kordofan State and then from there it transported to the marine terminal in Port Sudan using the GNPOC pipeline. The type of the crude oil produced from this block is heavy with an API of 18-20 degrees (Energy Information Administration, 2014; World Bank, 2009).

3.3.4.4 Block 6

This block is located in the west Kordofan State. In 2004, Petro-energy succeeded to bring online Block 6 (Fula field) at a modest rate of production of 3.4 thousand barrels a day. Petro-energy is a mini consortium comprising two oil companies, CNPC and Sudapet with equity shares of 95 per cent and 5 per cent, respectively. However, the oil production has steadily increased, reaching its peak of 53.9 thousand barrels per day in 2011 (Figure 3). This crude oil is of low quality with an API of 21.6 and it is highly acidic. The production from this block is more likely to increase slightly in the near future due drilling of more wells. The CNPC has constructed a pipeline to transport its crude oil from Fula field to Khartoum refinery for processing as this crude is entirely used for domestic consumption (Energy Information Administration, 2014; European Coalition on Oil in Sudan, 2010).

3.3.4.5 Other Blocks

Block B: This block, spreads over three southern states, namely Warab, Unity and Jonglei. It was licensed to Total, which is a French company. The company has encountered some difficulties due to the continued fighting in the area and licensing problems. Also, exploration operations were suspended as a result of the pulling out of Marathon Oil company from the consortium due to the existing U.S. economic sanctions on Sudan, which were imposed in 1997 (European Coalition on Oil in Sudan, 2010).

Block 5B: This block was initially under exploration by Petronas, ONGC, Sweden Lundin Company and Sudapet with equity shares of 39 per cent, 23.5 per cent, 24.5 per cent and 13 per cent, respectively. It spreads over three states, which are Jonglei, Unity and Lakes. In early 2009, the two biggest shareholders, namely Lundin Company and Indian ONGC have pulled out of this block due to the initial negative drilling results. Nevertheless, in August 2009, the Moldovan Ascom group joined the existing consortium in block 5B (European Coalition on Oil in Sudan, 2010).

Block Ea: This block is located in Warab state covering an area of 48 square kilometres and still under its exploration stage. Star Petroleum Company (Luxembourg) proclaimed in August 2010, that it has been awarded a concession to explore in this block. According, a Production sharing Agreement (PSA) for this block was signed. Star Petroleum has a 75 per cent stake, Sudapet has 20 per cent, and finally 5 per cent is held by the Norwegian Hamla Company (European Coalition on Oil in Sudan, 2010).

3.3.5 Oil infrastructure

3.3.5.1 Refineries

The infrastructure of the oil industry is located in the North, whereas most current proven reserves are located in the South. According to the Energy Information Administration (2014), Sudan has five refineries with a combined refining capacity of 143.7 thousand barrels per day. The Khartoum refinery, which is a joint venture between the CNPC and the government of Sudan, was constructed in 2000 with designing refining capacity of 50 thousand barrels per day. In 2006, its capacity was expanded to 100 thousand barrels per day. This new installed refining capacity allowed for processing of the two types of crude oil, which are the Nile and Fula blends for domestic use as well as export. The construction of the new expansion has converted Sudan from being a net-oil importer to net-oil exporter including export of refined products to neighbouring countries. The second refinery, which was constructed in 1970s is located in Port Sudan, was designed to refine 21.7 thousand barrels a day. This refinery is no longer operating. Also, there are three small refineries in Elobeid in Kordofan state, Shajara in Khartoum state and Abugabra in South Darfur with refining capacity of 10 thousand barrels per day, 10 thousand barrels per day and 2 thousand barrels per day, respectively (Energy Information Administration, 2014).

3.3.5.2 Pipelines

PDOC Pipeline

As can be seen from Table 1 there are four main pipelines namely PDOC, Petro-energy, WNPOC and GNPOC. The length of PDOC pipeline is 850 miles with a diameter of 32 inches. This pipeline transports the crude oil which produced from blocks 3 and 7, which are located in the Upper Nile states in the South Sudan, to Port Sudan on the Red sea. The total cost of its construction was US$ 1.2 billion. Likewise, the Petro-Energy pipeline transports the Fulla crude oil, produced from Block 6 in the west Kordofan state to the Khartoum refinery with a total length of 460 miles and a diameter of 24". The total cost of the construction was US$ 352 million. Furthermore, WNPOC pipeline length is 60 miles and it transports crude oil from Block 5a to an existing pump station at Heglig in the south Kordofan state. Finally, the length of the GNPOC pipeline is 1000 miles with 28 inches' diameter. It transports Nile blend crude oil, produced from blocks 1, 2 and 4 in the South and the West Sudan to Port Sudan on the Red sea. The pipeline's capacity is 450 thousand bpd (Energy Information Administration, 2014; Sudanese Petroleum Corporation, 2013). It is worth noting that the total storage capacity in Bashayer Terminal is approximately 2 million barrels (Sidahmed, 2014).

Table 1. Pipeline information

Operating companies	Origin	Destination	Miles	Cost
PDOC	Block 3 & 7	Bashayer Terminal 2, Port-Sudan	850	US$ 1.2 billion
WNPOC	Block 5a	Heglig facilities	60	n.a
Petro-Energy	Block 6	Khartoum Refinery	460	US$ 352 million
GNPOC	Block 1, 2 & 4	Bashayer Terminal 1, Port-Sudan	1000	US$ 1.2 billion

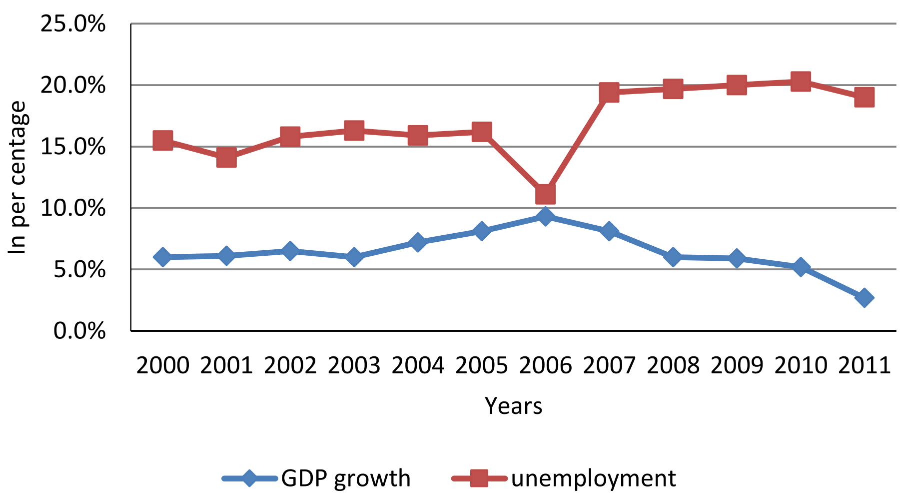
Source: Energy Information Administration, 2014, European Coalition on Oil in Sudan, 2008.

3.4 Macroeconomic stance

3.4.1 Real GDP growth and unemployment rates

The period 2000-2011 witnessed a remarkable increase in Sudan’s real economic growth rate, reaching a peak of 9.3 per cent in 2006 as shown in Figure 4. Throughout the period, 2000 – 2006, a steady growth of the GDP was reported with a slight drop in 2003. The average real GDP growth rate during this period was approximately 8 per cent. From 2007 and thereafter, the GDP growth started declining and reached its lowest rate in 2011. The increase of the real GDP growth rate was due to the advent of oil production and increase in foreign direct investment associated with oil sector activities. During this period, Sudan was classified among the fastest growing economies in the Sub-Saharan Africa (World Bank, 2009). From the economic theory point of view, unemployment moves in the opposite direction to GDP movement. That is, the surge in GDP growth rate reduces the unemployment rate as a better GDP performance creates more job opportunities thus shrinking the level of unemployment in the economy. Apparently from Figure 4, the unemployment rate reached its lowest point in 2006, which in the same year the real GDP rate hit its peak point. However, the general trend of the unemployment rate is shown to be growing. This might be attributed to the characteristics of the oil industry, which is associated with capital intensive rather than labour intensive projects. It also reflects minor spill-over effects on other productive sectors, which in general are more capable of availing new jobs. The overall trend of the GDP growth rate showed that oil revenues received during the first seven years (2000 – 2006) had not been invested in non-oil sectors to sustain the economic growth during the period when prices went down. Also, this may be attributed to increase in current expenditure as a result of expanding government administrative machinery and fulfilling of peace obligations (Comprehensive Peace Agreement, 2005).

Figure 4. Real GDP growth and unemployment rate



Source: Author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000 - 2011.

On the flip side, the GDP per capita increased drastically in nominal and real terms. However, the nominal measure dropped in 2009 and 2011 due to the global financial crisis (Table 2). The average nominal and real GDP per capita through the period 2000-2011 were US$ 1014.4 and US$ 533, respectively. Intuitively, the average GDP per capita over the period 2000-2006 (this period where still development of oil fields and associated facilities were undergoing) is lower than the average over the period 2008-2011 (this period where all oil sector facilities were in place and functioning), which were US$ 501.4 and US$ 699.4 respectively. This was due to the steady increase of GDP growth in the former period and decreasing in the latter. Although this showed an improvement in the general livelihood condition of the population, it did not tell much about the situation in reality due to uneven distribution of incomes. According to the national baseline household survey of 2009, the poverty rate in Sudan is approximately 56 per cent, that is, 56 per cent of the population living under the poverty line (International Monetary Fund, 2013).

Table 2. GDP per capita in US dollars

Year	Nominal	Real (2000 constant)
2000	444.8	444.8
2001	467.8	461.8
2002	513.9	476.0
2003	599.3	498.9
2004	712.8	513.0
2005	861.8	533.5
2006	1119.7	581.9
2007	1423.4	630.3
2008	1653.0	663.0
2009	1596.7	691.3
2010	1928.1	712.6
2011	1866.4	730.7

Source: World Bank databank, 2014

3.3.2 GDP sectors composition

During the period 2000-2011, the agriculture sector, which was once the cornerstone of Sudan's economy started to retreat, while other sectors grew rapidly. Before the advent of oil production and exportation in 1999, the contribution of agriculture, service and industry sectors to the GDP were 49.8 per cent, 34.4 per cent, 15.8 per cent, respectively. With the start of the oil production, the performance of the economy changed dramatically. As shown in Table 3, the contribution of the agriculture sector to the GDP declined to 31.5 per cent, services sector increased to 46.3 per cent and industrial sector increased to 22.2 per cent in 2011. The agricultural sector contribution to GDP started to decline from 2003 to the end of the period, a manifestation of the Dutch disease in the economy[2]. The increasing share of the industrial sector in the GDP was mainly driven by the increase in oil production and prices, but from 2008 its contribution shrank. The share of the services sector in the GDP was fluctuating, however, over the last three years it significantly contributed to the GDP.

Table 3. Main sectors as percentage of the GDP

Year	Agriculture	Industry	Services
2000	42.0%	21.0%	37.0%
2001	45.6%	16.6%	37.8%
2002	46.6%	16.3%	37.1%
2003	45.6%	24.1%	30.3%
2004	44.5%	25.4%	30.1%
2005	39.6%	28.3%	32.1%
2006	39.2%	28.3%	34.5%
2007	36.2%	33.0%	30.8%
2008	35.9%	31.4%	32.7%
2009	30.8%	24.8%	44.4%
2010	31.3%	24.5%	44.2%
2011	31.5%	22.2%	46.3%

Source: author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000-2011.

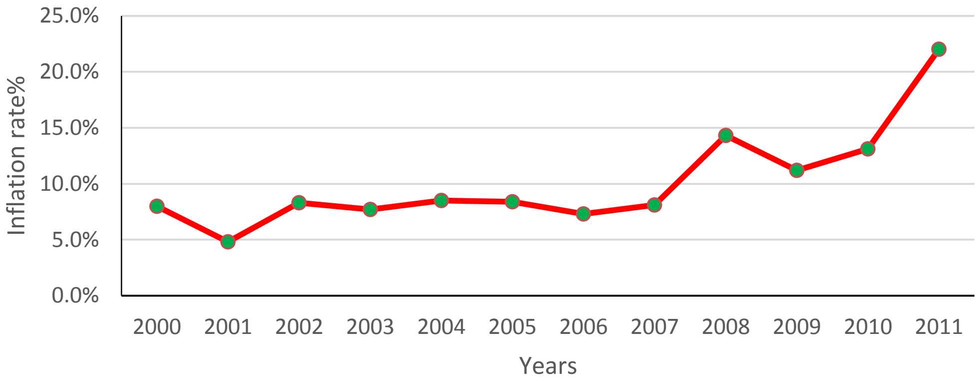
3.3.3 Inflation rates

The government succeeded in curtailing the inflationary pressure on the economy by having an inflation target during the preparation of the annual public budget. It is clear from Figure 5 that the inflation rate was kept approximately in the range of 5-9 per cent

[2] According Pegg (2010), the Dutch disease is an economic phrase coined by economists to refer to the negative impacts that North Sea oil and gas revenues had on the Dutch industrial production in late 1960s.

through 2000-2007. Then it increased in 2008 as a result of a surge in food and oil prices. In 2009, there was a drop in inflation rate due to the global financial crisis and decline of crude oil prices. Again the inflation rate started to climb up in 2010 and 2011, this was mainly attributed to the increase of taxes and increase of money supply in the economy as a result of substantial borrowings from the Central Bank to finance the fiscal deficit.

Figure 5. Inflation rates

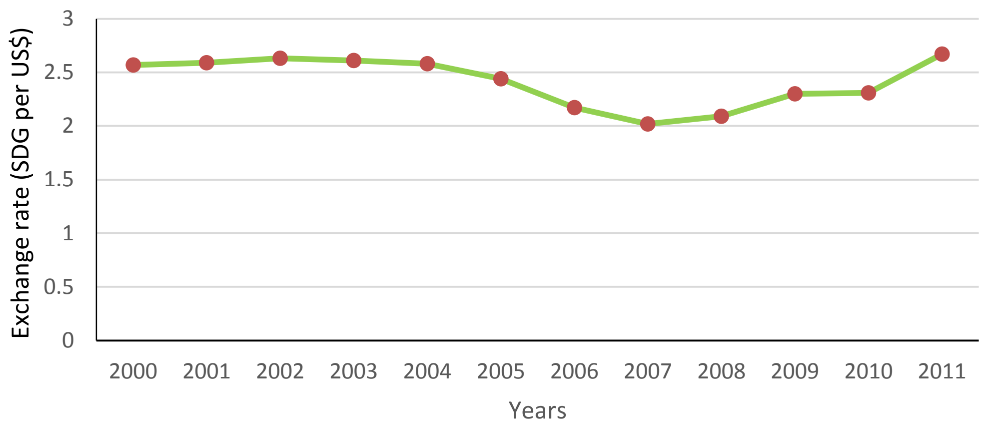


Source: author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000-2011.

3.3.4 Real exchange rate

Interestingly, the exchange rate remained almost unchanged during the first five years 2000-2004 as shown in Figure 6. The government used huge foreign inflows to stabilize the exchange rate. By doing so, the foreign reserved was depleted due to the continuous intervention in the exchange market by the Central Bank to maintain the exchange rate around 2.5 Sudanese pounds (SDG) per United States dollar (US$). However, the exchange rate appreciated by 6 per cent, 12 per cent and 7 per cent in years 2005, 2006 and 2007, respectively. For the rest of the period, the exchange rate showed an upward trend, that is, depreciation of the domestic currency against the US dollar. It is worth noting that the government has adopted a managed-float exchange rate regime since the year 1997 (Khalid, 2012). Generally speaking, the depreciation of the exchange rate in developing countries is considered to be desirable as their exports can compete in the global markets, thus improve the trading account (Abeysinghe and Yeok, 1998).

Figure 6. Real exchange rate

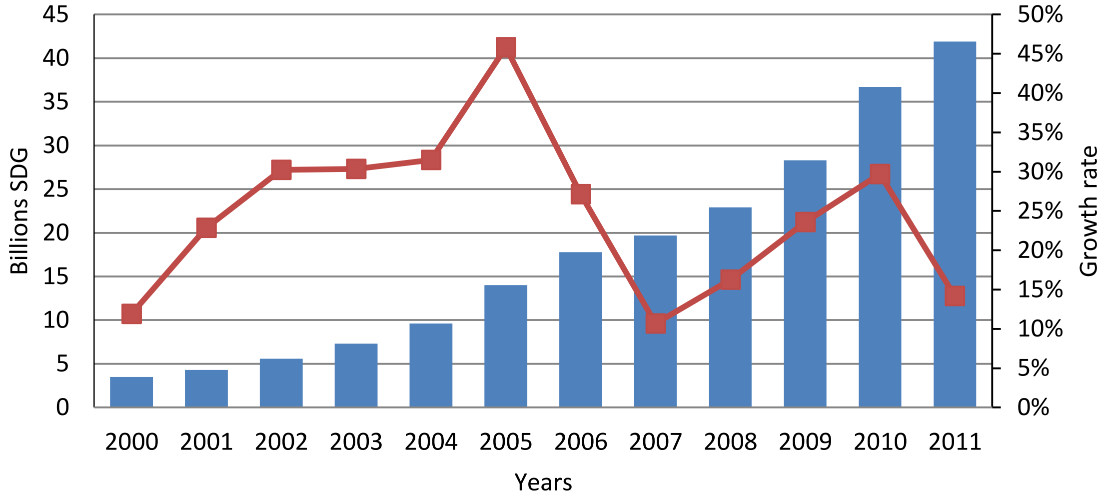


Source: author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000-2011.

3.3.5 Money supply

Figure 7 shows that money supply steadily increased from approximately SDG 4 billion in 2000 to more than SDG 45 billion by the end of year 2011. The growth rate of the money supply, which can be read from the right vertical axis, was increasing at an accelerating rate during the period 2000-2005. However, through the period 2006-2007, the money growth was increasing at a diminishing rate. Again, the growth rate witnessed an upward trend over the period 2008-2010. The increase of money supply was attributed to the increase in government spending and borrowing from the Central Bank to finance the budget deficit. On the other hand, money supply as a percentage of the GDP increased rapidly from 10 per cent in 2000 to 23 per cent by the end of year 2011. This increase of the money supply caused the inflation rate to soar as mentioned earlier.

Figure 7 Growth of money supply

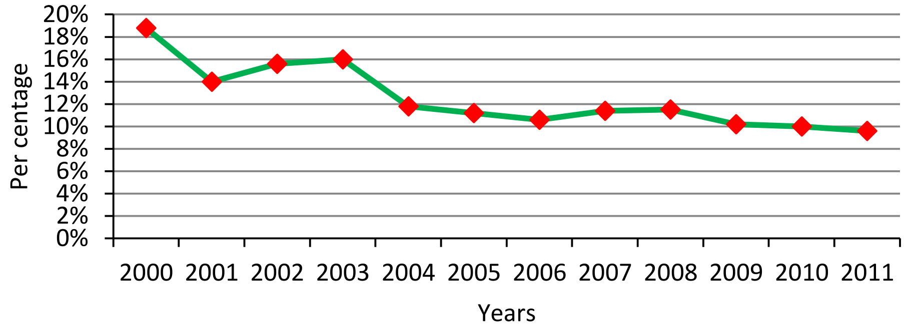


Source: author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000-2011.

3.3.6 Murabaha profit margin rate

Murabaha profit margin rate is a cost of finance used by Islamic financial institutions. The Monetary Authorities use Murabaha profit margin rate as a monetary instrument among others to manage the liquidity in the economy, similar to the traditional interest rate role. However, generally the Central Bank of Sudan announces Murabaha profit margin rate in its annual monetary policy as an indicative percentage and gives the commercial banks room to go over the declared rate. As can be seen from Figure 8, the Murabaha rate (profit margin) is trending downward. It dropped from 18.8 per cent in 2000 to 9.6 per cent in 2011. This also is another evidence of increasing money supply in the economy during the entire period. The low Murabaha profit margin rate encourages borrowing rather than bolstering the saving behaviour of the consumers. However, through the periods 2001-2003 and 2006-2008, it showed a slightly increasing trend.

Figure 8. Murabaha profit margin rate



Source: author's own work adapted from the Central Bank of Sudan, Annual Reports, 2000-2011.

3.5 Public budget

As shown in Table 4, the surge in oil price to over US$145 per barrel in July 2008, contributed to an increase in total government revenues from U$1.3 billion in 2000 to US$11.8 billion in 2008. The portion of oil revenues in the total revenues reached its peak of 65.7 per cent in 2008, with an overall average contribution of 48.6 per cent. In 2009, the total revenues plunged by almost 30 per cent, as a consequence of the global financial crisis. This situation led to a substantial increase in the contribution of the non-oil revenues from 43.3 per cent in 2008 to 51 per cent in 2009. On the other hand, the large increase in revenues coincided with a marked increase in the government expenditure. For example, the total expenditure rose from US$ 1.4 billion in 2000 to approximately US$ 11.2 billion in 2011. It is quite clear that the public spending was biased towards the current expenditure. This was evident from the persistent growth of current expenditure compared to the development expenditure. The average amount of money allocated to the current expenditure was 81.3 per cent of the total public expenditure, while development spending received 18.7 per cent through the entire period. The largest fund allocated to the current and development expenditure was US$ 10.6 and 1.9, respectively. It is apparent that the government had used the revenues generated from the crude oil export proceeds to finance its public current expenditure rather than investing it in development projects (Almosharaf and Tian, 2014). The average fiscal deficit during the period 2000–

2011 amounted to US$ 1.2 billion, which constituted 1.6 per cent of the GDP. The budget deficit jumped from 0.5 per cent of GDP in 2000 to 4.7 per cent in 2011. The fiscal stance worsened after 2008, as a result of a significant plunge in crude oil prices. It is worth noting that the government finances its budget deficit from domestic and foreign sources. On average the domestic finance sources constituted 58.7 per cent, while foreign sources (loans and grants) represented 41.3%. The finance from the domestic sources reached its peak at 78.4 per cent during the global financial crisis in 2009 (Central Bank of Sudan, 2009). Also, the Ministry of Finance introduced new financial instruments such as Government Musharaka Certificate, treasury bonds, etc. in order to finance the deficit from real sources, whilst still borrowing from the Central Bank of Sudan.

Table 4. Public budget by main components, 2000 - 2011 (in billion US$)3

Year	**Total revenue**	Oil revenue	Others	**Total public expenditure**	Recurrent exp.	Development exp.	**Deficit**
2000	**1.31**	0.55	0.76	**1.39**	1.17	0.22	**-0.08**
2001	**1.35**	0.48	0.87	**1.56**	1.30	0.26	**-0.21**
2002	**1.90**	0.77	1.12	**2.03**	1.49	0.54	**-0.13**
2003	**2.72**	1.47	1.25	**2.26**	1.69	0.57	**0.46**
2004	**3.61**	1.60	2.01	**4.21**	3.25	0.96	**-0.60**
2005	**4.87**	2.22	2.65	**5.64**	4.24	1.40	**-0.77**
2006	**7.09**	3.42	3.67	**7.88**	6.02	1.86	**-0.79**
2007	**8.98**	4.91	4.07	**10.30**	8.47	1.83	**-1.32**
2008	**11.81**	7.76	4.05	**11.83**	10.05	1.78	**-0.02**
2009	**8.33**	4.08	4.25	**10.18**	8.80	1.38	**-1.85**
2010	**10.19**	5.23	4.96	**11.98**	10.56	1.42	**-1.79**
2011	**8.05**	4.18	3.87	**11.20**	9.95	1.25	**-3.15**

Source: Department of budget performance, Ministry of Finance and National Economy, Budget Performance Annual reports, 2000-2011.

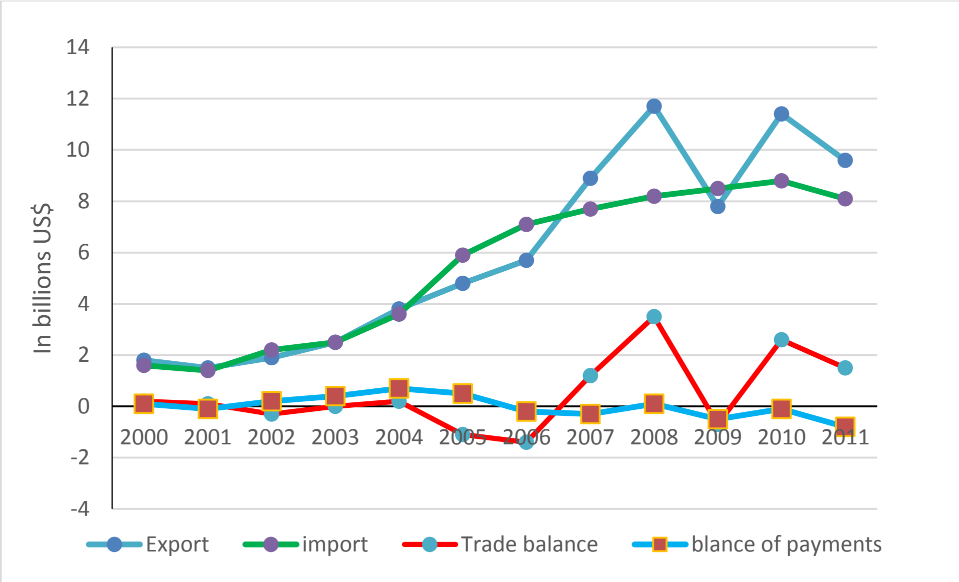
[3] The original data was in Sudanese pound, the author converted them to US$ using the average annual exchange rate.

3.6 External sector

3.6.1 Balance of payment

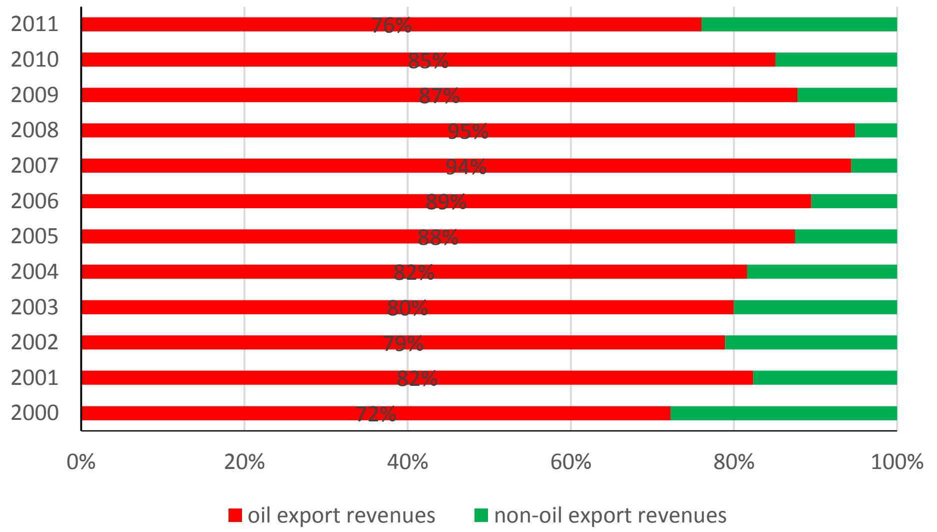
Over the period 2000 – 2011, the overall balance of payments (BoP) was positive in 2000, 2002-2005 and 2008, with an average surplus of US$ 0.6 billion as shown in Figure 9. This was mainly attributed to the increase of oil production, the surge in crude oil prices and increase in Foreign Direct Investment. Since Sudan started exporting its oil, the balance of payments did not suffer from a sharp deficit compared to the period before oil exploration. On the other hand, the trade balance improved and achieved a positive balance favouring Sudan with exceptional performance in 2007, 2008, 2010 and 2011 realizing US$1.2 billion, US$ 3.4 billion, US$ 2.6 billion and US$ 1.5 billion, respectively. The export proceeds have steadily increased throughout the period 2000-2011, but dropped in 2009 as a result of global financial crisis, which caused oil price to plunge. The increase of oil export earnings is acknowledged by the simultaneous increase of import. This has led to a deficit in trade balance in 2002, 2005-2006 and 2009. With regard to the composition of export revenues, oil export contributed on an average 85.3 per cent, reaching a peak of 95 per cent of the total export proceeds in 2008 as shown in Figure 10. Turning to the share of the non-oil exports in the total export proceeds, Figure 10 shows a negative relationship with oil export, that is, an increase of oil export resulted in a decrease in non-oil export revenues. For example, in 2008, the non-oil exports reached its lowest point, while oil exports were at its peak. However, compared to previous years, the non-oil exports dropped drastically at the expense of the oil exports throughout the period of the oil production. This showed that the government was highly reliant on oil export revenues as a main source of foreign exchange. The over-reliance of exhaustible natural resources might result in a devastating negative impact on the entire economy. Therefore, the government needs to diversify its export portfolio and boost the non-oil exports to avoid any unexpected shocks on oil prices and to further enhance the long term economic growth.

Figure 9. Balance of payments and trade



Source: Author's own work adapted from Central Bank of Sudan annual reports (2000-2011)

Figure 10. Composition of the export revenues

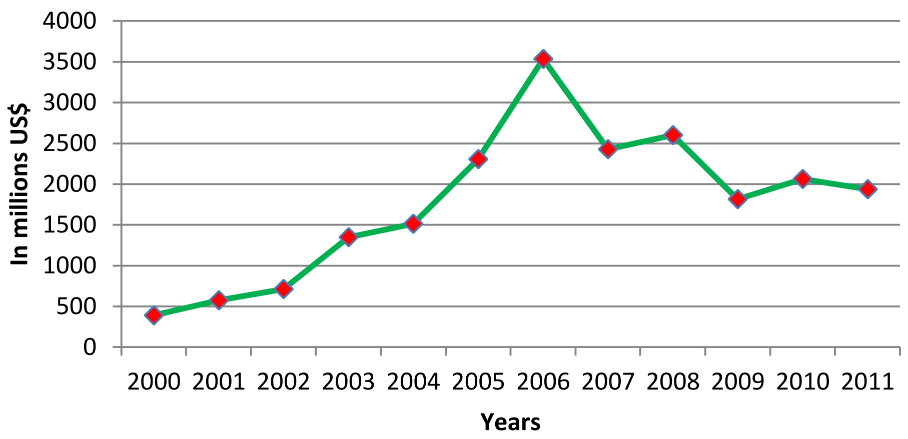


Source: Department of Budget Performance, Ministry of Finance and National Economy, Budget Performance Annual Reports, 2000-2011.

3.6.2 Foreign Direct Investment (FDI)

As can be seen from Figure 11, Sudan received huge foreign exchanges in terms of foreign direct investment, which amounted to US$ 5.5 billion in 2006. The majority of the FDI is associated with implementation of oil projects, communication and banking sectors (World Bank, 2009). In 2006, the FDI reached its peak point, when most of the oil projects were completed. From 2006 and thereafter, the general trend of the FDI was diminishing; exceptions were 2008 when crude oil prices reached its highest rate of US$ 145 and in 2010 after the economic recovery from the financial crisis of 2009. The main sources of FDI were Chinese companies, Malaysian natural oil company PETRONAS, Indian Oil Natural Gas Corporation and some Arab companies.

Figure 11. Foreign direct investment



Source: Author's own work adapted from Central Bank of Sudan, Annual Reports, 2000-2011

3.6.3 External debt position

Sudan's external debt grew at an accelerating rate due to the accumulation of the arrears. Currently, Sudan is paying only the critical debt owed to some countries and financial institutions that are still providing loans to the government (for example, the Arab countries, China, India, Malaysia), in addition to token-payments to the World Bank, the International Monetary Fund and the Arab Funds. Table 5 shows that the total external debt jumped by approximately 93.2% in 2011 compared to its value in 2000. This persistent increase was attributable to the accumulation of the penalty interest arrears as a result of not paying interest by its due date. The principal amount of the debt grew substantially, increasing from approximately US$ 10.8 billion in 2000 to US$ 16.3 billion in 2011, that is, an increase of 50.9%. The annual increase of the principal was due to new contracted loans. Although over the period 2000-2011 Sudan has received more than US$ 11.9 billion in crude oil revenues, it continued to borrow from abroad using crude oil as collateral for getting new loans. This situation aggravated the external debt position and jeopardized the economic stability. It is worth noting that on average 14 per cent, 37 per cent, 33 per cent, 13 per cent and 4 per cent of the total debt was owed to multilateral countries, non-Paris Club countries, Paris Club countries, commercial banks and foreign suppliers, respectively. According to the World Bank, the external debt position was unstainable as of the end of 2008. On the other hand, Sudan is eligible for the Highly Indebted Poor Countries (HIPCs) initiative proposed by the international community to help low income countries to resolve their debt issues. Though Sudan is technically eligible for the HIPCs initiative, other political issues hindered the government from enjoying the benefits of this initiative. These political issues could be summarized as follows: (1) Sudan is still on the US list of states that sponsors terrorism (2) American economic sanctions (3) ongoing conflicts in Darfur region, the Blue Nile and South Kordofan states.

Table 5 External debt during the period 2000-2011 (in billion US$)

Particular	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Principal	10.8	10.7	11.9	12.4	12.6	12.5	12.8	13.9	14.5	15.4	15.8	16.3
Interest	4.5	4.3	4.9	5.6	5.6	5.6	4.1	4.5	4.4	3.8	3.9	4.0
Delay interest	5.3	5.7	6.9	7.7	8.6	8.9	11.5	13.5	14.6	16.5	18.2	19.5
Total obligation	20.6	20.7	23.7	25.7	26.8	27.0	28.4	31.9	33.5	35.7	37.9	39.8

Source: Central Bank of Sudan, External Debt Unit, 2000-2011)

3.7 Economic performance post sample period (2012-2014)

After the secession of South Sudan from Sudan, the GDP growth rate dropped to 1.4 per cent in 2012 due to the loss of almost more than 70 per cent of oil producing fields. However, the GDP started to recover gradually in 2013 and 2014, achieving 3.6 per cent and 4.4 per cent growth rates, respectively. This improvement was mainly due to an increase in non-oil exports and gold exports proceed, in addition to foreign inflows from the Transitional Financial Arrangements with the government of South Sudan (Eltahir et al., 2014). In this regard, crude oil export still replenishes the country with foreign inflows. For example, during the period 2012 - 2014, total crude oil exports reached US$ 3.7 billion. Furthermore, gold production partially compensated the loss of oil revenues. It increased from 44.5 tons in 2012 to 73.3 tons in 2014, with total gold export earnings of US$ 2.1 billion (Central Bank of Sudan, 2014). According to the IMF (2013) crude oil production in Sudan stood at 133 thousand barrels per day as of 2012 and is expected to increase to 325 thousand barrels per day by 2017 as new concessions were signed, providing huge incentive to international oil companies for exploration in new areas. In fact, six agreements were signed in 2012 for the following blocks: 18, 15, 14, 12-B, 10, 9 and 8 (Sidahmed, 2014). Due to these positive developments, the balance of payment improved slightly as the deficit shrank from US$ 24.2 million in 2012 to US$ 15.1 million in 2014, thanks to the increase in gold production, agricultural exports and inflows from the Transitional Financial Arrangement with the government of South Sudan (Central Bank of Sudan, 2013, 2014; Eltahir *et al*, 2014). In this context, an agreement between the Government of Sudan and the Government of South Sudan concluded in September 2012 regarding crude oil transportation fees, using north facilities and compensating the government of Sudan for the loss in oil revenues. According to the agreement, the government of South Sudan pays US$ 1.6 as a processing fee for each barrel of crude oil, transportation fees of US$ 8.4 per barrel in GNPOC pipeline and US$ 6.5 in Petrodar pipeline, transit fees of US$ 1.0 per barrel, in addition to transfer of a sum of US$ 3.02 billion to be paid to the Government of Sudan over three years and half (The Agreement, 2012).

With regard to the sectoral contribution to the GDP, the services sector on average contributed almost 48.8% over the period 2012 – 2014. The Industrial sector contribution to GDP increased from 20.4 per cent in 2012 to 24 per cent in 2014 due to the boom in the mining sector (e.g. gold mining).

The public budget has improved slightly, shrinking budget deficit from 6.4 billion Sudanese pounds in 2013 to nearly 4.4 billion in 2014. This resulted in a low rate of borrowing from the Central Bank. To this end, the growth of money supply contracted from 40.2 per cent in 2012 to 17.0 per cent in 2014. Accordingly, the inflation rate declined from 37.1 per cent in 2013 to 25 per cent by the end of 2014 due to fiscal consolidation and monetary disinflationary policies (Central Bank of Sudan, 2012, 2013, 2014).

3.8 Summary

To conclude, oil exploration processes were limited to the western and south-central parts of Sudan due to civil war. Oil productions started in the early 1990s, but oil exports started in late 1999. Since then, oil production has shown an upward trend, reaching approximately 461 thousand barrels per day in 2007. This production is backed by well-established oil infrastructure, including pipelines, central processing units, storage facilities and refineries, which are entirely located in the north. With regard to Sudan's economy, it has witnessed a steady growth since the advent of oil production, thanks to an increase in crude oil production and the associated high oil prices up to mid-2008. Sudan was amongst the fastest growing economies in the Sub-Saharan Africa, achieving GDP growth of 9% on average and ranking third in crude oil production in Sub-Saharan Africa after Nigeria and Angola. At the sectoral level, the contribution of the agriculture sector to the GDP declined, which indicates presence of Dutch disease in the economy. Nevertheless, industrial and services sectors had increased over the study period. The increasing share of the industrial sector in the GDP was driven mainly by the increase in oil production and prices. The inflation rate was relatively stable up to 2007 and then started its upward trend due to the increase of money supply. The exchange rate was relatively stable with an appreciation and depreciation in the few years of the sample period. Murabaha profit margin rate decreased over the sample period. Money supply has shown steady growth during the study period. Also, total government revenues increased dramatically, thanks to crude oil revenues, which contributed on average 48.6% to the government total revenues annually. Likewise, the government spending and the budget deficit increased as well. The overall balance of payments performance has improved as a result of an increase in oil production, the surge in crude oil prices and an increase in FDI inflows. However, Sudan's external debt grew at an accelerated rate due to the accumulation of arrears. The period after the secession of South Sudan from the Government of Sudan witnessed a slowdown in GDP growth, but from 2013, the economy started to recover and achieved a GDP growth of 3.6 per cent up from 1.6 per cent in 2012. Another leap of 4.4 per cent GDP growth rate was recorded in 2014. This improvement can be attributed to the increase in non-oil exports, gold exports proceeds and foreign inflows from the Transitional Financial Arrangements with the government of South Sudan. Some other macroeconomic indicators have also shown a slight improvement.

Chapter four: Anatomy of Crude Oil Price Analysis

4.1 Introduction

In chapter two a brief description of Sudan's economy was provided, including the evolution of the oil sector. This chapter begins with an overview of the world crude oil proven reserves by region over the last fifteen years. Then, a thorough discussion of peak oil theory will be carried out to reflect the different views about the viability of the theory. The chapter then turns to the crude oil market by discussing the world crude oil supply and demand. Next, a brief glimpse of crude oil pricing mechanism is explained, followed by an elaboration of the main factors behind crude oil price fluctuations. Finally, historical crude oil price shocks will be reviewed and discussed. This chapter intends to provide comprehensive overview of oil price changes to help understand the sources and factors that affecting it.

4.2 World proven crude oil reserves

The quantities of crude oil that can be recovered from a specific field depend on the estimated oil reserve. The recoverable oil refers to the quantity of crude oil that can be produced under the current operational and economic conditions. In general oil reserves are classified into three types. Proven reserve, which has a high certainty, ranging between 90 – 95 per cent, that the quantity specified can be recovered. The other types are probable with greater than 50 per cent producible chance and possible reserve with very low certainty ranging between 10 – 20 per cent (Manescu and Nuno, 2015, Speight, 2012).

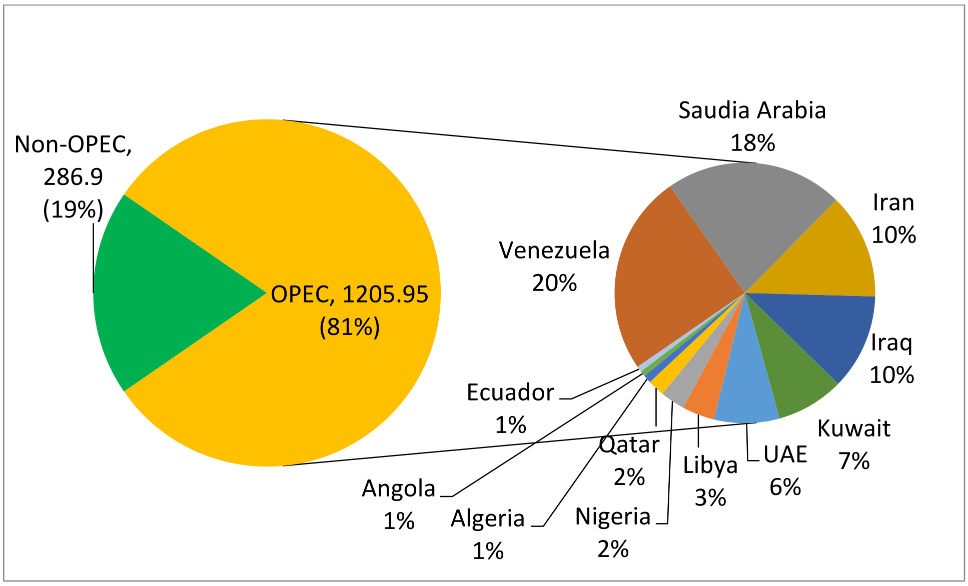
It is clear from Table 6 that over the period 2000 – 2005, the world proven conventional crude oil reserves grew nearly 7.2 per cent, while in the last decade the proven crude oil growth rate was as high as 29.4 per cent. The greatest increase in the proven crude oil reserves was due to an increase in OPEC reserves. North America region witnessed 53 per cent increase in its conventional crude oil reserves. However, the share of this region in the world proven crude oil reserves was as low as 2.7 per cent. With regard to Latin America, an outstanding growth in its proven crude oil reserves was achieved, almost 188.3 per cent contributing by 22.9 per cent in the world proven crude oil reserves. In the Middle East region, 8.1 per cent growth rate was observed over the last decade, contributing 53.7 per cent in the world proven oil reserves. Although Asia and Pacific region recorded 26 per cent increase during the last decade, its share of the world proven oil reserves is very small, almost 0.3 per cent. This was due to the continuous production and lack of new oil explorations. Finally, OPEC countries registered an increase of 30.5 per cent from 2005 to 2014, but their share in the world proven oil reserves was as high as 81 per cent. Figure 12 shows that four OPEC countries (namely Venezuela, Saudi Arabia, Iran and Iraq) hold more than half of OPEC proven crude oil reserves and contribute 46.9 per cent of world proven oil reserves.

Table 6. World proven crude oil reserves by region (billion barrels)

Regions	2000	2005	2014
North America*	30.5	26.6	40.7
Latin America	123.1	118.7	342.2
Eastern Europe	67.2	93.7	119.9
Western Europe	21.1	17.0	11.6
Middle East	694.6	742.7	802.5
Africa	95.5	117.8	127.6
Asia and Pacific	44.4	38.4	48.4
Total world	**1076.4**	**1154.0**	**1492.9**
Of which:			
OPEC	904.3	924.2	1206.0

Note: *nonconventional crude oil is not included.
Sources: OPEC Annual Statistical Bulletins 2000, 2005 and 2015.

Figure 12. OPEC share in the world proven crude oil reserves as of the end of 2014

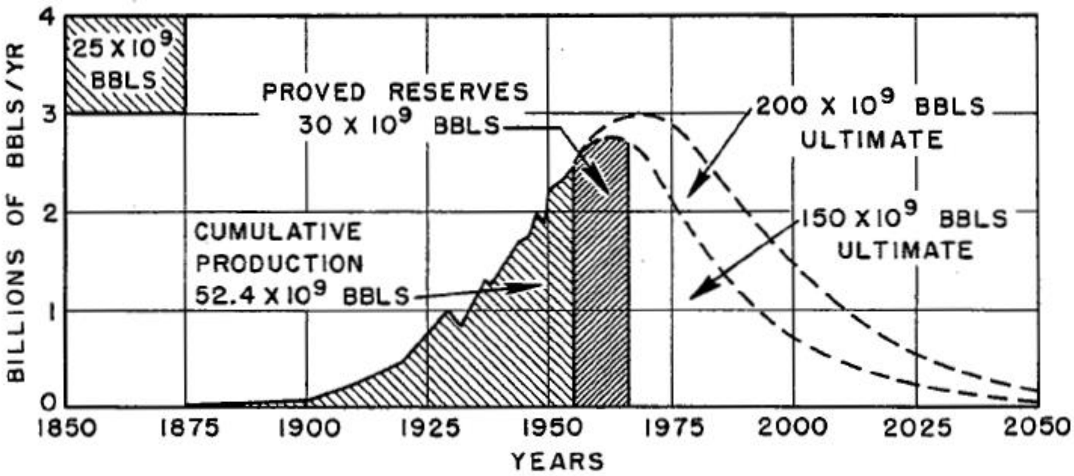


Source: OPEC Annual Statistical Bulletin, 2015.

4.3 Peak oil theory

Oil is the most essential input in modern life. Its importance is not confined to fuelling automobiles, heating our houses and providing energy to the industrial sectors, it also contributes to food security in terms of providing the necessary fertilizers for plants to grow. Having all these in mind and its exhaustibility, researchers started to think of how much of crude oil is left under the ground. In doing so, a geologist from Shell Oil Company, M. King Hubbert in 1956 introduced a theory that explained the trajectory of the exhaustibility of crude oil. This theory is known as "Peak oil theory" (Hubbert, 1956). The concept is that the rate of production in every field or region increases until it reaches the peak point (midpoint of depletion) and then it starts declining. Thus, Hubbert (1956) claimed that the oil production curve follows the bell shape. That is, the curve after the peak point is just a mirror image of the exponential growth before the peak point or the midpoint (Deffeyes, 2001). However, the bell shape has been rebutted by real observations as the peak point might be a plateau and the declining curve has shown gradual pace (Jackson, 2006). Figure 13 shows the hypothetical bell shape as described by Hubbert. The area under the curve reveals the cumulative production over time. Hubbert's curve was based on two assumptions of potentially: 200 billion barrels and 150 billion barrels of ultimate recoverable resources (Deffeyes, 2001). Although Hubbert succeeded in the prediction of the peak production in the United States, his model did not work well in other parts of the world.

Figure 13. US ultimate crude oil production based on assumed initial 150 and 200 billion barrels



Source: Hubbert, 1956.

This theory has received numerous critiques, which can be summarized in the following points (Maugeri, 2004; Speight, 2012):

1. The theory failed to capture the technological advancement that can further increase oil production. For example, using Enhanced Oil Recovery (EOR) technique in existing oil fields, the rate of production might be increased by 30 per cent or even more.
2. Negligence of geopolitical factors that could delay the peak oil. During the upheaval and instability in oil producing countries, the production of oil will be halted.
3. Future oil demand was not considered, which affect the production and decision making in further investment or development of existing oil fields.
4. New discoveries of oil resources have not been calculated in the formula of the peak oil theory. Still, some areas are not entirely explored as the initial estimated oil reserves tend to increase after the start of extraction operations. For instance, in an oil field in California, the oil reserve was estimated at around 54 million barrels,

but after almost 34 years, geologists found that the remaining oil was 54 million barrels, and a few years later the oil production reached 970 million barrels. Another example is the Kashagan field in Kazakhstan. The geologists estimated oil reserves to be in the range of 2 – 4 billion barrels, however, after drilling and appraisal of six wells the estimates were officially declared to be around 13 billion barrels. Other states like Iraq and Saudi Arabia have discovered more than 50 fields, but due to fears of excess supply have opted to postpone production in those new oil fields.

5. All data reported by the companies were not verified by an independent auditor. The accuracy of the size of oil reserves was difficult to assess as no third party verified those estimates (Tsoskounoghou, *et. al*., 2008)
6. Non-conventional oil such as tar-sand in Canada, heavy oil in Russia and Venezuela and shale oil in the US were not included in the model. Furthermore, Russia intentionally does not report its proven oil reserves and consider it a State secret. This makes a forecast of peak production difficult and incorrect, especially when the fabricated oil reserves that have been reported by OPEC countries are considered as well (Chapman, 2012).
7. Generally speaking, OPEC countries tend to increase their estimates to guarantee a high share in the OPEC quota system. That is, oil reserves estimates are inflated by OPEC countries. For example, OPEC members have increased their proved oil reserves by 360 billion barrels over the period 1984 – 2012 (Chapman, 2014). Given the fact that it possesses more than 40 per cent of the global proved oil, the forecast of the peak production is highly likely to be incorrect (Deffeyes, 2001: 149).

Furthermore, development of conventional and non-conventional oil supports the notion that oil production can be increased and the peak oil is not a single point, it is rather an undulating plateau, which might extend to decades before exhibiting a declining trend

(Jackson, 2006). In line with this notion, advanced technology had helped exploration operations in harsh areas such as ultra-deep water and the arctic region (Tsoskounoghou, *et. al.*, 2008)

On the other hand, Meng and Bentley (2008) have criticized Maugeri (2004) arguments of peak oil theory flaw. However, their critique is not convincing and contradicts the current situation in the oil industry. For example, some countries have discovered new oil fields, which had not been known in the past. Also, a number of peak production forecasts have failed to materialize and tend to be incorrect. In this regard, by reviewing the literature, it is clear that there is a lack of consensus among scholars regarding world oil reserves and timing of peak oil. Interestingly, in 1985, Hubbert claimed that world oil production will peak in 1995, but this has proved to be incorrect (Tsoskounoglou *et al.*, 2008). At present, the exact quantity of remaining global oil reserves is unresolved, therefore estimation of peak oil is just a matter of mathematical calculation rather than a reflection of the true situation. This statement is supported by a number of predictions carried out by various institutions and scholars. For example, pessimistic views claimed that the world had reached or will reach its peak production during the period 2005 -2015 (Deffeyes, 2010; Shell, 2008; Simons, 2006; Campbell, 2005; Bakhtiari, 2004). On the flip side, optimistic views projected peak production sometime in the far future and even some scholars think there is no visible peak (Shell, 2013; Maugeri, 2012; IEA, 2010; Jackson, 2006). It is clear that early peak oil supporters tend to use under-estimated data with regard to oil reserves, while late peak oil supporters rely more on over-estimated data. The conclusion that one can understand from the above discussion is that crude oil reserves data is not accurate to help precisely predict the world peak production. Although it is important to know when peak oil will take place in order to help countries to think ahead in a strategic manner for other potential economical alternatives or at least to work together for efficient use of the remaining oil resources, the inconsistency in crude oil reserve information and secrecy in production capacity will make this objective hard to achieve.

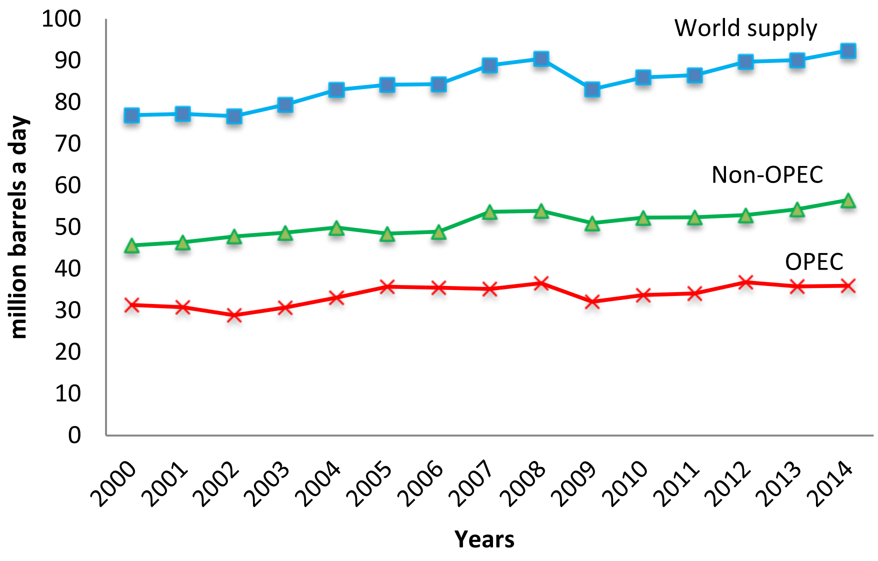
4.4 World crude oil market

4.4.1 Oil production

There are numerous factors that have a pivotal role in determining the exact amount of crude oil to be produced every single day. These factors are of physical, geopolitical, technical and economic nature. Physical factors are related to property of natural resources and its availability and accessibility. The geopolitical factors influence the oil production through either damage of oil facilities or an intentional suspension of pumping of oil to the market, similar to OPEC embargo and the Iraq - Iran War in 1973 and 1990, respectively. There are also technical factors such as Enhanced Oil Recovery (EOR), which is a technique of injecting gas, heated steam and chemical injection to stimulate the oil flow to increase production. This technique has succeeded in increasing oil production in the United States by 30-50 per cent. However, the technique is costly (Speight, 2012). The economic factors are related to the cost of production, using highly advanced technology and the difficulty to get credit to invest in high risk remote areas. For example, shale oil and ultra-deep-water exploration are associated with high capital investment costs.

Figure 14 shows that world crude oil supply steadily increased through the period 2000 – 2009, but witnessed a drop by nearly 4.9 per cent in 2009. This drop is attributed to cut in crude oil production by OPEC countries, crude oil price crash and economic recession following credit crunch. OPEC reduced its production from 36.5 million barrels a day in 2008 to 33 million barrels a day in 2009, a 7.7 per cent reduction. Within OPEC members, Saudi Arabia is playing the role of swing producer due to its huge production capacity. With regard to non-OPEC countries, the general trend of crude oil production has been increasing. However, in the year 2005 a slight drop occurred due to decline of oil production in China and North America, while the drop of 2008 was attributed to decline of oil production in Western Europe and North America (OPEC, 2005; OPEC, 2008).

Figure 14. World oil production (million barrels a day)



Source: OPEC Annual Statistical Bulletins 2003, 2004, 2008, 2010 and 2014.

4.4.2 World Oil demand

It is important for the oil companies to estimate the demand for crude oil to prudently manage their production operations. Pumping more oil than that demanded will cause oil prices to go down, thus discouraging further investment in the oil industry. However, crude oil demand estimation is not an easy task; since various factors influence it, for instance, geographical location, refining capacity, seasonal swings, population, economic activities, transportation, alternative fuels, among others. Despite that the most accurate estimates of crude oil demand are based on the following criteria (Speight, 2012):

1. Refinery output.
2. Refinery throughput.
3. Imported oil product.
4. Changes in oil inventory.

It is worth noting that industrial developed countries (namely OECD countries) accounted for more than 60 per cent of world crude oil consumption in 2000 (Table 7). Therefore, these countries are severely affected during the era of high oil prices or when there is a shortage of oil supply due to geopolitical reasons in oil producing countries. These countries generally show signs of slowdown in economic growth and in energy-intensive sectors as well. Although there are some endeavours to switch from oil to other renewable energy sources demand remain high, with the transport sector alone accounting for nearly 49 per cent of the world oil consumption in 2005 (Speight, 2012).

Table 7. World oil demand (million barrels a day)

	2000	2002	2004	2006	2008	2010	2012	2014
World demand	**76.2**	**77**	**82.28**	**84.9**	**85.62**	**86.7**	**89**	**91.3**
Of which:								
China	4.8	5.3	6.7	7.4	7.9	9.3	10.2	11.1
Japan	5.5	5.3	5.3	5.2	4.8	4.4	4.7	4.3
India	2.2	2.4	2.6	2.7	3.1	3.3	3.7	3.8
Russia	2.5	2.6	2.7	2.7	2.9	2.9	3.1	3.2
Brazil	2.1	2	2.1	2.1	2.5	2.7	2.9	3.2
BRIC	17.1	17.6	19.4	20.1	21.2	22.6	24.6	25.6
OECD	47.8	47.8	48.6	49.6	47.6	46.1	45.9	45.8
Others	11.3	11.6	14.28	15.2	16.82	18	18.5	19.9

Source: OPEC Annual Statistical Bulletins 2003, 2004, 2008, 2010, 2014 and BP Statistical Review, 2015.

The average growth of the world crude oil demand during the last fifteen years was 2.6 per cent. The increase in world demand is driven by developing and emerging countries (Table 7). Brazil, India, China and Russia (BRIC countries) have increased their oil consumption by almost 49.7 per cent over the period 2000 – 2014, with a remarkable demand growth in China. However, developed countries in general have shown a declining trajectory in oil consumption. This might be attributed to efficiency in using energy by way of employing advanced, efficient, low energy consumption technology. For example, oil demand declined from 49.6 million barrels a day in 2006 to 45.8 million barrels a day in 2014, approximately 7.7 per cent drop. However, developed countries' share of the world oil demand has dropped dramatically from more than 60 per cent in 2000 to 50.2 per cent in 2014. In contrast, developing countries' oil demand rose steadily from 11.3 million barrels a day in 2000 to nearly 20 million barrels a day in 2014, with an average growth rate of 5.4 per cent. It is observed that some OPEC countries such as Saudi Arabia have witnessed a remarkable demand growth. This might be attributed to low domestic oil prices, which are generally lower than the international oil prices.

4.4.3 Pricing of crude oil

In the early years of oil exploration, pricing of crude oil was based on the market fundamentals. However, in 1882, the three major international oil companies - Royal Dutch Shell, Standard Oil Company and Anglo-Persian Oil Company – signed an agreement between them to control the crude oil market, avoid collusion, competition and to get the maximum profit from selling out their crude oil. Later, other major oil companies joined the plot, namely Mobil, Chevron, Exxon and Gulf Oil Company (Energy Charter Secretariat, 2007: 76-77). Since then, the seven major companies have become known as the Seven Sisters, which was a kind of oligopoly in the crude oil market. Accordingly, pricing of crude oil before the 1970s was under the control of the seven multinational oil companies (Fattouh, 2007). The Seven Sisters' phrase was coined by Italian scholar Enrico Mattei to refer to the largest seven oil companies in the world at that time[4] (Sampson, 1975). The seven sisters succeeded in stabilizing oil prices and supply because they held concession covering various areas while paying very low royalty to host producing countries. During their era, all crude oil processes from the upstream to downstream were carried out by their affiliates. This situation helped them to keep internal payment transfers low, which led to lower tax intake by the hosting countries. However, this situation was later used against the Seven Sisters by the oil producing countries to force new arrangements to be put in place (Energy Charter Secretariat, 2007: 76-77).

Around this time internal pricing system of the international oil companies coupled with low demand for oil due to recession in Europe and an increase in crude oil production resulted in shrinking the tax revenues received by the oil producing countries. Against these backgrounds and in an endeavour to gain more profit from their resources, the oil

[4] The seven sisters were the Dutch (Shell), the British (BP), the American group (Exxon, Chevron, Texaco, and Mobil) and Gulf.

producing countries thought of forming a cartel. With five states namely, Kuwait, Iran, Saudi Arabia, Venezuela and Iraq, the Oil Petroleum Exporting Countries (OPEC) was founded[5] in September 1960 (Jones, 1988: 222; Energy Charter Secretariat, 2007: 76-77). Algeria, United Arab Emirates, Qatar, Indonesia, Libya and Nigeria had joined the cartel within a few years later (Speight, 2012). Also, during that period, OPEC governments decided to shift from granting concession to the international oil companies towards claiming equity participation, while some members opted right away for nationalization such as Libya, Iraq and Algeria (Fattouh, 2007). In this regard, Yan (2012) claimed that the Seven Sister lost their power in determining the crude oil prices after the oil producing countries started the nationalization campaigns and the establishment of their own national oil companies. In the 1970s a significant change took place when the power of oil pricing came under the control of OPEC. This transformation came as a result of an increase world crude oil demand, which has been mainly met by OPEC countries.

Since the launch of nationalization campaigns of the international companies in the host oil producing countries, government and national companies become key players in the crude oil market. During the period 1970 – 1985, OPEC dominated the crude oil market and had a greater influence in determining oil prices through managing their production. That is, cutting crude oil production when the market was over-supplied through the quota system that has been established within the cartel. Saudi Arabia was playing the role of swing producer within OPEC because of its huge spare capacity. In other words, the OPEC production was based on the market's call on its supply. The market's call is the difference between the world crude oil demand and the non-OPEC production. After calculating the market's call, OPEC sets production quotas for its members (Fattouh, 2007). However, this system collapsed in 1986, when OPEC members did not commit to the agreed quota. At this stage in time, a price war started and crude oil prices dropped to $12 per barrel

[5] OPEC established in September 24, 1960 with objectives of coordinating and unifying petroleum policies in a way that guarantee their interest. Also, is to working together for stabilizing prices in the global oil markets and minimizing harmful fluctuations.

(Speight, 2012). In addition, in the early 1980s, OPEC oil pricing power was weakened by the increase of oil production from non-OPEC countries, namely the Soviet Union, Mexico and the North Sea (Fattouh, 2007). After 1985, the futures market emerged as a new mechanism in oil pricing. This development in the crude oil market was justified in the fact that it was more transparent and less vulnerable to distortions. Since then, crude oil has begun to trade on commodity markets and the price was determined by supply and demand (Fattouh, 2007). In 1986, the pricing power of the OPEC collapsed mainly as a result of the shift in marketing behaviour of Saudi Arabia from being a swing producer to a new policy that focused on maintaining its market share (Energy Charter Secretariat, 2007: 76-77).

For the purpose of pricing a barrel of crude oil, its properties were taken into consideration. That is, crude oil with high gravity and lower sulphur content is expensive, but it is desirable because it is easy to refine and it produces high quality petroleum products. On the other hand, lower gravity and higher sulphur content crude oil is cheaper, but more expensive to refine. As there are different varieties of crude oil, buyers and sellers found it of help to have a reference or benchmark crude oil for pricing. Due to the emergence of wide spectrum varieties of crude oil, a new system of pricing was introduced in 1980, in which oil prices were determined as a differential to certain benchmark or reference price (Fattouh, 2007). The main four benchmarks crude oil are:

1. West Texas Intermediate (WTI) which is used as a benchmark for crude oil produced in the United Sates. It is light crude oil with American Petroleum Institute (API) gravity of 39.6 degrees and 0.24 per cent sulphur content, which makes it lighter and sweeter than Brent blend. It is generally priced at about $2 and $6 per barrel premium to Brent blend and the OPEC basket price, respectively.
2. Brent blend crude oil, which is light and sweet (but not as much as WTI). It is a blend of crude oil from different oil fields in the North Sea (United Kingdom and Norway). It has an API gravity of 38.3 degree and sulphur content of 0.37 per cent by weight.

3. Dubai crude oil is a benchmark for oil prices in the Persian Gulf. It is medium to heavy crude with low sulphur contents. It is generally sold out at a discount to Brent blend and West Texas Intermediate.
4. The OPEC basket crude oil, which is a weighted average of oil prices obtained from different oil producing countries. However, in 2005, the pricing mechanism had changed and the benchmark became a weighted average of crude oil produced by OPEC members.

It is worth noting that due to the decline of light crude oil production in the North Sea and United States, and at the same time increase of heavy crude production from Russia and the Middle East, oil companies started to make their oil exploration, production and development decisions based on heavy crude oil prices. Accordingly, Uras crude oil in Europe and Mars crude oil in the United Sates emerged as potential benchmarks in place of Brent blend and West Texas Intermediate, respectively. And, Dubai-Oman blend crude oil, which is heavy and sour, is set as a benchmark in the Middle East (Speight, 2012).

4.4.4 Factors affecting crude oil prices

In general, commodity prices are determined through demand and supply theory. Although crude oil prices are to a great extent determined by demand and supply, other factors have great influence on crude oil prices as well. That is, there are many other drivers of oil price fluctuations in the world market (Beirne et al., 2013; Fan and Xu, 2011, Nkomo, 2006). In this regard, Yan (2012) suggested a number of factors that could cause crude oil price to fluctuate through the time. These are proven reserves, increase of crude oil consumption within OPEC countries, changes of crude oil inventories, the influence of the US dollar exchange rate, opportunistic practices in the crude oil market, and geopolitical instability. In this regard, Yousefi and Wirjanto (2003) claim that the OPEC countries tend to adjust their oil price in line with movements of the US dollar exchange rate to maintain the real value of the oil price. For instance, a depreciation of the US dollar exchange rate by 10 per cent results in almost 8.5 - 19 per cent increase in oil prices. On the other hand, Beirne et al. (2013) pointed out twelve factors that cause crude oil prices to surge. The factors are strong economic growth, rising seasonal demand, limited OPEC storage capacity, production capacity, China's increasing demand, infrastructure limitations, risks to supply, the OPEC conservative management style, exploration and development costs, investors, speculation, and the weak US dollar. Although they came up with twelve factors that cause oil prices to surge, no explanation was provided of how these factors contribute to pushing oil prices up.

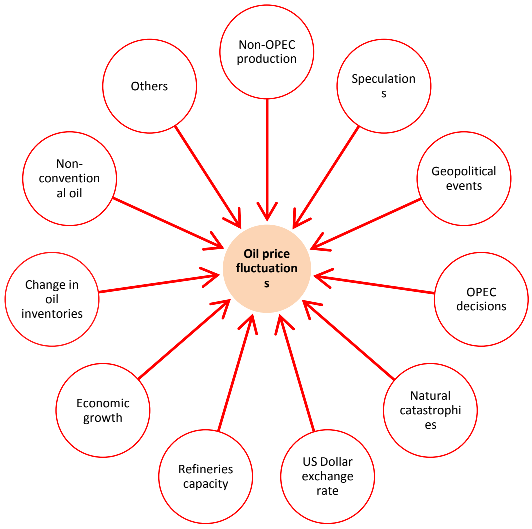
Furthermore, Speight (2012) suggested that the factors that have affected oil price movements were:

1. The world trade centre attack in September 11, 2001.
2. Second Gulf War in early 2003.
3. Instability of Iraq during the period 2003 – 2008.
4. Iranian nuclear reactor issue, which began in 2005.
5. Hurricane of 2004 in the United Sates.
6. Hurricane Rita and Katrina of 2005.
7. Accelerating crude oil demand in a manner that surpassed supply

Each of the above factors had played a role in determining the direction of the crude oil price movement. For example, after September 11, 2001 attack a remarkable decline in oil price was witnessed due to decline of crude oil demand. Moreover, following the second Gulf War and instability in Iraq, supply of Iraqi crude oil was halted, which led to a shortage in world production and consequently pushed oil prices up to US$43 a barrel in the third quarter of 2005. Likewise, the hurricanes that struck the Gulf coast of the United Sates (Katrina and Rita) resulted in an increase of oil price to US$60 a barrel in late summer of 2005.

In this regard, Tsoskounoghou et al. (2008) agreed with Hamilton (2013a) and Speight (2012) that the root causes of oil hikes were due to geopolitical events and natural catastrophes. However, they further gave attention to other factors such as the volume of oil demand, reserve production capacity, potential new discovery, global economic growth, willingness of global financial systems to finance investment in risky, remote areas and unstable countries, increase of world population, and the depreciation of the United States dollar exchange rate. Furthermore, Fan and Xu (2011) suggested that six main factors influence oil prices. These are supply-demand power, stock market, the US dollar exchange rate, speculation, gold market and geopolitics. In the short term, oil supply and demand oscillation is the key factor affecting oil price movement, but not in the long run. Also, the performance of the stock market has strong links with crude oil market behaviour, for example, investors in stock markets withdraw their fund when it is depressed and re-invest in the crude oil market, which in turn increases oil demand and oil prices go up. Moreover, all trades in the world crude oil market are settled in US dollar; therefore, any changes in the US dollar exchange rate will affect prices of crude oil. Since 2000, speculation has become an influential factor in oil price fluctuations in the world market. The increase of speculation operations was due to low interest rate policy in the world central banks, which in turn resulted in an increase of credit facilities. Accordingly, a number of speculative funds were invested in the oil futures market. These speculative funds have led to upward pressure on crude oil demand and hence increased oil prices. Finally, because crude oil is a strategic commodity for economic development and growth, it is generally affected by international politics. It is well known that political events disrupt oil supply in oil producing countries (Fan and Xu, 2011). Because crude oil prices are influenced by numerous factors, it is most likely that oil prices exhibit volatility behaviour. This explains why most of the oil price predictions appeared to be unrealistic (Yan, 2012). According to Jones (1988: 317) “indeed the only certainty about the oil market is uncertainty itself". Considering the above mentioned discussion, Figure 15 is an attempt to summarize the factors behind crude oil price fluctuations in the global markets.

Figure 15. Factors influencing crude oil prices



Source: Author's work adapted from Yan (2012) and Beirne et al. (2013)

4.5 Historical crude oil price shocks

Since the commencement of exploration and production of crude oil in August 27, 1859 by Edwin Drake in Titusville, Pennsylvania State in the US, crude oil price has witnessed numerous shocks (Jones, 1988: 3). Most of the early shocks were confined to the US as other countries had not started of crude oil explorations. This section is based on the most influential work by Hamilton (2013a) in which the oil industry was surveyed and the associated events were documented.

4.5.1 Early crude oil shocks: 1860 – 1953

The first crude oil shock took place between the 1862 -1864, during the American Civil War between the seven Southern States and the Northern States. During this period crude oil prices had risen dramatically due to drop in supply and increase in demand. Another factor that contributed to crude oil demand increase was the introduction of tax on alcohol from 20 cents per gallon to US$ 2, while oil was taxed at 10 cents per gallon. This in turn made alcohol less competitive to oil and people started demanding more crude oil. After the civil war, the oil industry witnessed a great increase in crude oil production. Conversely, oil prices climbed up in 1895 due to loss of oil supplies from Russia as a result of the outbreak of cholera in Baku. Again considerable drop in oil price took place due to the occurrence of the great depression in 1929 and discoveries of huge oil resources in East Texas.

4.5.2 Suez crises: 1956 – 1957

On July 26, 1965 the Egyptian President Jamal Abdul Nassir announced the nationalization of the Suez Canal Company, which has been jointly operated by France and Britain since its inception in 1869. Although the Egyptian president promised to compensate France and Britain governments, both states rejected the offer and invaded Egypt along with Israeli military forces. As a consequence of this war, 40 ships were sunk and the canal was blocked. At that time, around 1.2 million barrels of oil per day used to be transported through the Suez Canal. However, half a million barrels per day were moved out of the market due to the bombing of the pipeline that transport crude oil from Iraq to ports in the eastern Mediterranean. The total loss in oil supply was estimated at 10.1 per cent of the total world output. The result was that crude oil prices increased. The most affected region was Europe as it had been depending on crude oil coming from the Middle East (Hamilton, 2013a).

4.5.3 OPEC embargo 1973 – 1974

In an endeavour to take back the occupied areas that were seized by the Israeli militants in 1967, Egypt and Syria jointly launched an attack on Israel on the 6th of October 1973. And to punish countries which had supported Israel during the war, the Arab members of the Organization of the Petroleum Exporting Countries (OPEC) declared an embargo of crude oil exports to those countries. Accordingly, almost 4.4 million barrels per day moved out of the market, which constituted approximately 7.5 per cent of the world output. As a result of the OPEC embargo, crude oil price doubled by January 1974 (Hamilton, 1983a).

However, Barky and Killian (2001) claimed that economic factors were behind the increase of oil price rather than the embargo. In a response to that Hamilton (2003) emphasised the importance of economic context, but the timing, size and the way the supply cutbacks were carried out were no doubts of a geopolitical nature. In contrast, other scholars stated that the OPEC embargo had resulted in an economic recession in Western countries such as the United Sates, some European countries and Japan (Yan, 2012; Darby, 1982). This conclusion was further supported by Weiwen (2012).

4.5.4 Iranian revolution: 1978 – 1979

During the Arab-Israeli war, which was known as Yom Kippur or Ramadan war in 1973, Iran tried to increase its production to offset the cutbacks in production by Arab members of the OPEC. This later led to a public protest in 1978, followed by a strike in the oil sector, which resulted in a cutback in Iranian production by 4.8 million barrels per day, approximately equivalent to 7 per cent of global crude oil production at that time. Upon the return of Ayatollah Khomeini from his exile in January 1979, Shah Iran departed the country and Khomeini took power in Iran on February 1979. To bridge the gap made by the cutback of oil production in Iran, Saudi Arabia and other countries increased their production to compensate for the loss of production in the global market. During that period oil prices spiked and severe crude oil shortage was witnessed in the US (Hamilton, 2013a, 2013b).

4.5.5 Iran-Iraq War: 1980 – 1981

In September 1980, Iraq launched a war against Iran in a dispute over Small Island in the Arab Gulf. This war led to the cutback of crude oil production in the two countries by almost 6 per cent of the global production. The war lasted through 1978 – 1981 and resulted in a 100 per cent increase in crude oil price (Hamilton, 2013a).

4.5.6 The great price collapse: 1981 – 1986

The series of increases of oil price during the previous years had resulted in contraction of crude oil demand from importing countries. Accordingly, the volume of world crude oil consumption dropped substantially during the first half of the 1980s. To sustain the oil price at a favourable level of oil producers, Saudi Arabia took the first step by cutting back its production by approximately 75 per cent over the period 1981 – 1985. However, its endeavour did not succeed in preventing the decline of crude oil price, which dropped by 25 per cent. However, due to this unsuccessful attempt to curtail oil price from decline, Saudi Arabia resumed its production as usual in 1986, which aggravated the situation and pushed oil price down from US$27 per barrel in 1985 to US$12 per barrel in 1986. This was mainly due to the competition among the OPEC members to maximize their income and the shrinking demand for crude oil (Speight, 2012: 161). OPEC members had held a series of meetings through February and April 1986 in an attempt to determine its market share, but the outcomes were disappointing with no agreements reached. Subsequently, the oil price dropped to US$ 8 per barrel by the end of April 1986 (Jones, 1988: 309). According to Jones the disagreement between the thirteen OPEC member countries was due to two reasons (1988: 311):

1. Iraq wanted higher quota in order to meet the cost of the war against Iran. Likewise, Iran requested an increase of its quota.
2. Other countries demanded higher quotas to sustain their revenue levels.

4.5.7 The first Persian Gulf War: 1990 – 1991

At the end of the Iran- Iraq war in August 1988, Iraq returned to business as usual and its production level was similar to that in the 1970s. However, upon the invasion of Kuwait by Iraqi troops in August 1990, world crude oil production dropped by nearly 9 per cent, as a result of the disruption of oil supply from these two countries (Hamilton, 2003). Consequently, crude oil price doubled within eight weeks. Price per barrel of crude oil rose from US$ 14 to 40, almost tripling (Hamilton, 2011). To compensate for the loss of production from the Iraqi and Kuwaiti oil fields, Saudi Arabia made use of its spare capacity to increase crude oil production in order to bring back the global production to its level before the aggression against Kuwait. This shock did not last long and crude oil price went down again to US$ 20 a barrel (Yan, 2012).

4.5.8 East Asian crisis: 1997 – 1998

Although the oil consumption in what was known as the "Asian tigers" was modest, their economic growth if continued could have triggered crude oil price to increase according to Hotelling's rule[6]. In 1997 Thailand devalued its currency as a result of a huge flight of foreign exchange in its attempt to support its currency exchange rate. However, its borrowing and foreign debt aggravated the situation and led to a currency collapse. The financial crisis soon spread to the Southeast Asian countries. This created a turmoil in the financial system of most of the Asian countries and to a lesser extent on other stock markets. During this period crude oil price dropped to US$ 10 per barrel (Yan, 2012). Likewise, Weiwen (2012) argued that the coincidence of the Asian financial crisis and the increase of crude oil production by Iraq were the main causes of the drop in crude oil prices. In this regard, Speight (2012: 162) suggested the five reasons that were responsible for crude oil drop in late 1997, as follows:

1. Slowdown of Asian economies due to the financial crises.
2. Misreading of the global oil market trend by OPEC members had resulted in pumping more oil in the market.
3. Unlike previous years, the North Hemisphere witnessed mild winter, which led to lower demand for crude oil and its products.
4. Russia had increased crude oil exports to boost its economic growth and to improve its income balance.

[6] Hotelling (1931) claimed that in a competitive market non-renewable resources price would grow at a rate equivalent to the discount rate (interest rate).

5. Lack of adherence to the quota system among the OPEC members as well as the competition between Venezuela and Saudi Arabia to increase their share in the market ended in a high volume of crude oil exports, and subsequently crude oil supply outweighed its demand.

4.5.9 The Venezuelan turmoil and the second Persian Gulf War: 2002 - 2003

During the period December 2002 to January 2003 a general strike took place in Venezuela, which led to a removal of 2.1 million barrels a day from the world crude oil market. Immediately after this event, 2.2 million barrels a day from the Iraqi oil fields was removed as well due to the launch of military operations by the US forces and its allies against Iraq (Le and Chang, 2013). However, in terms of the share of global crude oil production, the 4.3 million barrels were smaller compared to what had happened in the previous events. This might be attributed to the overall increase of oil production from the OPEC and non-OPEC countries. Despite this fact crude oil price rose slightly and for a shorter period of time. However, Speight (2012: 145) attributed the increase of crude oil price to cold weather in the winter of 2003.

4.5.10 Oil demand pressure: 2007 – 2008

This period had witnessed global economic growth and associated with an increase of crude oil demand by 5 million barrels a day. It was widely acknowledged that the strong demand was the main cause of the continuous upward trend of oil price during the period 2007 - 2008. The strong economic growth, increased oil consumption by emerging economies such as China and speculative activities had resulted in an increase of crude oil price to a record high by July 2008 (Hamilton, 2013a; Kilian and Morphy, 2014). For example, West Texas Intermediate crude oil exceeded US$ 145 (Speight, 2012: 138). Unlike the previous periods, there were no geopolitical events associated with the increase of oil price this time. Some assumptions were made to explain why production was not increased to bring prices down. One explanation was that the ongoing instability in Iraq and Nigeria at the time played a contributing factor. Some key oil fields reached their peak and entered the declining stage, such as oil production from North Sea fields which declined by more than 2 million barrels a day by the end of 2007. Also, the Mexican major field "Cantarell" had shown a decline of oil production by nearly 1 million barrels a day over the period 2002 - 2008. Interestingly, in 2007 production from Saudi fields declined by 850,000 barrels a day compared to its production in 2005. This unexpected decline of the Saudi oil fields was explained by the maturity of its largest oil field "Ghawar", which had been in production for more than 50 years (Simmons, 2005). However, Gately (2001) suggests that it was not in the interest of OPEC to increase crude oil production at that time. This claim was supported by Speight (2012) who observed that the withholding of oil supply by OPEC countries, speculation in future markets and the profiteering of oil companies were major issues. Likewise, Bhar and Malliaris (2011) claimed that Saudi Arabia had deliberately kept its oil production rate unchanged to stabilize oil prices. They also emphasised the role of market fundamentals and the US dollar depreciation in the oil price hike. On the other hand, Speight (2012: 137) claimed that geopolitical concerns over Iraq, Nigeria and Venezuela had contributed to oil price fluctuation during the period 2007 – 2008. Furthermore, Kaufmann (2011) stated that increase of crude oil prices in mid-2008 were due to supply shock and speculation rather than demand shock. Although Kaufmann (2011) claimed that it is hard to measure speculation, three indicators suggested that changes in oil prices were partially due to speculation. These indicators were:

1. Increasing crude oil inventories by the private sector.
2. Breakdown of the co-integration between crude oil prices in spot and futures market.
3. Failure of the econometric models to forecast crude oil prices, according to supply-demand theory.

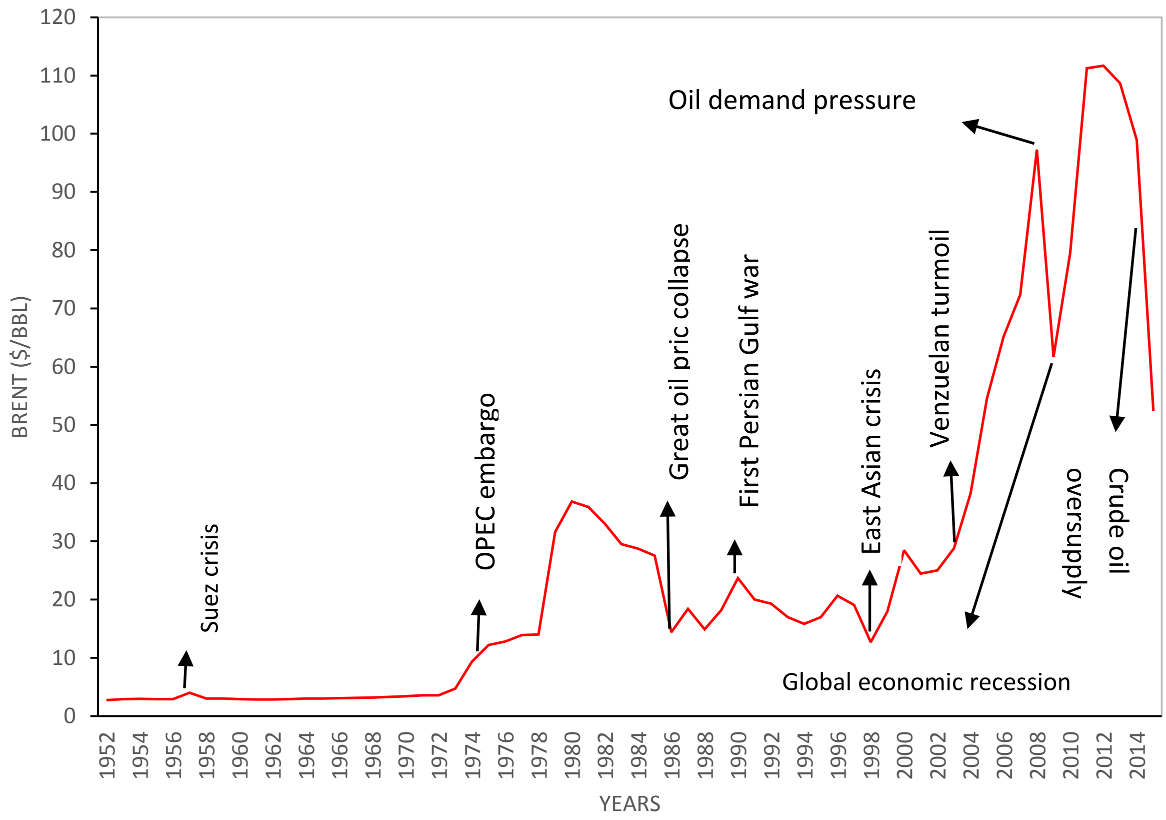
However, there was no clear evidence that supports the role played by speculation in the 2008 oil price hike, but failure of market fundamentals to justify the oil price increase led to an assumption of other factors. Tsoskounoglou et al. (2008) and Yan (2012) attributed the oil price hike in 2008 to the increase of demand in OECD countries and high level of demand in emerging countries such as China and India. However, due to occurrence of financial crisis in the last two quarters of 2008, crude oil prices plummeted dramatically to US$ 40 a barrel by the end of 2008, a 262 per cent drop.

4.5.11 Recent oil price drop: 2014-2015

In the last few months of 2014/15, crude oil price has plunged to a record low after four years of relative oil price stability at approximately US$ 105 a barrel. The drop of crude oil to just above US$ 40, which started in June 2014, was not an unprecedented one; there are five episodes of crude oil price plunge that have occurred in the last three decades (Baffes et al., 2015, Tokic, 2015). The first episode of oil price drop was in 1985-86, when OPEC countries abandoned OPEC's oil price targeting policy and continued increasing production, which then resulted in a rapid growth in oil supply. The end result was that crude oil price dropped from US$27 to US$12 barrel (Speight, 2012: 161). The second oil drop was in 1990-91, which was mainly attributed to the weakening of global demand. Crude oil price went down from US$ 40 to US$ 20 a barrel. The third plunge took place in 1997-98 as a result of the Asian crisis as mentioned earlier. During this period the barrel oil price dropped to US$10 (Yan, 2012). The fourth decline of crude oil occurred in 2001, due to the contraction of the global demand after the September 11 attack. Finally, the crude oil price drop of 2008–09 was a consequence of global financial crisis. The crude oil price dropped from its historical peak of US$ 145 to nearly US$ 30 per barrel (Speight, 2012: 138; Tokic, 2015). The recent plunge of crude oil price has been attributed to a number of factors (Baffes et al., 2015). Firstly, slowdown in the global demand for crude oil, especially that of the emerging countries. Secondly, the shift of OPEC policy from a price targeting policy to that one aims at maintaining its market share in the global crude oil market. This has resulted in oversupply of crude oil, which put more downward pressure on oil prices (Bentley and Bentley, 2015; Manescu and Nuno, 2015). Thirdly, the remarkable increase of nonconventional crude oil production, e.g. US shale oil and Canadian oil sand. Fourthly, appreciation of the US dollar exchange against other currencies by about 10 per cent. Since the US dollar is the denominator currency for pricing crude oil, its volatility affects crude oil prices. Fifthly, receding of the geopolitical risks, which have appeared to be less prominent than expected. Libya, for example, has increased its oil production by 0.5 million barrels per day and also Iraq succeeded in stabilizing its production at 3.3 million barrels per day despite existing conflicts. This argument is consistent with those of Manescu and Nuno (2015). The current crude oil price drop would benefit oil importing countries to push inflation rate downwards. However, oil exporting countries will suffer from low oil revenues and worsening of their fiscal stance. Likewise, the nonconventional oil producers will also suffer if the existing price continues for quite a long time as their break-even point is relatively higher compared to those of conventional crude oil producers. On the other hand, despite the wide acknowledgement in the financial media of the glut in oil production, slowdown of China's demand and increase of the US shale oil production as contributing factors to the 2014 plunge, Tokic (2015) suggested that the main cause of the 2014 oil bust was due to the appreciation of the US dollar against the Euro.

The oil price shocks event could be presented in a single graph as shown in Figure 16.

Figure 16. Major crude oil events



4.6 Summary

This chapter has provided an overview of the quantity of world proven crude oil, global crude oil demand and supply, peak oil theory, how crude oil is priced, factors that affect its movement, historical crude oil price shocks and the recent plunge in crude oil prices. The world proven oil reserve has shown an increase of 29.4 per cent over the last decade. In this context, the peak theory introduced by M. King Hubbert in 1956 has been refuted by a number of scholars. The world crude oil supply steadily increased through the period 2000 – 2008, but witnessed a drop by nearly 4.9 per cent in 2009. This drop was attributed to a cut in crude oil production from OPEC countries. In contrast, the average growth rate of the world crude oil demand during the last fifteen years was 2.6 per cent. The increase of crude oil demand in the world was driven mainly by both developing and emerging countries. The pricing mechanism of the crude oil has witnessed significant changes through history. Before the 1970s, the Seven Sister companies were the major determinants of crude oil prices, then followed by the OPEC era. Since the early 1980s, a new system of pricing was introduced, in which prices were determined as a differential to certain benchmark or reference price (e.g. Brent, WTI and Dubai). Although crude oil prices are generally determined by the demand and supply, other factors have played influential role in the crude oil prices. For example, the geopolitical events, speculation, environmental conditions and the US dollar exchange rate. These factors had led to a series of oil price shocks in the past. Recently, the plunge of crude oil was attributed to a number of factors, similar to those that occurred in earlier times. However, the most significant new factor is the increase of crude oil from non-conventional sources.

Chapter five: Research framework and Methodology

5.1 Introduction

This chapter discusses the philosophical framework of the mixed research methodology. It also presents the process of the Delphi method including the designing of the semi-structured questionnaire and selection criteria adopted in selecting the experts. The VAR model will be explained, as well as data definition and sources. Then, the specification, estimation and adequacy test of the VAR will be expounded. Subsequently, Granger causality test, impulse response function and forecast error variance decomposition analysis are articulated. Finally, the process of comparing the outcomes of the Delphi method with the signs of the VAR model coefficients as external validation is explained.

5.2 Philosophical framework

Before the 1980s there were two philosophical paradigms. The positivist paradigm supports or associates with what is known as quantitative approach. In this paradigm, the researcher makes assumption of knowledge through cause and effect, measuring variables and examining theories. On the other hand, the constructivist paradigm supports qualitative approach and according to this philosophy researcher understand the problem through subjective opinions of participants. Positivists view reality as singular, while constructivists view reality as multiple. A debate between these two paradigms continued for quite a long time (Tashakkori and Teddlie, 1998: 3-4; Creswell and Plano Clark, 2011).

During the 1980s and early 1990s the debate between the two paradigms became unproductive. In an attempt to make peace between the two paradigms, a new paradigm was proposed that supported the compatibility of using both methods in a research. This paradigm is called pragmatism. The new paradigm refers to what is called 'mixed methods' or mixed methodology, which encompasses both qualitative and quantitative approaches in one study (Tashakkori and Teddlie, 1998: 5). Creswell and Plano Clark (2011:41) have explained the pragmatism paradigm as follow:

Pragmatism is typically associated with mixed methods research. The focus is on the consequences of the research, on the primary importance of the question asked rather than the methods, and on the use of multiple methods of data collection to inform the problem under study. Thus it is pluralistic and oriented toward "what works" and practice.

The mixed method came into existence in late 1980s after a number of researchers from different disciplines produced various publications in which they discussed and established solid foundations of the mixed methods, for example, Brewer and Hunter, 1991; Fielding and Fielding, 1989; Greene *et al*., 1989; Bryman, 1988; Morse, 1991; Creswell, 1994 (Creswell and Plano Clark, 2011). The mixed methods have gone through different names before researchers agree on the current name 'mixed method research'. For instance, it has been given the following names: 'combined or integrated research', 'quantitative and qualitative methods', 'hybrid research', and finally 'methodological triangulation' (Creswell and Plano Clark, 2011: 22). There is a growing interest in using mixed methods in research, for example, in the last five years 1460 PhD students employed mixed methods in their theses as the main research methodology (ETHOS, 2013).

According to Tashakkori and Teddlie (2003a), pragmatism is identified as the best philosophical base for mixed method research. Pragmatists support using multiple paradigms to address the research problem. A mixed methodology study refers to a single study or multi-phased study that uses qualitative and quantitative approaches into its research methodology of (ibid: 17).

There are four major mixed methodology designs. These are the explanatory sequential design, the convergent parallel design, the exploratory sequential design and embedded design (Creswell and Plano Clark, 2011: 71). In convergent design the researcher implements both quantitative and qualitative methods at the same time and mix their results at the interpretation point. The explanatory sequential design is in two phases, quantitative data will be collected and analysed first, then followed by qualitative phase to further explain the quantitative results. The exploratory design is just the reverse of the explanatory design, starts with qualitative phase, and then followed by quantitative phase to examine or generalize the qualitative findings. Finally, the embedded design refers to the implementation of both qualitative and quantitative methods within the traditional qualitative or quantitative design.

One of the main principles in designing a mixed methods research is to clearly set off the reasons for mixing qualitative and quantitative methods (Creswell and Plano Clark, 2011: 61). Greene et al. (1989) identified five reasons for mixing methods in research. These are

1. Triangulation or convergence of results.
2. Complementarity: study different aspects of a phenomenon.
3. Initiation: exploring contradictions or new perspectives.
4. Development: using methods sequentially in a way that findings from the first method feed into the second method for more investigation.
5. Expansion: combined method adds more breadth and widening project scope.

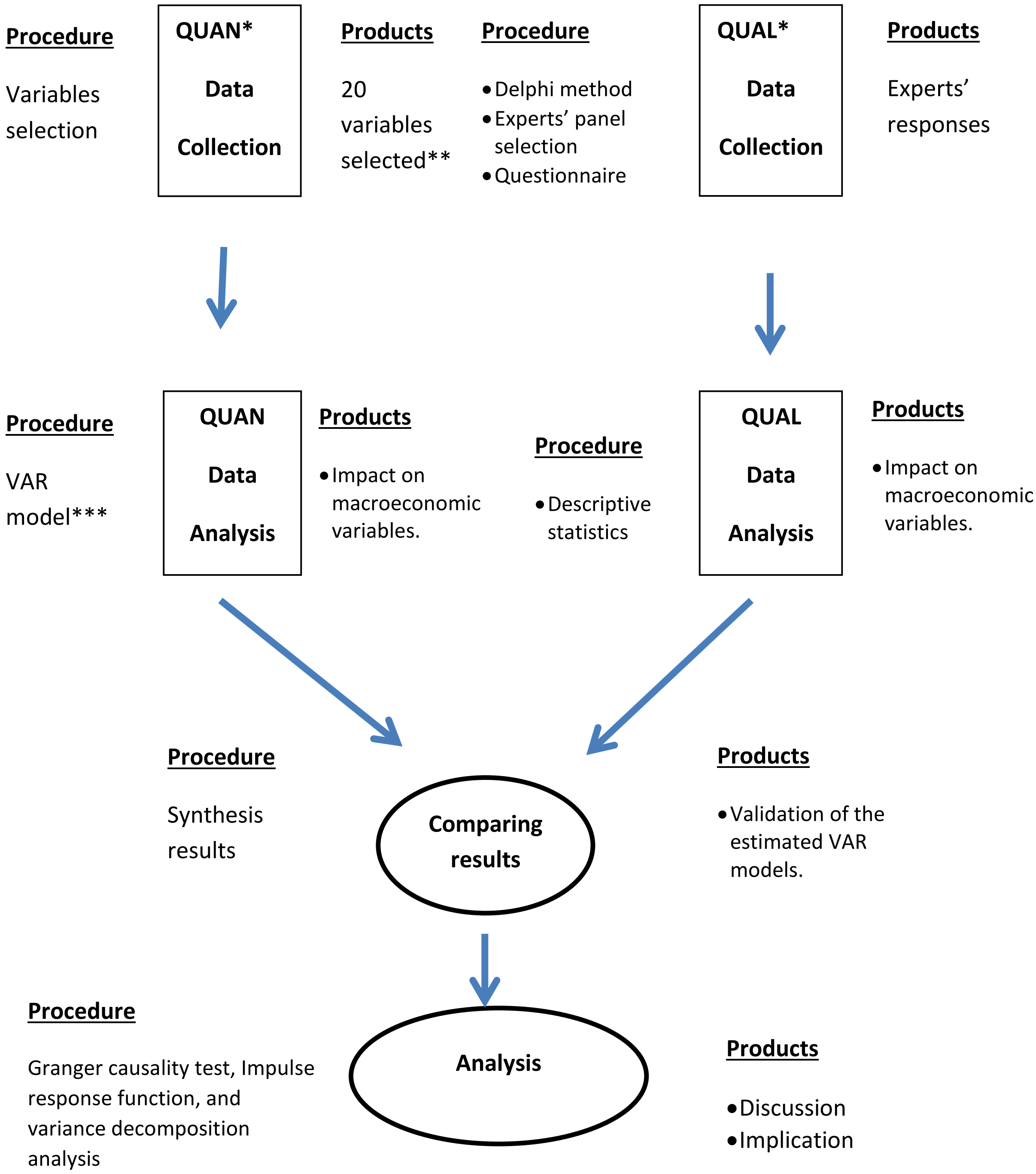
Furthermore, Venkatesh et al. (2013) stated seven purposes of using mixed methods: complementarity, completeness, development, expansion, corroboration/confirmation, compensation and diversification. However, detailed reasons have been specified by Bryman (2006). He identified sixteen reasons as follows: triangulation or greater validation, completeness, off-setting, process, answering different questions, unexpected results, explanation, instrument, development, sampling, credibility, context, illustration, utility or improving the usefulness of findings, confirm and discover, diversity of views, and enhancement or building among qualitative and quantitative findings.

The three challenges in employing the mixed methodology are: first, the researcher has to have previous experience and skill in using quantitative and qualitative methods individually before conducting mixed methods in a study. Secondly, mixed method research entails extensive time, resource and efforts from the researcher. Finally, the issue of convincing others with mixed methodology, as it is relatively new compared to the traditional methodologies (Creswell and Plano Clark, 2011: 13).

This research used the Convergent Parallel Mixed Methods Design, in which qualitative and quantitative data was collected concurrently, analysed separately and then the results compared to each other (Creswell & Plano Clark, 2011). This research used mixed methods for corroboration and validation purposes. According to Bill (2011), a questionnaire is considered to be of high value specially when used with other methods. He further emphasised that using multi-methods approach to investigate a phenomenon is critical as each single method has its limitations. Moreover, if the findings of the different methods fit together, it gives more confidence on the results (Bill, 2011: 2).

The diagram below portrays the procedural processes of implementing the convergent parallel mixed method design:

Figure 17. The procedural process of implementing convergent parallel mixed methods design



Source: Adapted from Creswell and Plano Clark, 2011.

* QUAN= Quantitative and QUAL= qualitative.
**Quantitative variables are: positive and negative real oil price shocks, inflation rate, money supply growth, unemployment rate, Murabaha profit margin rate, non-oil exports, imports, current account balance, trade balance, real exchange rate, growth of the Gross Domestic Product, total revenues, development expenditure, current expenditure, tax revenues, budget deficit, agricultural sector growth rate, industrial sector growth rate and services sector growth rate.
*** VAR= Vector Auto Regression model.

When a disagreement between the two methods took place, a researcher has the flexibility to assess the credibility of results according to appropriate criteria such as whether the relationship between variables is theoretically and conceptually sound and acceptable and consistency of results with previous findings in the literature (Creswell and Plano Clark, 2011: 69-71). Another way to do that is to use the estimated econometric model to simulate the historical variable time series data and compare the simulated values with the actual time series data. Then, five simulation evaluating measures will be used to evaluate the accuracy of the simulation. These measures are Root Mean Square Error (RMSE), Theil inequality coefficient, bias proportion, variance proportion and covariance proportion (Pindyk and Rubinfeld, 1998).

5.3 The qualitative approach: Delphi Method

Delphi method was developed mainly for forecasting of future events according to the knowledge of a panel of experts. However, in the last five decades, this method has been applied for different purposes, such as policy analysis, planning and long term prediction (Pickard, 2012). In this research, Delphi method aimed at obtaining a general consensus of the views of the experts about the impact of oil price shocks on Sudan’s macroeconomy. Traditionally, an open-ended questionnaire was used in the Delphi method; however structured questionnaire can be accepted in the modified Delphi format, especially when a thorough revision of the literature review has been undertaken (Hsu and Sandford, 2007). Delphi has been used in this research for the following reasons: first, the response of the macroeconomic variables to fluctuations of oil prices in the world markets is somewhat complex, which requires solid experience and knowledge in this area. Secondly, it does not necessitate experts to meet physically. Thirdly, the number of the experts is small, between 10 to 18 experts, so it is easy to administer the questionnaire. Fourthly, it is flexible and can be followed up by interview for further information, if necessary (Chitu et al., 2004). It is worth noting that the Delphi method has been used as secondary and main methodology in other fields of research in almost 2247 published articles and 1668 dissertations and theses (Jon, 2006).

The following steps have been adopted in using the Delphi method:

1. An overview of the relevant literature (article, studies and reports) with regard to the oil price shocks and the macroeconomy nexus was carried out.
2. Purposive sampling was used to select the experts' panel. That is to say, specific experts who have knowledge, experience and core concepts of the case were intentionally recruited (Creswell and Plano Clark, 2011: 173). A purposive sampling is used when the researcher knows who provides the most beneficial information to the research questions. This type of sampling is generally used in qualitative research (Kumar, 2011: 207). Accordingly, the experts have been identified, contacted and informed about the purpose and objectives of the research. Fifteen experts were selected to form the panel representing the following institutions and organizations: World Bank Group, International Monetary Fund (IMF), Ministry of Finance and National Economy, African Development Bank Group, Central Bank of Sudan, the Council of Ministers, and expatriate national expert from the Inter-Governmental Authority on Development (IGAD). The selection has been guided by the following criteria: He/she must have gotten at least a master degree in economics or related discipline, minimum working experience of 14 years, occupying a senior post in his/her institution or organization, and has a good background on the relationship between oil prices and macroeconomic activities. Three of the experts were occupying higher political posts, that is, State Minister of Finance, senior economic advisor for the Council of Ministers and Advisor for the State Minister of Finance and National Economy (Appendix 1).

3. The following steps were undertaken in designing the semi structured questionnaire and implementing the Delphi method (Appendix 2):
    - Various questions have been developed to obtain the required information.
    - Potential questions have been reviewed and prioritized.
    - Each question has been scrutinized using the following criteria: clarity, non-leading questions, no ambiguity and simplicity.
    - The wording in each question has been checked carefully.
    - The semi-structure questionnaire was organized into six sections, each section intended to answer a specific research question, as follows:
        - The first section was to collect data with respect to the effect of crude oil price shocks on the Murabaha profit margin rate, money supply, real exchange rate and inflation rate.
        - The second section dealt with the effect of crude oil price shocks on the public budget variables, specifically total revenues, tax revenues, development expenditure, current expenditure and budget deficit.
        - Section three assessed the correlation between the crude oil price shocks, the GDP growth and the unemployment rate.
        - The impact of crude oil price shocks on the main sectors growth rate was calibrated in section four, namely agricultural, industrial and services sectors growth rates.
        - Section five identifies the impact of crude oil price shocks on the current account balance, trade balance, non-oil exports and imports.
        - Section six dealt with confirming the selection of the appropriate macroeconomic variables that would be included in the VAR model.
    - A pilot phase was carried out to evaluate the questionnaire.

- Some questions were amended based on the received feedback during the piloting phase.

4. The distribution of the questionnaire to the experts' panel was either through their email addresses or in person (Round 1).
5. In round 2, all feedback from the experts in round 1 were analysed, summarised and included in the questionnaire as multiple answers to each question, with percentage of agreement to each answer. These were then sent back to the experts for reviewing and articulating whether they agree or disagree with them.

The research has strictly followed the rules of the Delphi method, which are summarised as follows:

1. Only knowledgeable and experienced individuals were chosen to participate in the panel of the experts.
2. All information had been gathered in writing.
3. A consensus of the views of the expert was systematically targeted, but that did not mean there were manipulations of the data to achieve that. This was attained through two rounds of Delphi method, experts review and consider the views of other experts till a general consensus was reached.
4. The identity of experts in the panel were not revealed or disclosed. However, Turoff and Hiltz suggested that it is of benefit to let the experts know each other to encourage them take the process seriously and honesty as their answer would be seen by other experts (1997).
5. The minimum number of the Delphi rounds to reach a consensus among the experts is two rounds. However, in some studies, general consensus was reached in the first round. This study reached a consensus among the experts in the second round.

It is worth noting that the general consensus was considered to be reached when 60 per cent or more of the views of experts showed the same answer to each single question. However, in some studies the cut-off rate of the consensus was less than 60 per cent (Rayens and Hahn, 2000).

5.4 The quantitative approach: Vector Auto-Regression (VAR) Model

This research used the VAR model in analysing the quantitative data. The VAR model was widely used in numerous empirical studies that examined the impact of oil price shocks on macroeconomic variables (Hamilton, 1983; Mork, 1989; Stock and Watson, 2001; Jimenez-Rodriguez; 2005, Zhang, 2011). According to Stock and Watson (2001), "in data description and forecasting, VARs have been proven to be powerful and reliable tools that are now, rightly, in everyday use". The VAR model came into existence in macroeconomics due to the unsatisfactory results of the large scale simultaneous structural equation models in the 1950s and 1960s. Researchers have found that using the VAR model in assessing and tracing the effect of external shocks on economic activities was better than the large-scale structural equation systems (Sims, 1980). Basically, the VAR has been used in the macroeconomy for forecasting, in addition to testing the Granger causality between variables and in examining the impact of policies by employing the Impulse Response Function (Greene, 2008: 695). In general, a VAR model comprises of a set of variables regressed on their own past values and lagged values of other variables as well (Guidi, 2009, Stock and Watson, 2001, Holden, 1995, Gujarati, 2003, Lutkephohl, 1993). It treats all variables in the model as endogenous and does not require a priori structural identification for selecting the variables in the model (Sims, 1980).

Generally speaking, VAR model has a number of upsides compared to the simultaneous equation structural models and univariate time series models. All variables are supposed to be endogenous, that is, no need for specifying whether variables are endogenous or exogenous. Because of its inclusion of lag values of variables, VAR model provides a quite a rich structure that captures more properties of the data. VAR model was found to provide better forecast results compared to the traditional structural Models (Brooks, 2002; Mark and Watson, 2001). Also, because the VAR model includes the same variables in each equation on the right hand side and there is no feedback from the Left Hand Side (LHS) variables to the Right Hand Side (RHS) variables, Ordinary Least Square (OLS) is a valid estimation method to be used in each single equation (Holden, 1995). On the downside, VAR has large numbers of coefficients/parameters to estimate and there is a difficulty to interpret them. The number of the parameters can be calculated using the following formula: $K^2 L + K$; where K is number of variables and L denotes lag length. For example, if a VAR model includes 6 variables with 4 lags, this will result in 150 unknown parameters including intercepts (Stock and Watson, 2001). However, Sims (1980) claims that the intention is to study the relationship between variables not to estimate the coefficients. Moreover, credible scholars such as Hamilton (1983), Gisser and Goodwin (1986), Mork (1989), Mork et al. (1994), Lee et al. (1995) and Chuku (2012), Gunu and Kilishi (2010), used the sign of the VAR model coefficients to explain the direction and the effect of the explanatory variables on the dependant variables. The general form of the VAR model is as follows:

$$Y_t = c + \boldsymbol{\Phi}_1 y_{t-1} + \boldsymbol{\Phi}_2 y_{t-2} + \ldots\ldots\ldots + \boldsymbol{\Phi}_p\, y_{t-p} + \boldsymbol{\epsilon}_t \qquad (1)$$

Where y_t is (n ×1) vector of variables; c is (n ×1) vector of constant; $\boldsymbol{\Phi}_j$ is (n × n) matrix of coefficients for j = 1, 2, …, p where p is the lag length; and $\boldsymbol{\epsilon}_t$ is (n ×1) vector of white noise term (Hamilton, 1994: 257). Generally speaking, researchers use the VAR model to analyse Granger causality, impulse responses and variance decomposition. These tests are computed using different econometric software such as EViews. As a result of the dynamic nature of the VAR model these tests give plausible information compared to the estimated VAR parameters. This is why VAR regression parameters go unreported by researchers (Stock and Watson, 2001; Guidi, 2009). However, Hamilton (1983), Gisser and Goodwin

(1986), Mork (1989), Mork et al. (1994), Lee et al. (1995) and Chuku (2012) used the sign of the coefficient to explain the direction of its effect on dependent variables.

It is worth noting that every VAR model has a Moving Average representation (MA). The vector MA model describes the relation between the current value of endogenous variable and the current and past values of the error terms in the VAR system. This relationship helps in tracing out the response of the endogenous variable over time to unit shock to an error term in each equation separately. Therefore, the MA representation is used to obtain the impulse response function and also to analyse the unexpected movement in the indigenous variable as a result of shock to itself and to the other variables in the VAR model as well. However, this process requires that error terms should be uncorrelated. To avoid that error terms, should be orthogonalized using Cholesky decomposition in order to make the covariance matrix diagonal. The general MA (q) takes the following form (Hamilton, 1994: 50)

$$y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} \qquad (2)$$

Where μ is (n x 1) vector of the mean of y_t, while θ is (n x n) matrix of MA coefficients and ε is a vector of white noise.

The five VAR models used to investigate the impact of real oil price shocks on the macroeconomy are:

1. Public budget model. This VAR model contains seven variables: positive and negative real crude oil price shocks, total revenues, development expenditure, current spending, tax revenues and budget deficit.
2. Selected macroeconomic variables model. This VAR model contains six macroeconomic variables: positive and negative real crude oil price shocks, money supply, real exchange rate, Murabaha profit margin rate and inflation rate.

3. Current account model. This VAR model includes six variables: positive and negative real crude oil price shocks, non-oil exports, import, current account balance and trade balance.

4. GDP growth model. This VAR model includes four variables: positive and negative real crude oil price shocks, real GDP growth rate and unemployment rate.

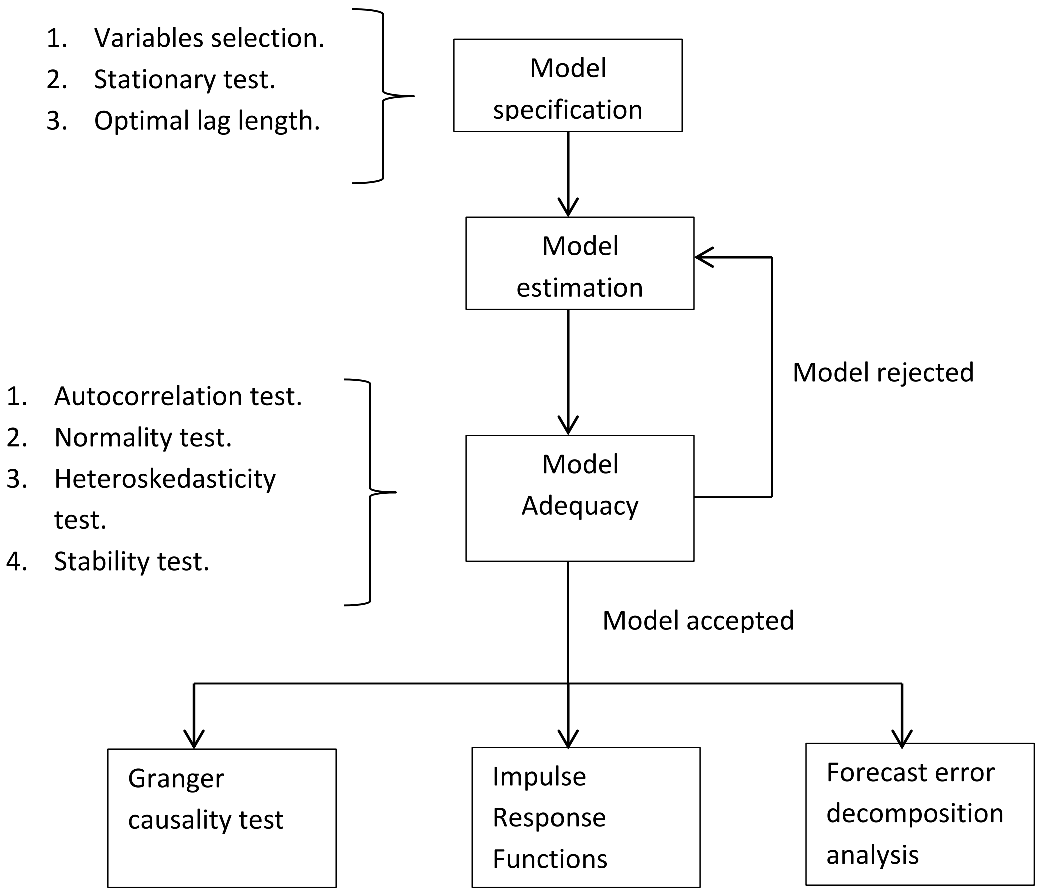
5. Sectors growth rate model: this VAR model includes five variables: positive and negative real crude oil price shocks, agricultural sector growth rate, industrial sector growth rate and services sector growth rate.

These VAR models were analysed using the EViews econometric software package. Also, the VAR models were estimated and examined using different tests. The following steps were adopted in developing the VAR models:

1. Selection of the variables
2. Checking the properties of the time series data.
3. Selecting the optimal lag length for the model.
4. Estimating the model
5. Checking the adequacy of the model using four diagnostic tests.
6. Employing Granger causality test.
7. Performing Impulse Response Function.
8. Performing Variance Decomposition Analysis.

These steps are sketched out in Figure 17.

Figure 18. VAR analysis process



Source: adapted from Lütkepohl, 2011.

5.4.1 Data definition and sources

A total of twenty macroeconomic variables were used in this research. The selection of the variables in the five VAR models were based on similar empirical research studies and further confirmed by the experts who took part in the Delphi method. The notations of these are shown as follows:

Table 8. Variables notation

Variables	Notations
Positive Real Oil Price (oil price increase)	PROILP
Negative Real Oil Price (oil price decrease)	NROILP
Inflation rate (%)	INF
Money Supply growth (%)	M2
Unemployment rate (%)	UNE
Murabaha profit margin rate (%)	MUR
Non-oil Exports (as % of GDP)	NOEX
Imports (as % of GDP)	IMP
Current account balance (as % of GDP)	CAB
Trade Balance (as % of GDP)	TB
Real exchange rate	RER
Real Gross Domestic Product growth rate (%)	RGDPG
Total Revenues (as % of GDP)	REV
Development Expenditure (as % of GDP)	DEVEXP
Current expenditure (as % of GDP)	CUREXP
Tax Revenues (as % of GDP)	TAX
Budget Deficit (as % of GDP)	DEFICIT
Agricultural sector growth rate	AGRICULTURE
Industrial sector growth rate	INDUSTRY
Services sector growth rate	SERVICES

In the following section, the definition and sources of time series data are explained:

- The real world oil price used in this research is denominated in US dollars. To calculate the real oil price, the nominal oil price was divided by the US Consumer Price Index (CPI). West Texas Intermediate oil price was used in this research as benchmark for global oil prices. However, if the research used other benchmark oil price such as UK Brent or Dubai, it would not affect the outcomes of the analysis as crude oil prices were empirically found to be moving in tandem across the three benchmarks (Weiwen, 2012). The real oil price was considered to be exogenous variable as Sudan has no influence on oil prices in the global markets. That is, Sudan is entirely a price taker. In this research oil price specification proposed by Mork (1989) was used. Chuku (2012) explained that in a very simple mathematical form as follows:

$$\text{Positive real oil price (PROILP)} = \begin{Bmatrix} O_t \ \ if \ O_t > 0 \\ 0 \ \ otherwise \end{Bmatrix} \quad (3)$$

$$\text{Negative real oil price (NROILP)} = \begin{Bmatrix} O_t \ \ if \ O_t < 0 \\ 0 \ \ otherwise \end{Bmatrix} \quad (4)$$

Where O_t denotes the rate of change in real oil price from year t to year t+1.

- Inflation rate refers to the percentage change in the general level of prices (O'Sullivan et al. 2005: 134). In other words, inflation is the percentage change in the Consumer Price Index (CPI) over a given period.
- Money supply (M2) is composed of money circulated in the economy plus the demand deposits. The volume of money in the economy will help forecast the inflation. The monetary authority uses money supply as a tool for monetary policy to control inflation and stimulate the economy.
- Unemployment reflects the percentage of unemployed individuals of the total labour force that are willing to work at the current wages (OECD, 2013). A decrease in the unemployment rate is a good sign for economic growth and vice versa.

- Murabaha profit margin rate is the cost of finance used by the Islamic banking systems based on the Islamic Sharia Laws. Generally, the Central Bank of Sudan determines an indicative Murabaha profit margin rate for commercial banks to follow. The Murabaha profit margin rate is equivalent to the interest rate in the traditional banking system. However, the difference is on the procedure and the implementation processes.
- Non-oil exports proceeds include export of all goods and services, excluding crude oil earnings. It is expressed as a percentage of the GDP. Increasing non-oil export earnings show an improvement in diversifying Sudan exports base. It also lessens the high dependency on the oil sector.
- Imports refer to the good and services produced in other countries and purchased by residents of the home country (O'Sullivan et al. 2005: 106). The value of imports is expressed as a percentage of the GDP. Generally speaking, increasing imports worsen the trade balance.
- Current account balance is one component of the balance of payments. It includes balance of trade, net income from abroad and net current transfer. A current account balance shows whether a country is a net borrower from the rest of the world or a net receiver of foreign exchange. The current account balance is expressed as a percentage of the GDP. A positive current account balance is a good sign of healthy country's external sector.
- Trade balance refers to the difference in monetary value between a country's exports and imports over a specific period of time. When the value of exports exceeds imports, the trade balance is said to be in surplus. On the contrary, if the value of imports is greater than the value of exports, the trade balance is said to be in deficit. The trade balance is expressed as a percentage of GDP. Positive trade balance shows inflows of foreign exchange earnings and vice versa.
- The exchange rate is defined as the value of a country's currency (domestic currency) versus the currency of another country (foreign currency). For example, the value of

Sudanese pound versus one US dollar. The appreciation of the local currency has negative impact on the country's export competitiveness, as its exports become expensive in the world market and vice versa.

- GDP refers to the total value of the output in a country in one year (O'Sullivan et al. 2005: 103). The GDP growth shows the change in GDP as a result of increasing the market value of the output of an economy over specific time. The real GDP will be used in this research to reflect the value of the output calculated using prices of specific year (based year).
- Total government revenue includes taxes and non-tax sources (e.g. Oil and non-oil export proceeds) in addition to grants. It is expressed as a percentage of the GDP.
- Current expenditure refers to the government spending on non-capital items such as wages and salaries, while development expenditure refers to spending on assets that last for more than one year such as building, equipment and construction of roads. Both variables are in percentage of the GDP.
- Tax revenues are the total amount of money paid by companies and workers for the government in term of personal income tax and business profit tax. It is expressed as percentage of GDP.
- Budget deficit refers to the situation where the total government expenditure outstrips the total government revenues in a given fiscal year (O'Sullivan et al., 2005:220). Similar to other budget variables it is expressed as percentage of the GDP.
- Agricultural sector growth rate refers to the percentage change of the value of agricultural sector outputs in one year. It is expressed as percentage of growth.
- Industrial sector growth rate refers to the percentage change of the value of all industrial sector products in one year. It is expressed as percentage of growth.
- Services sector growth rate refers to the percentage change of the value of services activities in one year. It is expressed as percentage of growth.

A quarterly data for the period 2000:q1 – 2011:q2 were collected from the following sources: Ministry of Finance and National Economy (General Directorate for Public Budget), Central Bank of Sudan and US Energy Information Administration. However, the real GDP growth data and the unemployment rate data were available only on annual base.

5.4.2 Unit root and stationary tests

Generally speaking, the time series variable is said to be stationary if the mean is zero and variance does not change over the time. Variables should be stationary in order to give a meaningful estimation. If non-stationary variables are regressed on each other, they can lead to the so-called "spurious regression". This simply means that the results are different to what they are assumed to be (Halcoussis, 2005). Each set of the time series data has to be checked for a unit root using Phillips-Perron (PP) and Augmented Dickey Fuller (ADF) tests. Both tests are based on the null hypothesis of a unit root. The latter test, have been criticized for being of low power when the process is stationary, but with root almost equal to 1, for example, 0.95. In order to confirm the result from ADF and PP tests, another stationary test proposed by Kwiatkowski, Phillips, Schmidt and Shine (KPSS) is employed. The KPSS is based on the null hypothesis that time series is stationary. Using the stationarity and unit root tests together is known as "confirmatory data analysis" (Brooks, 2002). The above-mentioned tests were carried out for the 20 variables included in the five models. If the probability value (*p*) is found to be less than 5 per cent or the *t* statistics is greater than the critical value, the null hypothesis would be rejected, otherwise the alternative hypothesis will be accepted (Brooks, 2002: 379-381). Most of the modern software packages provide *p*-value to test the hypotheses. This helped researchers to make their decision regarding rejection or non-rejection of the null hypothesis without referring to the appropriate critical values (Verbeek, 2000: 30). In case some variables are found to be non-stationary, then a differencing procedure should be adopted until the variables become stationary. For example, variable Y will be ΔY which equals to $Y_t - Y_{t-1}$

(Halcoussis, 2005). In the latter case, the variable would be integrated of order (*d*), which denoted by *I* (d), depend on the number of differencing. According to Engle and Granger (1987), if the time series are found to be stationary after taking differencing, cointegration test which was proposed by Johansen (1991) would be employed to check whether the time series is cointegrated or not. In case time series is found to be cointegrated, the VAR model should be estimated with error correction terms to deter variables bias as a result of throwing away some variables during the differencing procedure. That is to say, Vector Error Correction Model (VECM) would be used instead of VAR model. On the other hand, if there is no proof of the existence of cointegration or the series are integrated of different orders, the standard/unrestricted VAR model will be estimated (Ewing and Thompson, 2008; Iwayemi and Fowowe, 2011).

Although all variables of the VAR model should be stationary before testing hypotheses, some scholars claimed that using differencing technique to make the variables stationary should be avoided, as it results in losing some information, which would be of beneficial for the long run relationship between time series variables (Sims, 1980, Brooks, 2008: 240). Also, Halcoussis (2005: 242) reported two problems related to the differencing procedure. The first problem is that the mean of the variable is no longer the same as before taking the difference. Instead of having variable Y, now the VAR model includes only the difference of Y. This situation makes interpretation of the result somehow difficult. Second, it results in losing information regarding the movement of the variables over time. Furthermore, Hamilton (1994) pointed out three alternatives to deal with the issue of non-stationarity in time series data. The first alternative is to neglect the non-stationarity in time series and estimate the VAR model in levels, using T and F distributions for testing hypotheses. The second alternative is to difference the variables that seem to be non-stationary before estimating the VAR model and then estimate the VAR model. If the actual process is a VAR in differences, this will result in improving estimates of the model. However, if some of the variables are stationary, a VAR in differenced form is considered to be misspecified. The third alternative is to examine each variable carefully for nonstationarity and cointegration among the series. Based on the results of this investigation the model can be estimated. It is worth noting that the simplest non-stationary process is the random walk as follow:

$$X_t = \emptyset X_{t-1} + \epsilon_t \quad (5)$$

Where ϵ_t refers to the white noise which is identically and independently distributed with 0 mean and σ^2 variance. The process is said to be stationary if $\emptyset$ is in the range of less than 1 and greater than -1, that is, -1 < $\emptyset$ < 1. And if $\emptyset$ is not less than 1 or greater than -1 or equal to 1 then the process is said to be non-stationary.

5.4.3 VAR lag length

Selection of the optimal lag length of variables in test regression is very important in order to remove any existence of autocorrelation. Few lags will not completely remove autocorrelation and more than appropriate will increase the coefficient standard errors. The end result of not selecting the optimal lag length is that the value of test statistics will be reduced; hence, the null hypothesis of the unit root will most likely not be rejected. In this research, the most common used methods will be employed, which is the information criteria (Guidi, 2009). Therefore, three multivariate types of the information criteria will be used to determine the VAR order. These are Hannan-Quinn Criterion (HQIC), Akaike's Information Criterion (AIC), and Schwarz's Bayesian Criterion (SBIC). These criteria could be mathematically stated as follows (Brooks, 2002: 334):

$$\mathrm{HQIC} = \mathrm{Log}\backslash\hat{\mathrm{E}}\backslash + (\mathrm{k}'/\mathrm{T}) \log (\mathrm{T}) \quad (6)$$

$$\mathrm{AIC} = \mathrm{Log}\backslash\hat{\mathrm{E}}\backslash + 2k'/T \quad (7)$$

$$\mathrm{SBIC} = \mathrm{Log}\backslash\hat{\mathrm{E}}\backslash + (2\mathrm{k}'/\mathrm{T}) \log (\log (\mathrm{T})) \quad (8)$$

Where Ê refers to variance covariance matrix of residuals, k' denotes to total number of repressors in all equations and T refers to the number of observations. The number of lag that minimizes the value of each of the above three criteria will be chosen as the appropriate VAR order.

Alternatively, researchers can use another way to determine the optimal lag length, which depends on the use of the frequency of the time series data. For instance, if the time series is on an annual base, use of one lag, if a time series is on quarterly base, use of 4 lags, if time series on a monthly base, use 12 lags and so on (Brooks, 2002).

5.4.4 VAR estimation and testing

Estimating the VAR model using the ordinary least square is the most important step in analysing the dynamic relationships among variables. Based on the outcomes of the above mentioned tests, the VAR model will be estimated and the VAR coefficients will be obtained. The signs of these coefficients will be compared later, after checking the adequacy of the VAR model, with the expected relationship between the real oil price shocks and macroeconomic variables that have been reported by the experts who participated in the Delphi method.

5.4.5 Diagnostic tests

It is important to have the VAR model checked for its adequacy to ensure that it represents the data generation process adequately before using it for a specific purpose (Lutkepohl, 2011). Four regression model adequacy tests will be conducted to make sure that the VAR model is valid for further analysis. These are autocorrelation/serial correlation, normality, heteroscedasticity and stability tests. If the outcomes of the four tests confirmed the good adequacy of the VAR model, then the model will be accepted and ready for further analysis. On the other hand, if the model failed to pass the adequacy test, then it will be rejected and further improvement will be considered.

Serial autocorrelation/serial correlation refers to a situation where the error terms (residuals) in one period are correlated with error terms in the following period. This problem affects the efficiency of the OLS regression estimators (Seddighi, 2012: 72). In order to detect serial correlation, Portmanteau test which is widely used by practitioners will be employed. The null hypothesis is set to no serial correlation between residuals. That is, all residuals auto-covariance are zero, while the alternative hypothesis is that at least one auto-covariance (one auto-correlation) in not zero (Lutkepohl, 2011). If the result shows that *p*-value is greater the 5 per cent, then the null hypothesis cannot be rejected.

For normality, as one of the assumptions of the regression model is that error terms are normally distributed, Jargu-Bera test will be used to confirm that the assumption of normal distribution is true (Seddighi, 2012: 85). The null hypothesis is that residuals are normally distributed. If the *p*-value is found to be greater than 5 per cent, the null hypothesis which residuals are normally distributed cannot be rejected and in case p-value is less than 5 per cent the alternative hypothesis will be accepted. It is worth mentioning here that Jargu-Bera is sensitive to outlier observations as it results in large residuals, therefore the rejection of normal distribution might be due to the presence of outliers. Furthermore, the Jarque - Bera test suffer from low power when used for small sampling (Thadewald and Buning, 2004). Moreover, the normality of the residuals is not a necessary condition for validation of most of the VAR model statistical tests (Lütkepohl, 2009). In line with above two mentioned statements, Pindyck and Rubinfeld (1998: 146) claim that the violation of the assumption of normality is not serious and the estimated coefficient will remain unchanged, however the intercept will pick up the effect.

Heteroscedasticity refers to the violation of the assumption of constant variance of the distribution of the residuals in the regressive model. The existence of heteroscedasticity in the repressive model will result in biased or unreliable estimators (Seddighi, 2012: 83). To detect heteroscedasticity, the White test (1980) will be used. The null hypothesis is that residuals are homoscedastic, if the p-value is found to be more than 5 per cent, then the rule is that the null hypothesis cannot be rejected and accordingly the model is said to be homoscedastic, which is desirable.

Finally, to determine whether the VAR model is stable or oscillatory, the characteristic equation of the VAR model should be derived. For the smaller model it is easy to derive the characteristic equation, however in larger model this need to be derived and solved using an econometric package such as EViews. To this end, if the modulus of each characteristic root of the model is found to be less than 1, thus the model is said to be stable, as it satisfied the stability condition (Pindyck and Rubinfeld, 1998: 420).

5.4.6 Granger causality test

As VAR model have various lags of variables and large numbers of coefficients, it is difficult to identify which variables have a significant influence on the dependent variable. To address this problem, the Granger causality test will be employed. In this test, zero restriction will be imposed to all lags of a particular variable. Then, the null hypothesis is set to no causality between variables, if the *p*-value is found to be less than 5 per cent, then the null hypothesis will be rejected. That is, there is causality running from that variable to another. For example, if Y can cause X, then we can say Y Granger cause X. Moreover, bidirectional Granger causality might exist between two variables, that is, Y causes X and X Granger causes Y variable as well (Brooks, 2002: 298).

5.4.7 Impulse Response Function (IRF)

The Granger causality test shows the impact of a variable on the future values of other variables in the VAR model. However, it neither tells the direction of the impact nor how long the effect would be work through the VAR system. To know these effects, the impulse response function will be employed. By imposing one unit shock to specific indigenous variable, real oil price in this case, the IRF traces out the effect on other dependent variables in the model over time. In case the error terms are not correlated with each other; the process is straightforward, but if they are correlated, it is difficult to identify shock with specific variable, as error term has a common component that affects more than one variable (Pindyck and Rubinfeld, 1998: 432). In order to single out the effect of individual shock, residuals have to be orthogonalised using Cholesky decomposition (Enders, 1995: 307). Furthermore, if the time series is stationary, the shock fades away gradually after some periods (Brooks, 2002: 299).

5.4.8 Forecast error variance decomposition analysis

This analysis is a little bit different, however, to some extent gives similar results to the impulse response. The variance decomposition explains the proportion of the movement or variation in the dependent variables that attributable to its own shocks and shocks to the other variables in the VAR system (Pindyck and Rubinfeld, 1998: 433). As a result of the dynamic structure of the VAR model, the shock will be transmitted to all other variables in the system. Similar to the impulse response function, ordering of the variables is very important. Therefore, it is important to seek economic theories to suggest the order of the variables or refer to similar empirical studies. However, if the error terms are uncorrelated, ordering has no significant importance (Brooks, 2002: 301).

5.5 Comparing Delphi results with VAR models

As mentioned earlier that the convergent parallel mixed methods designed approach is used for the purpose of corroboration and validation. Accordingly, the estimated coefficients of the five VAR models: budget model, selected macroeconomic variables model, current account model, GDP growth and unemployment model, and sectors growth rates model will be compared with those findings obtained from the Delphi method. That is to say, the results obtained from the estimation of the five VAR models will be compared with the experts' responses to the impact of oil price shocks on the macroeconomy. Following Hamilton (1983), Gisser and Goodwin (1986), Mork (1989), Mork et al. (1994), Lee et al. (1995) and Chuku (2012), the coefficient sign of the oil price shocks in the VAR model shows the direction of the effect on macroeconomic variables. To this end, oil price coefficient with a plus sign refers to positive effect or an increase in the dependent variable, while a negative sign reflects a negative effect or a decrease. In case conflicting results are reported when comparing the findings obtained from both methods, the estimated VAR model will be used to simulate the historical series of the variable in question and compare it with the actual time series data. If the simulated variable series are found to have a good fit with the actual data, then the VAR model coefficients signs are correct. To do so, a historical simulation of the variable data, also called Ex-post simulation will be carried out over the period 2000: q1 – 2011: q2. Furthermore, to confirm whether the simulated variables were well tracked by the actual values or not, the outcomes of the simulation process will be graphically plotted and assessed using simulation evaluation techniques, namely Root Mean Square Error (RMSE), Theil inequality coefficient (U). Furthermore, the Theil inequality coefficient will be decomposed into three useful measures, namely bias proportion (U^m), variance proportion (U^s) and covariance proportion (U^c) (Kaplan, 1998). According to Pindyck and Rubinfeld (1998: 383-285), a comparison of simulated time series data for each endogenous variable is a useful test for the validation of the model in case the model is developed to apply hypothesis tests, while ex-post forecasting is generally performed on forecast models to test their forecasting accuracy. The mathematical forms and the explanation of the simulation evaluation techniques are as follows:

- RMSE measures the deviation of simulated variable from the actual value of the time series data. The lower the RMSE values, the better the simulated series. Also, the RMSE can be compared to the standard deviation of the data series. The low value of the RMSE is only one desirable measure of the simulation fit (Kaplan, 1998).

$$\text{RMSE} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2} \qquad (9).$$

Where Y_t^s is simulated value of Y_t, Y_t^a is actual value and T is the number of periods.

- Theil inequality coefficient is another measure to evaluate the goodness of the simulation. It values fall between 0 and 1, where 0 values mean perfect fit, while 1 means poor simulative performance of the model.

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^a)^2}} \qquad (10)$$

- The bias proportion (U^m) shows the existence of systematic error, as it measures the difference between the means of the actual and simulated series. Smaller values of bias proportion are a good indicator of simulated series, however the optimal value of the U^m ranges between 0.0 - 0.2.

$$U^m = \frac{(\bar{Y}^s - \bar{Y}^a)^2}{{}^1/_T \sum (Y_t^s - Y_t^a)^2} \qquad (11)$$

where $\bar{Y}^s$, $\bar{Y}^a$ are the means of the series Y_t^s, Y_t^a, respectively.

- The variance proportion (U^s) shows the ability of the model to capture the variability of the variable in question. A large value of U^s means that the simulated data show considerable volatility, while the actual data show less volatility, or vice versa.

$$U^s = \frac{(\sigma_s - \sigma_a)^2}{{}^1/_T \sum (Y_t^s - Y_t^a)^2} \qquad (12)$$

where σ_s and σ_a are the standard deviations of series Y_t^s, Y_t^a, respectively.

- Finally, the covariance proportion (U^c) measures the unsystematic error. In other words, it measures the remaining error after considering the systematic error. Because the simulation is not expected to be perfectly fit with the actual data, this measure is less worrisome compared to the bias and variance proportions.

$$U^c = \frac{2\,(1-\rho)\sigma_S - \sigma_a}{1/_T \sum (Y_t^s - Y_t^a)^2} \tag{13}$$

where ρ is the correlation coefficient.

5.6 Summary

The research methodology was formulated under the philosophical framework of the pragmatic paradigm. Accordingly, the Convergent Parallel Mixed Methods Design, in which quantitative and qualitative data were collected concurrently, analysed separately and then compared with each other (Creswell & Plano Clark, 2011). This research used the mixed methods for corroboration and validation. The quantitative data was analysed using five VAR models. Specification test was performed for each VAR model, checking the stationarity of time series through the most common tests (ADF, PP and KPSS) and selecting the optimal lag length. Then the VAR model estimated using the OLS method, followed by adequacy tests for internal validation. Whereas, the qualitative data was collected through a semi-structured questionnaire and was analysed using descriptive statistics under the Delphi method. The results of the Delphi method were compared to those of the estimated VAR model for corroboration and validation, before using the five VAR models for further analysis. After the external validation using the Delphi method results and the historical simulation technique, three tests, namely, Granger causality, Impulse Response Function and Error Variance Decomposition analysis were conducted to investigate the effect of real oil price shocks on the macroeconomy.

Chapter six: Empirical findings, analysis and discussion

Chapter five provided the research framework and the processes that was followed to assess the impact of real oil price shocks on Sudan's macroeconomy. It also discussed the data sources and definitions. In this chapter, the impact of oil price shock on the macroeconomy was analysed and discussed using five VAR models and Delphi method under the framework of the Convergent Parallel Mixed Methods Design. The purpose of using mixed method was to corroborate and validate the findings of the VAR model outcomes. Each VAR model was estimated using ordinary least squares, then a set of adequacy tests of the model were performed, namely, autocorrelation, normality, heteroscedasticity and stability. Next, the results obtained from estimation of the VAR model were compared with the experts responds to validate the sign of the VAR model estimates. After the validation of the estimated VAR model, Granger causality test, the Impulse Response Functions and variance decomposition analysis were performed to assess the impact of oil price shocks on Sudan's macroeconomy.

6.1 Descriptive statistics of the data

6.1.1 Public budget VAR model variables

This model analyses the impact of oil price shocks on the public budget variables. The model includes the following variables: total government revenues (REV), tax revenues (TAX), current expenditure (CUREXP), development expenditure (DEVEXP), the deficit (DEFICIT), positive real oil price (PROILP) and negative real oil price (NROILP). Table 9 shows the descriptive statistics of the VAR model variables over the period 2000: q1 – 2011: q2. It shows the mean, maximum, minimum, standard deviation and the number of the observation. It is apparent that all variables have a low standard deviation, which shows that there are no outliers in the times series data. The standard deviation measures the dispersion of each set of data from its mean.

Table 9. Descriptive statistics for the budget variables

Statistics	PROILP	NROILP	TAX	REV	CUREXP	DEVEXP	DEFICIT
Mean	0.080	-0.039	0.013	0.032	0.029	0.006	0.004
Maximum	0.4130	0.000	0.017	0.049	0.043	0.011	0.011
Minimum	0.000	-0.526	0.010	0.019	0.018	0.003	0.000
Std. Dev.	0.090	0.095	0.001	0.007	0.007	0.002	0.002
Observations	46	46	46	46	46	46	46

6.1.2 Selected macroeconomic VAR model variables

The selected macroeconomic variables model includes Money supply (M2), inflation rate (INF), real exchange rate (RER), Murabaha[7] profit margin as a proxy for interest rate (MUR), positive real oil price (PROILP) and negative real oil price (NROILP). The descriptive statistics of these variables over the period 2000: q1 – 2011: q2 is presented in Table 10. The standard deviation of the series is very small, which shows low dispersion. That is, there is no extreme outlier in the series.

Table 10. Descriptive statistics of the macroeconomic variables

Statistics	PROILP	NROILP	M2	INF	RER	MUR
Mean	0.080	-0.039	0.0602	0.098	1.320	0.130
Maximum	0.413	0.000	0.1650	0.206	2.416	0.242
Minimum	0.000	-0.526	0.0110	0.018	1.015	0.093
Std. Dev.	0.090	0.095	0.036	0.043	0.331	0.034
Observations	46	46	46	46	46	46

6.1.3 Current account VAR model variables

This model includes non-oil exports (NOEX), imports (IMP), trade balance (TB), current account balance (CAB), positive real oil price (PROILP) and negative real oil price (NROILP). The descriptive statistics of these variables over the period 2000: q1 – 2011: q2 are presented in Table 11. The standard deviation of the series is so small, ranges from

[7] Murabaha profit margin rate is a cost of finance used by Islamic financial institutions

0.002 to 0.0959, which presents low dispersion among series. That is, there is no extreme outlier in the series.

Table 11. Descriptive statistics of the current account variables

	PROILP	NROILP	NOEX	IMP	TB	CAB
Mean	0.080	-0.039	0.006	0.039	0.001	-0.014
Maximum	0.413	0.000	0.011	0.072	0.033	0.022
Minimum	0.000	-0.526	0.002	0.024	-0.027	-0.045
Std. Dev.	0.090	0.095	0.002	0.009	0.012	0.013729
Observations	46	46	46	46	46	46

6.1.4 GDP growth and unemployment rates VAR model

This model includes the growth rate of the real Gross Domestic Product (GDP) (RGDPG), unemployment rate (UNEM), positive real oil price (PROILP) and negative real oil price (NROILP). The descriptive statistics of these variables over the period 2000– 2011 is presented in Table 12. The standard deviation of the series was small, ranging from 0.022 to 0.160, which presents low dispersion among the series. The increase in the standard deviation for both oil price series was attributed to the unexpected increase and decrease in 2008 and 2009.

Table 12. Descriptive statistics of the GDP growth and unemployment rates

	PROILP	NROILP	RGDPG	UNEM
Mean	0.209167	-0.046667	0.072833	0.155083
Median	0.209000	0.000000	0.079500	0.155083
Maximum	0.550000	0.000000	0.102000	0.175000
Minimum	0.000000	-0.330000	0.019000	0.120000
Std. Dev.	0.160763	0.111056	0.023335	0.015078
Observations	12	12	12	12

6.1.5 Sectors growth rates VAR model variables

This model includes agricultural sector growth rate (AGRICULTURE), industrial sector growth rate (INDUSTRY), services sector growth rate (SERVICES), positive real oil price (PROILP) and negative real oil price (NROILP). The descriptive statistics of these variables over the period 2000– 2011 is presented in Table 13. The standard deviation of the series was small, ranging from 0.034 to 0.160, which presented low dispersion among series. The increase in the standard deviation for both oil price series was attributed to the unexpected increase and decrease in 2008 and 2009. An outlier value was found in the agricultural sector growth and had been amended. The outlier was truncated and recorded to the lowest reasonable value (Osborne and Amy, 2004).

Table 13. Descriptive statistics of the sectors' growth rates

	PROILP	NROILP	AGRICULTURE	INDUSTRY	SERVICES
Mean	0.209	-0.046	0.052	0.152	0.055
Median	0.215	0.000	0.070	0.120	0.070
Maximum	0.550	0.000	0.080	0.470	0.210
Minimum	0.000	-0.330	0.030	0.000	-0.250
Std. Dev.	0.160	0.111	0.034	0.132	0.109
Observations	12	12	12	12	12

6.2 Unit root and stationary tests

Since macroeconomic time series data is characterized by non-stationarity, unit test is employed using Augmented Dickey Fuller (1979) and Phillips and Perron (1988) and cross-checked by Kwiatkowski, Philips, Schmidt and Shin (1992). The former two tests based on the null hypothesis of non-stationarity, while the latter based on the hypothesis of stationary. Using of the stationarity and unit root tests together is known as "confirmatory data analysis" (Brooks, 2002: 379-381). If the probability value (*p*) is found to be less than 5 per cent or the *t* statistics is greater than the critical value, the null hypothesis would be rejected; otherwise the alternative hypothesis will be accepted. Instead of testing the three equations for stationarity (with constant, constant and trend and no constant and no trend), the time series data was graphically plotted. Then, the right equations that would be tested were visually selected (see Appendix 3, 6, 9, 12 and 15). However, when there was uncertainty between two equations, the test was run for more than one equation.

6.2.1 Public budget VAR model

Table 14 shows the results of the three stationary tests. As can be seen from Table 10, the total revenues, development expenditure, current expenditure and budget deficit exhibit non-stationary at level, while becoming stationary after taking the first difference. Negative and positive real oil prices and tax revenues variables are stationary at level.

Table 14. Budget VAR model: Unit and stationary test results

Variables	ADF		PP		KPSS	
	Level	1st. differ.	Level	1st. differ.	Level	1st. differ.
PROILP	0.0000*	-	0.0000*	-	0.3512*	-
NROILP	0.0000*	-	0.0000*	-	0.0582*	-
TAX	0.2513	-	0.0268*	-	0.5306*	-
REV	0.2349	0.5382	0.1120	0.0000*	0.5266*	0.3048*
DEVEXP	0.3380	0.1906	0.0203*	0.0000*	0.0000	0.2936*
CUREXP	0.1881	0.0000*	0.1916	0.0000*	0.12998*	0.5000*
DEFICIT	0.1469	0.0000*	0.1496	0.0000*	0.0689*	0.6002*

*indicate significance at 5%.

6.2.2 Selected macroeconomic VAR model

Table 15 shows the result of stationary and unit root tests. It is clear that PROILP, NROILP, M2, INF and MUR are stationary at level, while RER is stationary at first difference. That is, the latter variable is not stationary at level and becomes stationary after taking the first difference.

Table 15. Selected macroeconomic variables VAR model: stationary tests

Variables	ADF		PP		KPSS	
	Level	1st. difference	Level	1st. difference	Level	1st. difference
PROILP	0.0000*	-	0.0000*	-	0.3512*	-
NROILP	0.0000*	-	0.0000*	-	0.0582*	-
M2	0.0001*	-	0.0001*	-	0.2909*	-
INF	0.0219	-	0.0243	-	0.7984	-
RER	1.0000	0.0000*	0.9929	0.0000*	0.1744*	0.156992*
MUR	0.0212*	-	0.0243*	-	0.1780*	-

*indicate significance at 5%.

6.2.3 Current account VAR model

Table 16 shows the results of the ADF, PP and KPSS tests. Current account balance, imports, non-oil exports and trade balance variables exhibit non-stationary at level, while becoming stationary after taking the first difference. Negative and positive real oil price variables are stationary at level.

Table 16. Current account VAR model: results of the unit and stationary tests

Variables	ADF		PP		KPSS	
	Level	1st. difference	Level	1st. difference	Level	1st. difference
PROILP	0.0000*	-	0.0000*	-	0.3512*	-
NROILP	0.0000*	-	0.0000*	-	0.0582*	-
CAB	0.1127	0.0000*	0.1318	0.0000*	0.2448*	0.2443*
IMP	0.2003	0.0000*	0.0046*	0.0000*	0.2435*	0.1448*
NOEX	0.0920	0.0000*	0.0920	0.0000*	0.4693*	0.2685*
TB	0.1437	0.0000*	0.1181	0.0000*	0.2892	0.2924*

*indicate significance at 5%.

6.2.4 GDP growth and unemployment rates VAR model

Table 17 shows the result of the stationary and unit root tests. It is apparent that negative real oil price (NROILP) and positive real oil price (PROILP) rejected the null hypothesis of non-stationary using ADF and PP tests and failed to reject the stationary null hypothesis of the KPSS test. Accordingly, NROILP and PROILP are stationary at level. However, Real GDP growth (RGDPG) failed to reject the null hypothesis of non-stationary using ADF and PP tests and also failed to reject the stationary null hypothesis of the KPSS test. Therefore, real GDP growth is said to be non-stationary at level. But it became stationary after taking the first difference. Finally, the unemployment rate (UEM) exhibited non-stationary at level using ADF and PP, but became stationary after taking the second difference. As the sample period was short and the number of observations was relatively small, all variable was used at level in the VAR model. Some scholars claim that using differencing technique to make the variables stationary should be avoided, as it results in losing of some information, which is of benefit for the long run relationship between time series variables (Sims, 1980; Hamilton, 1994; Enders, 1995: 301; Halcoussis, 2005; Brooks, 2008). It is worth mentioning that the small size of the sample or fewer number of the observation was not an issue as long as the model can be validated (Harrel, 2011: 66).

Table 17. GDP and unemployment VAR model: unit and stationary test results

Variables	ADF		PP		KPSS	
	Level	1st. difference	Level	1st. difference	Level	1st. difference
PROILP	0.0000*	-	0.0000*	-	0.3512*	-
NROILP	0.0000*	-	0.0000*	-	0.0582*	-
RGDPG	0.5202	0.0000*	0.4557	0.0000*	0.2006	0.1013*
UEM**	0.2869	0.4079	0.7423	0.4079	0.1822	0.2918

*indicate significance at 5%
**became stationary after taking the second difference

6.5.2 Sector growth rates VAR model

Table 18 shows the result of stationary and unit root tests. It is clear that negative real oil price (NROILP) and positive real oil price (PROILP) rejected the null hypothesis of none stationary using ADF and PP tests and failed to reject the stationary null hypothesis of the KPSS test. Accordingly, NROILP and PROILP were stationary at level. Likewise, agricultural sector growth and the industrial sector growth rejected the null hypothesis of non-stationary at level using ADF and PP, and failed to reject the null hypothesis of stationary using KPSS. For the services sector growth, it failed to reject the non-stationary null hypothesis of the ADF, but rejected the null hypothesis of the PP and failed to reject the stationary hypothesis of the KPSS. Accordingly, agricultural sector growth, industrial sector growth and services sector growth were stationary at level.

Table 18. Sector growth VAR model: unit and stationary tests results

Variables	ADF		PP		KPSS	
	Level	1st. difference	Level	1st. difference	Level	1st. difference
PROILP	0.0018*	-	0.0015*	-	0.5000*	-
NROILP	0.0209*	-	0.0180*	-	0.1989*	-
Agriculture	0.0180*	-	0.0021*	-	0.5000*	-
Industry	0.0281*	-	0.0009*	-	0.5000*	-
Services	0.1792	-	0.0128*	-	0.5000*	-

*indicate significance at 5%

6.3 Lag length selection criteria

The next step before estimating the VAR model is to select the appropriate lag length that captures the relationships among the variables. By knowing the integrated order of the model, it will be easy to run the VAR model and conduct the required tests. Similar to the stationary test, the research uses three tests to identify the optimal lag length, namely Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC) and Hannan-Quinn information Criterion (HQIC). According to these information criteria, lag that corresponds to the highest absolute value of the criterion will be selected. Generally, whenever there are conflicting results, researchers opt for the lag chosen by the majority.

6.3.1 Public budget VAR model

Table 19 displays the different criteria for selecting the optimal lag length of the VAR model. As it can be seen from the table, the majority of the criteria selects lag one.

Table 19. Public budget VAR model: lag length selection criteria

Lag	AIC	SC	HQ
0	-55.20540	-54.91579*	-54.49472
1	-55.34395*	-53.02706	-55.09925*
2	-54.50001	-50.15583	-52.90769
3	-54.33437	-47.96292	-51.99898

*indicate significance at 5%.

6.3.2 Selected macroeconomic VAR model

As can be seen from Table 20, the results suggest that the VAR model is integrated of order one, *I* (1).

Table 20. Selected macroeconomic variables VAR model: lag length selection criteria

Lag	AIC	SC	HQ
0	-17.66458	-17.41382*	-17.57327
1	-18.71114*	-16.95577	-18.07193*
2	-18.51154	-15.25158	-17.32444
3	-18.30273	-13.53816	-16.56774
4	-18.57386	-12.30469	-16.29097

* indicate significance at 5%

6.3.3 current account VAR model

Table 21 presents the different criteria for selecting the optimal lag length of the current account VAR model. As it can be seen from table 29, the majority of the criteria selected lag one.

Table 21. Current account VAR model: lag length selection criteria

Lag	AIC	SC	HQ
0	-35.61994	-35.36918*	-35.16375
1	-35.80296*	-34.04759	-35.52863*
2	-34.74184	-31.48187	-33.55474
3	-34.55394	-29.78938	-32.81895
4	-34.36014	-28.09097	-32.07725

* indicates lag order selected by the criterion

6.3.4 GDP growth and unemployment rates VAR model

Due to the short period of the time series data with regard to the real GDP growth rate and the unemployment rate, which both are available on an annual basis, the standard lag length is one (Brooks, 2008). That is, the VAR model is of order one.

6.3.5 Sectors growth VAR model

Due to the short period of the time series data with regard to the agricultural sector growth rate, industrial sector growth rate and services sector growth rate, which were available on an annual basis, the recommended lag length was one (Hamilton, 1994, Brooks, 2008). That is, the VAR model was of order one.

6.4 Models estimation

This section discusses the outcomes of the five estimated VAR models using Ordinary Least Squares (OLS). Following Hamilton (1983), Gisser and Goodwin (1986), Mork (1989), Mork et al. (1994), Lee et al. (1995), Chuku (2012), and Gunu and Kilishi (2010), the sign of the VAR model coefficients was used to explain the direction and the effect of the explanatory variables on the dependant variables over the period 200: q1 – 2011: q2. That is, negative sign of the coefficient shows negative relationship, while the positive sign means positive link. According to Chuku et. al. (2011) the sign of the coefficients gives a baseline intuition of the basic relationship among the variables.

6.4.1 Public budget VAR model

Table 22 presents the estimates of the budget VAR model using an ordinary least squares method. Each column constitutes an equation in the VAR model. The entire system of equations is provided in Appendix 4. As can be seen from Table 22, positive real oil price has a positive relationship with the entire set of the public budget variables. The negative real oil price shock showed a negative relationship with all budget variables.

Table 22. Public budget VAR model estimated coefficients

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
PROILP(-1)	0.1562	-0.1803	0.0005	0.0065	0.0029	0.0023	-0.0030
	(0.1542)	(0.1864)	(0.0034)	(0.006)	(0.0045)	(0.0028)	(0.0045)
	[1.0134]	[-0.9670]	[0.1649]	[1.0592]	[0.6510]	[0.8274]	[-0.6728]
NROILP(-1)	-0.0636	0.2476	-0.0046	-0.0303	-0.0214	-0.0020	0.0073
	(0.1439)	(0.1739)	(0.0032)	(0.0058)	(0.0042)	(0.0026)	(0.0042)
	[-0.4423]	[1.4234]	[-1.4211]	[-5.2386]	[-5.1020]	[-0.7773]	[1.7545]
TAX(-1)	3.8223	-1.9011	0.6719	-0.8131	-0.4062	-0.1886	-0.1682
	(5.8522)	(7.0761)	(0.1323)	(0.2358)	(0.1708)	(0.1087)	(0.1714)
	[0.6531]	[-0.2686]	[5.0771]	[-3.4480]	[-2.3778]	[-1.7351]	[-0.9811]
D(REV(-1))	-4.7548	4.0790	0.0550	0.0069	0.0323	0.0304	0.1219
	(5.8183)	(7.0351)	(0.1315)	(0.2344)	(0.1698)	(0.1080)	(0.1704)
	[-0.8172]	[0.5798]	[0.4183]	[0.0298]	[0.1906]	[0.2815]	[0.7155]
D(CUREXP(-1))	-10.5112	4.9786	-0.0373	-0.2643	-0.1682	-0.0012	0.0865
	(7.9969)	(9.6693)	(0.1808)	(0.3222)	(0.2334)	(0.1485)	(0.2343)
	[-1.3144]	[0.5148]	[-0.2066]	[-0.8202]	[-0.7208]	[-0.0082]	[0.3693]
D(DEVEXP(-1))	-0.6792	-8.3855	-0.1187	-0.5607	-0.0351	-0.3021	0.0960
	(11.4104)	(13.796)	(0.2580)	(0.4597)	(0.3330)	(0.2119)	(0.3343)
	[-0.0595]	[-0.6077]	[-0.4601]	[-1.2194]	[-0.1054]	[-1.4253]	[0.2872]
D(DEFICIT(-1))	3.0524	-2.7645	-0.0043	0.3146	0.1376	0.0295	-0.1087
	(6.9404)	(8.3919)	(0.1569)	(0.2796)	(0.2026)	(0.1289)	(0.2033)
	[0.4398]	[-0.3294]	[-0.0278]	[1.1249]	[0.6793]	[0.2292]	[-0.5346]
C	0.0196	0.0698	0.0049	0.0125	0.0068	0.0026	0.0024
	(0.0850)	(0.1028)	(0.0019)	(0.0034)	(0.0024)	(0.0015)	(0.0024)
	[0.2311]	[0.6792]	[2.5753]	[3.6475]	[2.7410]	[1.6466]	[0.9846]
R-squared	0.3286	0.1425	0.4906	0.6136	0.5245	0.5108	0.6155
S.E equation	0.0818	0.0990	0.0018	0.0033	0.0023	0.0015	0.0023

6.4.2 Selected macroeconomic VAR model

Table 23 presents the estimated selected macroeconomic variables VAR model using the ordinary least square method. Each column constitutes an equation in the VAR model. The entire system of equations is provided in Appendix 7. As can be seen from Table 23, positive real oil price had a positive relationship with money supply, inflation rate and Murabaha profit margin rate, while it had a negative relationship with the real exchange rate. The negative relationship between positive real oil price and the real exchange rate means that when oil price increase exchange rate appreciates as it becomes stronger due to an increase of foreign exchange reserve at the central bank of Sudan. On the other hand, negative real oil price shock showed a negative relationship with inflation and Murabaha profit margin rate, while exhibit a positive relationship with real exchange rate and money supply.

Table 23. Selected macroeconomic variables VAR model estimated coefficients

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	M2	INF	D(RER)	MUR
PROILP(-1)	-0.0218	-0.0762	0.0262	0.0844	-0.1280	0.0023
	(0.1747)	(0.1740)	(0.0659)	(0.0669)	(0.2192)	(0.0178)
	[-0.1247]	[-0.4383]	[0.3983]	[1.2618]	[-0.5840]	[0.1311]
NROILP(-1)	-0.0468	0.1953	0.0602	-0.0295	0.1980	-0.0046
	(0.1714)	(0.1707)	(0.0646)	(0.0656)	(0.2150)	(0.0174)
	[-0.2735]	[1.1439]	[0.9314]	[-0.4502]	[0.9209]	[-0.2683]
M2(-1)	-0.3583	0.2640	0.2919	-0.0072	0.2465	-0.0298
	(0.4427)	(0.4408)	(0.1670)	(0.1695)	(0.5553)	(0.0451)
	[-0.8094]	[0.5989]	[1.7477]	[-0.0428]	[0.4439]	[-0.6609]
INF(-1)	-0.3354	1.0545	-0.1684	0.4729	0.4425	0.0009
	(0.4049)	(0.4033)	(0.1528)	(0.1550)	(0.5080)	(0.0412)
	[-0.8283]	[2.6149]	[-1.1026]	[3.0498]	[0.8712]	[0.0223]
D(RER(-1))	0.1691	-0.1283	-0.0638	0.0286	-0.3031	-0.0068
	(0.1394)	(0.1388)	(0.0526)	(0.0534)	(0.1749)	(0.0142)
	[1.2124]	[-0.9238]	[-1.2137]	[0.5367]	[-1.73279]	[-0.4846]
MUR(-1)	-0.6975	0.7884	0.0582	-0.2897	-0.4673	0.8663
	(0.5358)	(0.5336)	(0.2021)	(0.2051)	(0.6722)	(0.0546)
	[-1.3017]	[1.4774]	[0.2883]	[-1.4121]	[-0.6952]	[15.868]
C	0.2228	-0.1777	0.0495	0.0843	0.0422	0.0161
	(0.1062)	(0.1058)	(0.0400)	(0.0406)	(0.1332)	(0.0108)
	[2.0976]	[-1.6795]	[1.2362]	[2.0731]	[0.3171]	[1.4918]
R-squared	0.0897	0.2114	0.5078	0.4252	0.5205	0.8961
S.E equation	0.0941	0.0937	0.0355	0.0360	0.1180	0.0096

6.4.3 current account VAR model

Table 24 presents the current account VAR model estimates using ordinary least square method. Each column constitutes an equation in the VAR model. The entire system of the equations is provided in Appendix 10. As can be seen from Table 24, positive real oil price had a negative relationship with non-oil exports, trade balance and current account balance, while it had a positive relationship with imports. The negative relationship between positive real oil price and trade balance and current account balance means that when oil price increase these two variables improve as the gap in the two accounts narrows down. On the flip side, decrease in real oil price showed a positive relationship with all variables in the model except imports. That is, negative real oil price shock increases gap in the trade balance and the current account balance, while enhancing non-oil exports.

Table 24. Current account VAR model estimates

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	D(NOEX)	D(IMP)	D(TB)	D(CAB)
PROILP(-1)	-0.1105	0.0225	-0.0003	0.0266	-0.0279	-0.0383
	(0.1683)	(0.1983)	(0.0031)	(0.0159)	(0.0193)	(0.0220)
	[-0.6563]	[0.1136]	[-0.1286]	[1.6701]	[-1.4443]	[-1.7379]
NROILP(-1)	0.2354	-0.0752	0.0062	-0.0220	0.0193	0.0485
	(0.1739)	(0.2049)	(0.0032)	(0.0164)	(0.0200)	(0.0227)
	[1.3534]	[-0.3671]	[1.9546]	[-1.3377]	[0.9673]	[2.1309]
D(NOEX(-1))	9.6561	-7.5508	-0.2425	-0.7916	0.5311	-0.1864
	(8.3811)	(9.8722)	(0.1542)	(0.7937)	(0.9649)	(1.0979)
	[1.1521]	[-0.7648]	[-1.5717]	[-0.9972]	[0.5504]	[-0.1698]
D(IMP(-1))	0.9146	-3.7079	0.0312	-0.8414	0.6450	0.8538
	(2.1199)	(2.4970)	(0.0390)	(0.2007)	(0.2440)	(0.2777)
	[0.4314]	[-1.4849]	[0.8017]	[-4.1907]	[2.6430]	[3.0745]
D(TB(-1))	-1.7315	-5.0545	0.0690	0.0710	-0.1399	0.0385
	(3.2084)	(3.7792)	(0.0590)	(0.3038)	(0.3693)	(0.4203)
	[-0.5397]	[-1.3374]	[1.1691]	[0.2337]	[-0.3789]	[0.0918]
D(CAB(-1))	6.3290	-0.6422	-0.0128	-0.4307	0.6648	0.6389
	(2.2973)	(2.7060)	(0.0422)	(0.2175)	(0.2644)	(0.3009)
	[2.7549]	[-0.2373]	[-0.3044]	[-1.9796]	[2.5137]	[2.1230]
C	0.0770	0.0436	-0.0003	-0.0009	0.0015	0.0012
	(0.0190)	(0.0224)	(0.0003)	(0.0018)	(0.0021)	(0.0025)
	[4.0426]	[1.9435]	[-1.0355]	[-0.5086]	[0.6923]	[0.5028]
R-squared	0.3092	0.1626	0.5465	0.4770	0.6595	0.7031
S.E equation	0.0819	0.0965	0.0015	0.0078	.0094	0.0107

6.4.4 GDP growth and unemployment rates VAR model

Table 25 presents the GDP and employment VAR model estimates using Ordinary Least Square (OLS) method. Each column constitutes an equation in the VAR model. The entire system of equations provided in Appendix 13. As can be seen from Table 25, positive real oil price had a positive relationship with the real GDP growth, but negatively related to the unemployment rate. The negative relationship between positive real oil price and unemployment rate means more jobs will be created during the oil price boom. Looking at the negative real oil price shock, it negatively related to the growth rate of the GDP and unemployment rate as well. That is, negative real oil price shock shrank GDP growth rate and reduced unemployment rate.

Table 25. GDP and unemployment VAR model estimates

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	RGDPG	UNEM
PROILP(-1)	-0.4838	0.5643	0.0914	-0.0665
	(0.2926)	(0.2441)	(0.0387)	(0.0703)
	[-1.6533]	[2.3118]	[2.3626]	[-0.9462]
NROILP(-1)	-0.4325	0.1916	-0.0240	-0.0272
	(0.4207)	(0.3510)	(0.0556)	(0.1011)
	[-1.0279]	[0.5460]	[-0.4322]	[-0.2692]
RGDPG(-1)	-1.2119	1.2044	0.2401	0.4142
	(1.9208)	(1.6025)	(0.2540)	(0.4617)
	[-0.6309]	[0.7516]	[0.9453]	[0.89716]
UNEM(-1)	1.6024	1.1039	-0.4381	0.5425
	(1.5102)	(1.2600)	(0.1997)	(0.3630)
	[1.0610]	[0.8761]	[-2.1938]	[1.4943]
C	0.1170	-0.3447	0.1063	0.0642
	(0.3443)	(0.2872)	(0.0455)	(0.0827)
	[0.3399]	[-1.2000]	[2.3356]	[0.7761]
R-squared	0.4332	0.5336	0.7119	0.3847
S.E. equation	0.1219	0.1017	0.0161	0.0293

6.4.4 Sectors growth rates VAR model

Table 26 presents the sectors growth VAR model estimates using ordinary least square method. Each column constitutes an equation in the VAR model. The entire system of equations is provided in Appendix 16. As can be seen from Table 26, positive real oil price had a positive relationship with the agricultural sector growth rate and growth rate of the service sector, while it had a negative relationship with the industrial sector growth rate. The positive relationship between positive real oil price and agricultural and services growth means that when real oil price increased these two sectors witnessed a boom. On the flip side, negative real oil price shock had shown a positive relationship with the growth rate in agricultural and negative impact on both the industrial and the service sector growth rates. That is, negative real oil price shock increased the rate of growth in the agricultural sector, while retarding growth in the industrial and the services sectors.

Table 26. Sectors growth VAR model estimated coefficients

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	AGRICULTURE	INDUSTRY	SERVICES
PROILP(-1)	-0.0704	0.5544	0.1369	-0.2187	0.2021
	(0.5038)	(0.4423)	(0.0663)	(0.3892)	(0.2273)
	[-0.1398]	[1.2534]	[2.0648]	[-0.5619]	[0.8893]
NROILP(-1)	-0.0929	0.2453	0.1540	-0.5321	-0.6553
	(0.5119)	(0.4494)	(0.0673)	(0.3955)	(0.2309)
	[-0.1814]	[0.5457]	[2.2863]	[-1.3453]	[-2.8372]
AGRICULTURE(-1)	-3.7089	0.8935	-0.9427	1.5174	-2.6076
	(2.6945)	(2.3656)	(0.3546)	(2.0817)	(1.2157)
	[-1.3764]	[0.3777]	[-2.6581]	[0.7289]	[-2.14492]
INDUSTRY(-1)	-0.1768	-0.0960	-0.1183	0.1532	-0.2693
	(0.4891)	(0.4294)	(0.0643)	(0.3779)	(0.2207)
	[-0.3615]	[-0.2236]	[-1.8385]	[0.4055]	[-1.2205]
SERVICES(-1)	-0.4050	0.3298	0.1229	0.3491	-0.3006
	(0.4115)	(0.3613)	(0.0541)	(0.3179)	(0.1856)
	[-0.9841]	[0.9129]	[2.2700]	[1.0980]	[-1.6192]
C	0.4675	-0.1243	0.0922	0.0626	0.2670
	(0.1521)	(0.1335)	(0.0200)	(0.1175)	(0.0686)
	[3.0740]	[-0.9307]	[4.6064]	[0.5330]	[3.8913]
R-squared	0.5188	0.5616	0.7170	0.4499	0.8812
S.E. equation	0.1231	0.1081	0.0162	0.0951	0.0555

6.5 Diagnostic tests

For testing the adequacy of the VAR model, four tests were carried out, namely serial correlation, heteroskedasticity, stability and normality tests.

6.5.1 Public budget VAR model

As can be seen from Table 27, the outcomes of the tests were that no serial correlation, no heteroskedasticity, VAR satisfies the stability condition (detailed information provided in Appendix 5). However, the VAR model failed to pass the normality test using the Jarque-Bera test. Generally speaking, the Jarque - Bera test suffers from low power when used for small samples (Thadewald and Buning, 2004). Moreover, normality is not a necessary condition for validating most of the VAR model statistical tests (Lütkepohl, 2009). This statement is further emphasised by Pindyck and Rubinfeld (1998: 146). They also claim that the violation of the assumption of normality is not serious and the estimated coefficient will remain unchanged, however the intercept will pick up the effect.

Table 27. Summary of the public budget VAR model adequacy tests

Type of test	Null Hypothesis	*p*-value	Decision
Autocorrelation (Portmanteau test)	No residual autocorrelations up to lag *h*	Greater than 5%	Null hypothesis accepted
Normality (Jarque-Bera test)	Residuals are multivariate normal	Less than 5%	Null hypothesis rejected
Heteroscedasticity (Whit test)	VAR residuals are homoscedasticity	Greater than 5%	Null hypothesis accepted
Stability (Roots of characteristic polynomial)	No root lies outside the unit circle	N.A*	Null hypothesis accepted

*Not applicable

6.5.2 Selected macroeconomic VAR model

As can be seen form table 28, the outcome is that no serial correlation, no heteroskedasticity, VAR satisfies the stability condition (detailed information provided in Appendix 8). However, the VAR model fails to pass the normality test using the Jarque-Bera test. As mentioned earlier, Jarque-Bera test suffers from low power when used for small sampling (Thadewald and Buning, 2004). Moreover, normality is not a necessary condition for validating most of the VAR model statistical tests (Lütkepohl, 2009). This statement is further emphasised by Pindyck and Rubinfeld (1998: 146). They further claim that the violation of the assumption of normality is not a serious and the estimated coefficient will remain unchanged, however the intercept will pick up the effect.

Table 28. Summary of the selected macroeconomic variables VAR model adequacy tests

Type of test	Null Hypothesis	*p*-value	Decision
Autocorrelation (Portmanteau test)	No residual autocorrelations up to lag *h*	Greater than 5%	Null hypothesis accepted
Normality (Jarque-Bera test)	Residuals are multivariate normal	Less than 5%	Null hypothesis rejected
Heteroscedasticity (Whit test)	VAR residuals are homoscedasticity	Greater than 5%	Null hypothesis accepted
Stability (Roots of characteristic polynomial)	No root lies outside the unit circle	N.A*	Null hypothesis accepted

6.5.3 Current account VAR model

As can be seen from Table 29, the outcome was that no serial correlation, no heteroskedasticity, VAR satisfies the stability condition (detailed information provided in Appendix 11). However, the VAR model failed to pass the normality test using the Jarque-Bera test. But this is not a serious problem as Jarque-Bera test suffers from low power when used for the small sample (Thadewald and Buning, 2004). Also, normality is not a necessary condition for validating most of the VAR model statistical tests (Lütkepohl, 2009). This statement is further emphasised by Pindyck and Rubinfeld (1998: 146). They also claim that the violation of the assumption of normality is not a serious problem and the estimated coefficient will remain unchanged, however the intercept will pick up the effect.

Table 29. Summary of the current account VAR model adequacy tests

Type of test	Null Hypothesis	*p*-value	Decision
Autocorrelation (Portmanteau test)	No residual autocorrelations up to lag *h*	Greater than 5%	Null hypothesis accepted
Normality (Jarque-Bera test)	Residuals are multivariate normal	Less than 5%	Null hypothesis rejected
Heteroscedasticity (Whit test)	VAR residuals are homoscedasticity	Greater than 5%	Null hypothesis accepted
Stability (Roots of characteristic polynomial)	No root lies outside the unit circle	N.A*	Null hypothesis accepted

*not applicable

6.5.4 GDP growth and unemployment rates VAR model

As can be seen from Table 30, the outcome was that no serial correlation, no heteroskedasticity, VAR satisfied the stability condition and the VAR model passed the normality test using the Jarque-Bera test (detailed information provided in Appendix 14).

Table 30. Summary of the GDP growth VAR model adequacy tests

Type of test	Null Hypothesis	*p*-value	Decision
Autocorrelation (Portmanteau test)	No residual autocorrelations up to lag *h*	Greater than 5%	Null hypothesis accepted
Normality (Jarque-Bera test)	Residuals are multivariate normal	Less than 5%	Null hypothesis accepted
Heteroscedasticity (Whit test)	VAR residuals are homoscedasticity	Greater than 5%	Null hypothesis accepted
Stability (Roots of characteristic polynomial)	No root lies outside the unit circle	N.A*	Null hypothesis accepted

6.5.5 Sectors growth rates VAR model

As can be seen from Table 31, the outcome was that no serial correlation, no heteroskedasticity, VAR satisfied the stability condition and the VAR model passed the normality test using the Jarque-Bera test (detailed information provided in Appendix 17).

Table 31. Summary of the sectors growth VAR model adequacy tests

Type of test	Null Hypothesis	*p*-value	Decision
Autocorrelation (Portmanteau test)	No residual autocorrelations up to lag *h*	Greater than 5%	Null hypothesis accepted
Normality (Jarque-Bera test)	Residuals are multivariate normal	Less than 5%	Null hypothesis accepted
Heteroscedasticity (Whit test)	VAR residuals are homoscedasticity	Greater than 5%	Null hypothesis accepted
Stability (Roots of characteristic polynomial)	No root lies outside the unit circle	N.A.	Null hypothesis accepted

6.6 Delphi method analysis

6.6.1 Impact on Public budget variables

Figure 19 displays the response of the panel of experts on some items of the public budget. More than 60 per cent of the experts reported that increase in oil prices had a positive impact on revenue, development expenditure, current expenditure, tax revenues and budget deficit. The positive impact on revenue, current expenditure and development spending was consistent with the findings obtained by Eltoni and Al-Awadi (2001) and Lorde et al. (2009) in Kuwait and Trinidad and Tobago, respectively. Less than 13 per cent, agreed upon the negative impact on development expenditure, current expenditure, tax revenue and budget deficit. Approximately 7 per cent of the experts reported that impact on tax revenue and current expenditure was neutral.

Figure 19. Experts' response: impact of positive real oil price on public budget

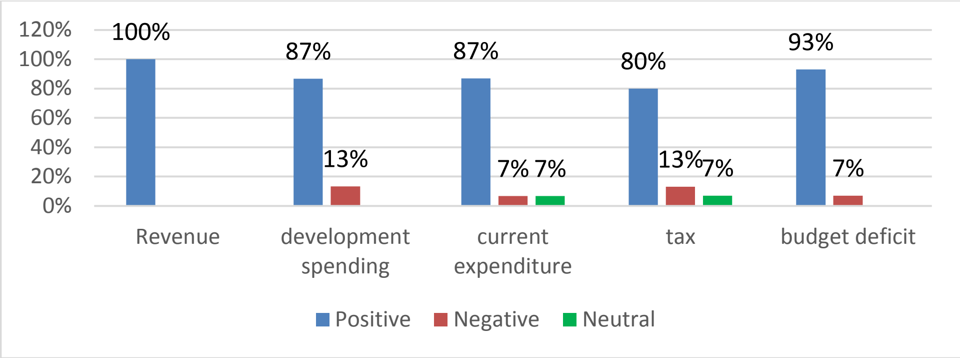
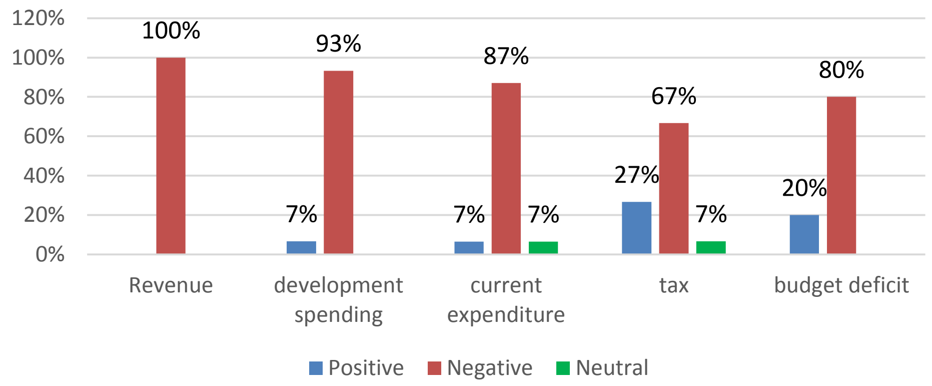


Figure 20 illustrates the impact of the decrease (negative) in oil prices on the budget items. More than 67 per cent of the experts suggested that the decrease in oil prices negatively impacted the five variables. However, 27 per cent of the experts claimed that decrease in oil prices positively affected tax revenue while less the 27 per cent opted for positive impact on development expenditure, current expenditure, and budget deficit. Moreover, 7 per cent of the experts reported neutral effect on the current expenditure and tax revenue as a result of a decrease in oil prices. Similar findings of negative impact on government expenditure was reported in Nigeria by Iwayemi and Fowowe (2011).

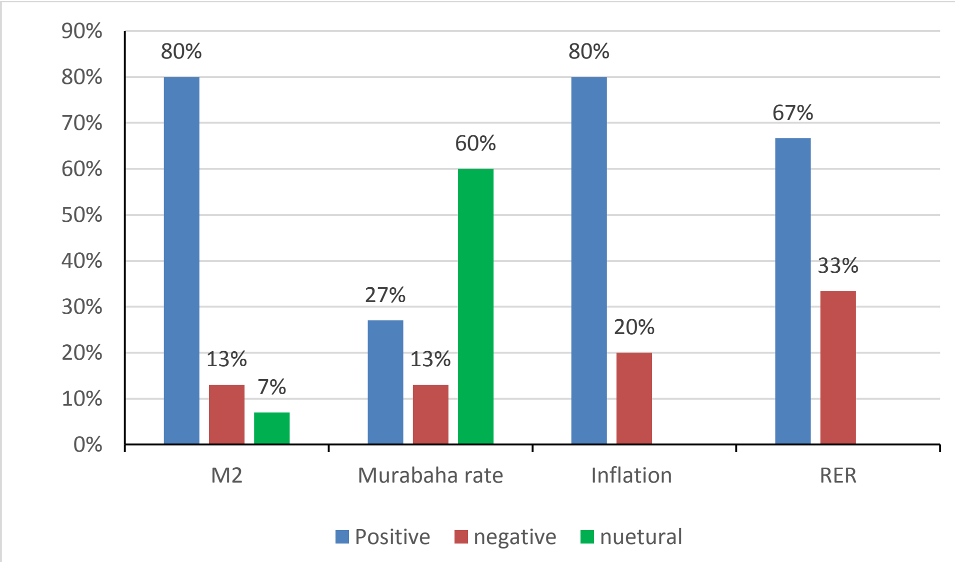
Figure 20 Experts' response: impact of negative real oil price on public budget



6.6.2 Impact on selected macroeconomic variables

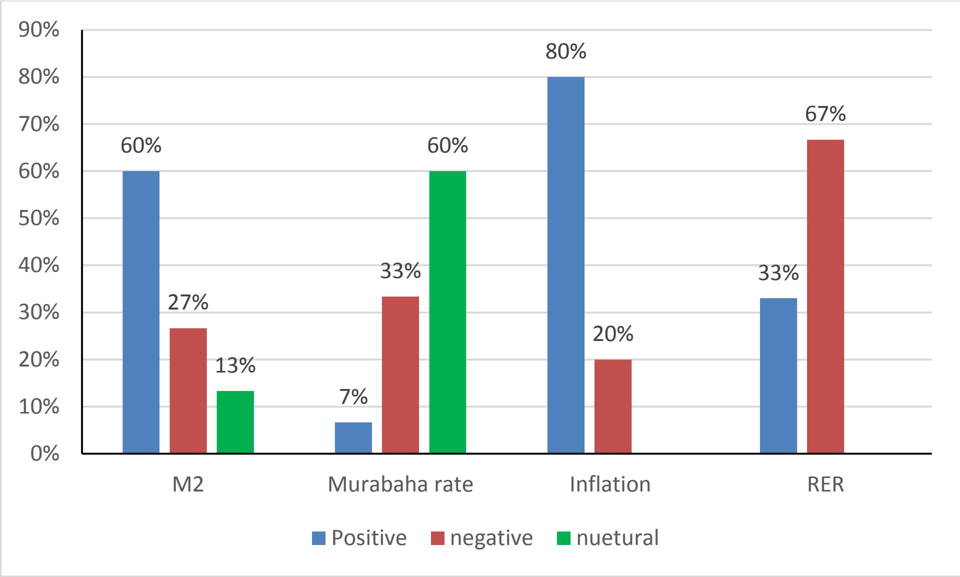
As can be seen from Figure 21 below, 60 per cent to 80 per cent of the experts claimed positive relationship between the increase in real oil prices and money supply, inflation rate, in addition to exchange rate appreciation. Similar results were reported by Al-mulali and Che Normee (2010), Farzanegan and Markwardt (2009) and Aliyu (2009) in Qatar, Iran and Nigeria, respectively. A few experts explained that the surge in oil prices had a negative impact on the above mentioned four macroeconomic variables. Murabaha profit margin rate was reported as neutrally affected by the increase in oil prices, respectively

Figure 21. Experts' response: impact of positive real oil price on selected macroeconomic variables



On the other hand, more than 60 per cent of the experts reported that the decrease in oil prices had a positive impact on inflation and money supply (Figure 22). This corroborated with findings by Farzanegan and Markwardt (2009). Real exchange rates were found to be negatively affected by decrease in oil prices. The negative impact on unemployment rate was confirmed in Algeria by Bochaour et al. (2012). The negative impact of the decrease in oil prices on real exchange was found in similar studies in Nigeria (Iwayemi and Fowowe, 2011) and Iran (Farzangean and Markwardt, 2009)

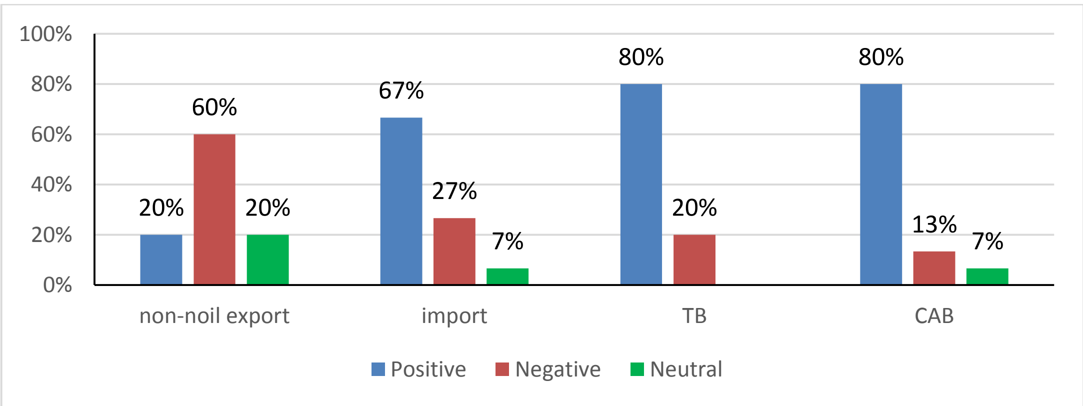
Figure 22. Experts' response: impact of negative real oil price on selected macroeconomic variables



6.6.3 Impact on the Current Account variables

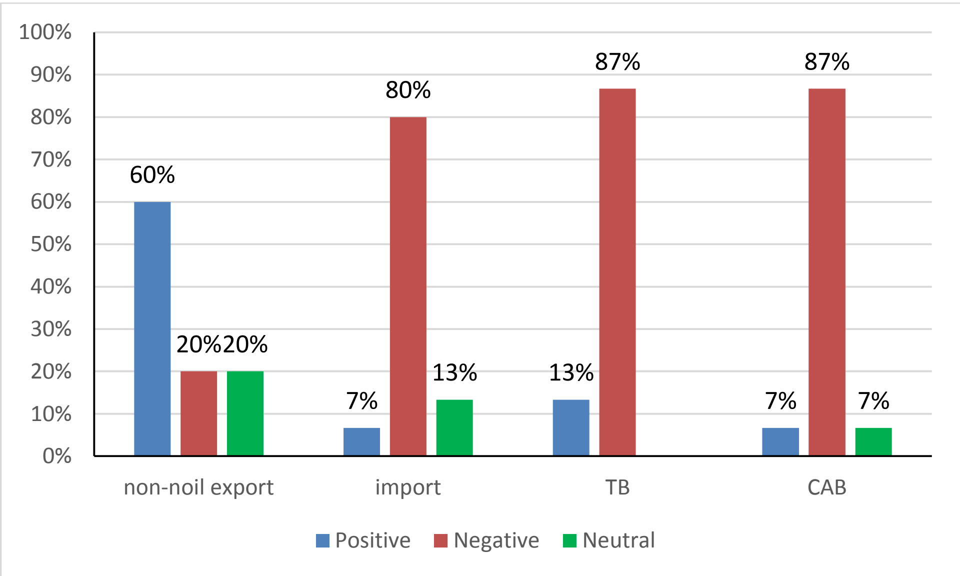
It is clear from Figure 23 that the majority of the experts supported the positive effects of increase in oil prices on real exchange rate, import, trade balance and current account balance. An interesting result is that 60 per cent of the experts reported that increase in oil prices negatively impacted none-oil exports. This result was explained by the shift of resources from the tradable to non-tradable sector. This result showed some signs of Dutch disease during the oil sector boom. Positive effect on import and export was found in Trinidad & Tobago (Lorde et al., 2009).

Figure 23. Experts' response: impact of positive real oil price on current account variables



On the flip side, a consensus was reached among experts that the decrease in oil prices had a negative impact on imports, trade balance and current account balance (Figure 24). This result reflected that Sudan was heavily dependent on oil export proceeds as the main source of foreign exchange. Almost 60 per cent of the experts reported that the decrease in oil prices positively impacted non-oil exports. This could be explained as a sign of the restoration of the tradable sectors to their vital role in the economy, especially agricultural sector. The negative impact of the decrease in oil prices on import was reported in similar studies conducted in Nigeria (Iwayemi and Fowowe, 2011) and Iran (Farzangan and Markwardt, 2009).

Figure 24. Experts' response: impact of negative real oil price on current account variables



6.6.4 Impact on GDP growth and unemployment rates

Figure 25 shows that 93 per cent of the panel of experts agreed on the positive impact of increase in real oil prices on GDP growth and 60 per cent confirmed the positive effect on the unemployment rate. They explained that oil windfalls during oil price hikes made available huge foreign exchange resources. This helped create a boom in other sectors such as trade, transport and other services, which in turn led to an increase in the value added in the economy. On the other hand, figure 26 shows that 86 per cent and 67 per cent of the experts supported the negative effects of real oil price decrease on GDP growth and unemployment rate, respectively.

Figure 25. Experts' response: impact of positive real oil price on GDP growth and unemployment rates

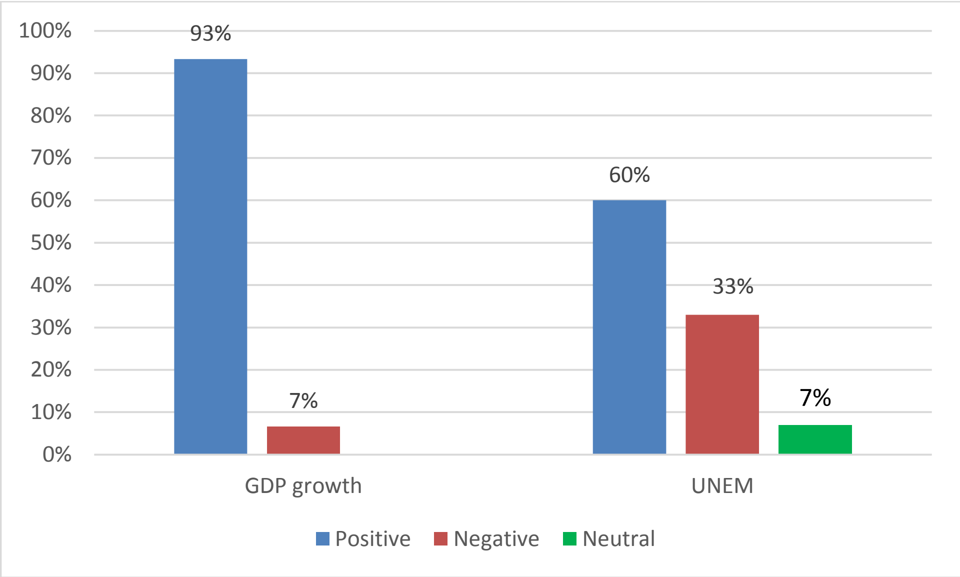
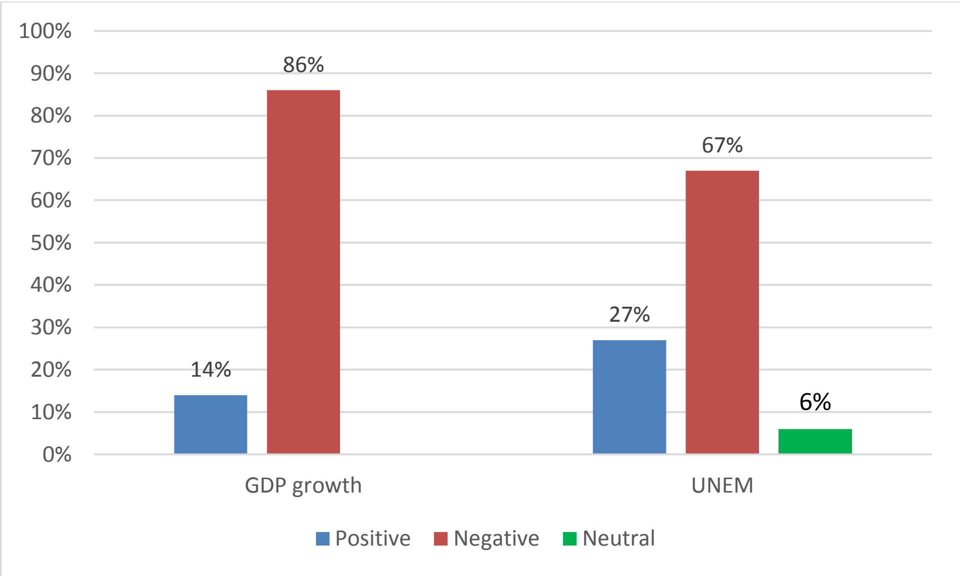


Figure 26. Experts' response: impact of negative real oil price on GDP growth and unemployment rates



6.6.5 Impact on sectors growth rates

Figure 27 reveals that more than 60 per cent of the experts reported a negative impact of the increase in real oil prices on agricultural and industrial sectors. This result was attributed to the effect of the appreciation of the exchange rate. However, they all agreed that the increase in real oil prices led to a boom in the services sector. Less than 40 per cent of the experts suggested that the surge in real oil prices positively affected the agricultural and industrial sectors. They claimed that the rise in real oil prices made huge foreign resources available for the government to invest in the latter two sectors.

Figure 27. Experts' response: impact of positive real oil price on sectors growth rates

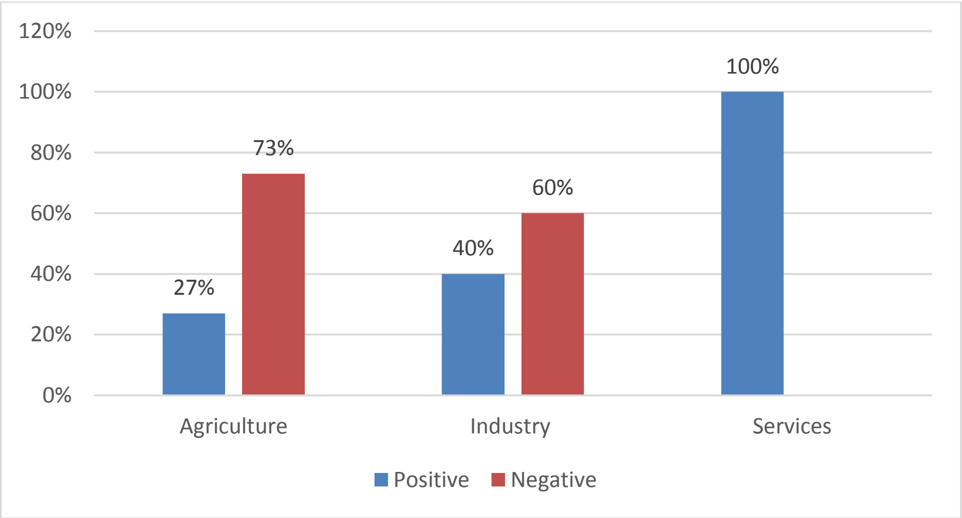
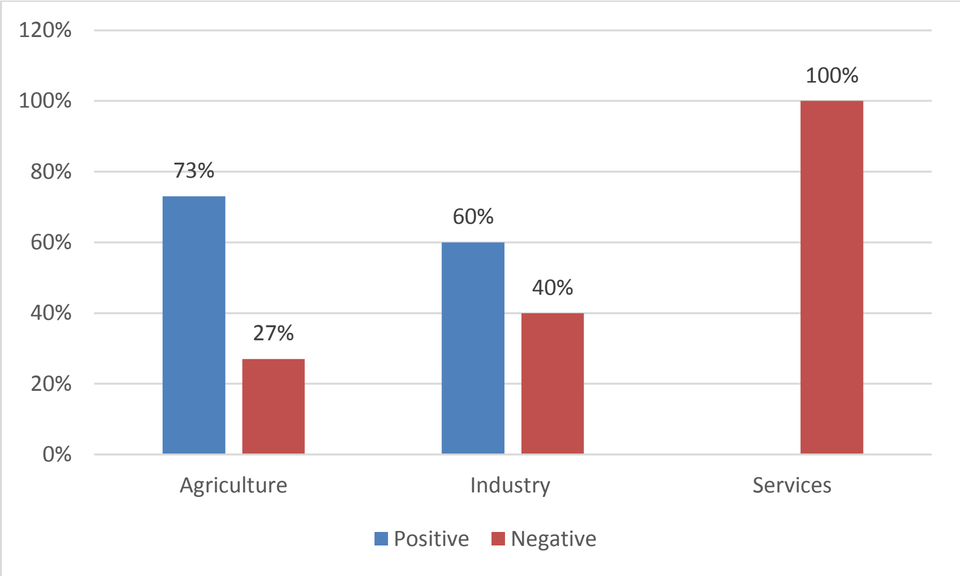


Figure 28 shows that almost more than 60 per cent of the experts supported the positive impact of real oil price decreases on the agricultural and industrial sectors. Again, there were unanimous agreement among the experts that the services sector growth rate was negatively affected by the drop in real oil prices. A range of 26.7 per cent to 40 per cent of experts suggested a negative effect on agricultural and industrial sectors as a result of a fall in real oil prices.

Figure 28. Experts' response: impact of negative real oil price on sectors growth rates



6.7 External validation of the estimated VAR models using Delphi Methods' results

6.7.1 Public budget VAR model

Tables 32 presents the relationships between oil price shocks and the public budget variables obtained from the VAR model and Delphi method as well as the decision reached regarding the corroboration and validation of the VAR model estimates. As can be seen from Table 32, the surge in the real oil prices resulted in a positive effect on the tax revenues, total revenues, current expenditure and improved the budget deficit. These findings, which have been obtained from the estimated budget VAR model, were corroborated by the experts' responses. On the other hand, a decrease in real oil price showed a negative effect on the tax revenues, total revenues, current expenditure, development expenditure and worsened the budget deficit. It is clear that results obtained from both methods were consistent with each other. In other words, no conflicting results were reported and the estimated public budget VAR model was validated by the experts. Accordingly, the estimated VAR model will be used for further analysis to investigate the relationship between real oil price shocks and the public budget variables.

Table 32. Public budget VAR model and Delphi results comparison

Variables	Estimated VAR model results		Delphi results		Decision
	Positive real oil price shock	Negative real oil price shock	Positive real oil price shock	Negative real oil price shock	
TAX	Increase (+ 0.0005)	Decrease (- 0.0046)	increase	Decrease	Validated
REV	Increase (+ 0.0056)	Decrease (- 0.0303)	Increase	Decrease	Validated
CUREXP	Increase (+ 0.0029)	Decrease (- 0.0214)	Increase	Decrease	Validated
DEVEXP	Increase (+ 0.0023)	Decrease (- 0.00020)	Increase	Decrease	Validated
DEFICIT	Decrease (- 0.0030)	Increase (+ 0.0073)	Decrease	Increase	Validated

* VAR model coefficients are in parenthesis.

6.7.2 Selected macroeconomic variables VAR model

Table 33 displays the comparison between the results obtained from the selected macroeconomic variables VAR model with those reported by the Delphi method regarding the impact of the real oil price shocks on the selected macroeconomic variables. It is clear from Table 33 that the impact of real oil price increase on the macroeconomic variables, based on the two methods is positive, with an exception of the impact on Murabaha profit margin rate. The experts' response was that oil price shocks had no effect on the Murabaha rate as it is administratively determined; however, the oil price coefficient sign that obtained from the estimated VAR model had shown that it did affect the Murabaha rate positively. Turning to the impact of decrease in real oil price, there were conflicting results on two variables, namely inflation and Murabaha profit margin rates. In order to reach to a decision on which result is correct, the estimated macroeconomic VAR model will be used to simulate the historical data of the inflation and Murabaha rates over the period 2000: q1 – 2011: q2. Figure 29 shows that the simulation of the inflation rate traced the actual data quite well. This conclusion was further confirmed by the lower values of the simulation measures as shown in table 23, RMSE (0.05269), Theil inequality coefficient (0.1555412), with zero value of bias proportion and 0.208318 for variance proportion (Table 34). Accordingly, the estimated VAR model will be used for further analysis to investigate the relationship between real oil price shocks and the public budget variables.

Table 33. Selected macroeconomic variables VAR model and Delphi results comparison

Variables	Estimated VAR model results		Delphi results		Decision regarding results
	Positive real oil price shock	Negative real oil price shock	Positive real oil price shock	Negative real oil price shock	
M2	Increase (+ 0.0262)	Increase (+ 0.0602)	Increase	Increase	Validated
INF	Increase (+ 0.0844)	decrease* (- 0.0295)	Increase	increase*	Not validated
RER	Appreciate (- 0.1280)	Depreciate (+ 0.1980)	Appreciate	Depreciate	Validated
MUR	increase* (+ 0.0023)	decrease* (- 0.0046)	Neutral*	neutral*	Not validated

Figure 29. Historical simulation of inflation rate versus actual values

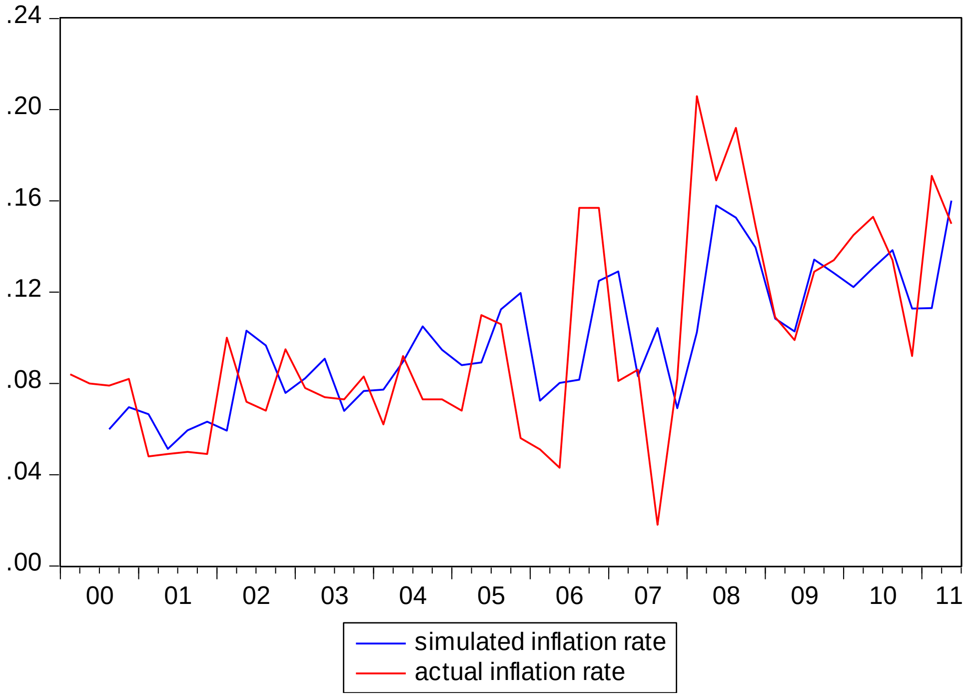


Table 34. Summary statistics for evaluating the historical simulation of the inflation rate over the period 2000:q1 - 2011:

Root Mean Squared Error	0.032604
Theil inequality coefficient	0.155412
Bias proportion	0.000000
Variance proportion	0.208318
Covariance proportion	0.791682

Figure 30 shows the comparison between the simulated Murabaha profit margin rate and the actual data. As can be observed from Figure 30, that the simulated value of the Murabaha profit margin rate captured the trend but fell below the actual values. Looking at the simulation evaluating measures in Table 35, the RMSE was small which indicates a good fit, Theil inequality is in the favourable range, bias and variance showing lower values as well. All in all, the VAR model has, to a great extent, well simulated the values of inflation and Murabaha rates over the period 2011: q1 to 2011: q2. Accordingly, an increase and decrease of the real oil prices is said to have a positive effect on Murabaha rate, while a decrease in the real oil price has a negative effect on the inflation rate.

Figure 30. Historical simulation of Murabaha margin profit rate versus actual values

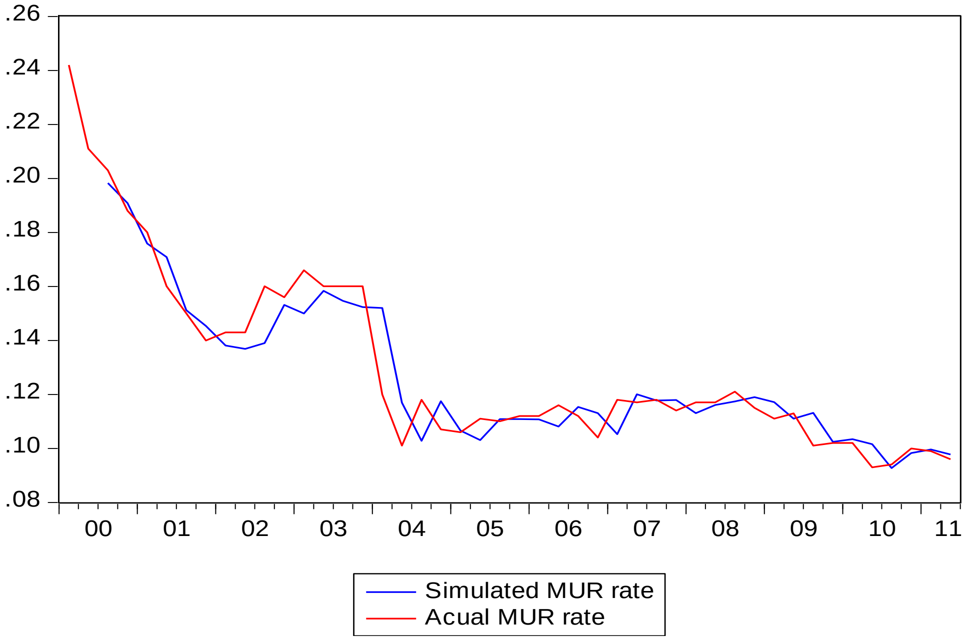


Table 35. Summary statistics for evaluating the historical simulation of Murabaha profit margin rate over the period 2000:q1 - 2011:q2

Root Mean Squared Error	0.008787
Theil inequality coefficient	0.034109
Bias proportion	0.000000
Variance proportion	0.027411
Covariance proportion	0.972589

6.7.3 Current account VAR model

Table 36 presents the results obtained from the estimated current account VAR model and Delphi method. With regard to the impact of the increase in real oil price on non-oil exports, imports, trade balance and current account balance, both experts' responses and the sign of the estimated coefficients of the VAR model were consistent and corroborating each other. Likewise, the sign of the coefficient of the negative oil price that have been obtained from the estimated VAR model have been confirmed by the experts who participated in the Delphi method. Hence, the estimated current account VAR model was validated by the experts. Accordingly, the estimated VAR model will be used for further analysis to investigate the relationship between real oil price shocks and the public budget variables.

Table 36. Current account VAR model and Delphi results comparison

Variables	Estimated VAR model results		Delphi results		Decision regarding results
	Positive real oil price shock	Negative real oil price shock	Positive real oil price shock	Negative real oil price shock	
NOEX	Decrease (- 0.0004)	Increase (+ 0.0062)	Decrease	Increase	Validated
IMP	Increase (+ 0.0266)	Decrease (- 0.0220)	Increase	Decrease	Validated
TB	Decrease (-0.0279)	Increase (+ 0.1937)	Decrease	Increase	Validated
CAB	Decrease (- 0.0383)	Increase (+ 0.0485)	Decrease	Increase	Validated

6.7.4 GDP growth and unemployment rates VAR model

Table 37 displays the results obtained from the GDP growth and the unemployment VAR model and the experts' responses. It is clear from Table 37 that the coefficients of the real oil price increase have shown a positive effect on GDP growth and unemployment rates. These results were further confirmed by the experts who participated in the Delphi method. On the other hand, the coefficients of the real oil price decrease showed a negative effect on GDP growth and positive effect on unemployment rates. That means there was a conflict on the impact of the negative real oil price on the unemployment rate. In order to reach to a decision on which result was correct, the estimated macroeconomic VAR model was used to simulate the historical data of the unemployment rates over the period 2000:q1 – 2011:q2. Figure 31 showed that the simulation of the unemployment rate traced the actual data quite well. This conclusion was further confirmed by the lower values of the simulation measures as shown in table 40, RMSE (0.010044), Theil inequality coefficient (0.032731), with zero value of bias proportion and 0.166082 for variance proportion (Table 38). Accordingly, the estimated VAR model will be used for further analysis to investigate the relationship between real oil price shocks and the public budget variables.

Table 37. GDP and unemployment VAR model and Delphi results comparison

Variables	Estimated VAR model results		Delphi results		Decision regarding results
	Positive real oil price shock	Negative real oil price shock	Positive real oil price shock	Negative real oil price shock	
RGDPG	Increase (+0.0479)	Decrease (-0.0508)	Increase	Decrease	Validated
UNEM	Decrease (-0.0014	Decrease (-0.0028)	Decrease	Increase	Not validated

Figure 31. Historical simulation of unemployment rate versus actual values

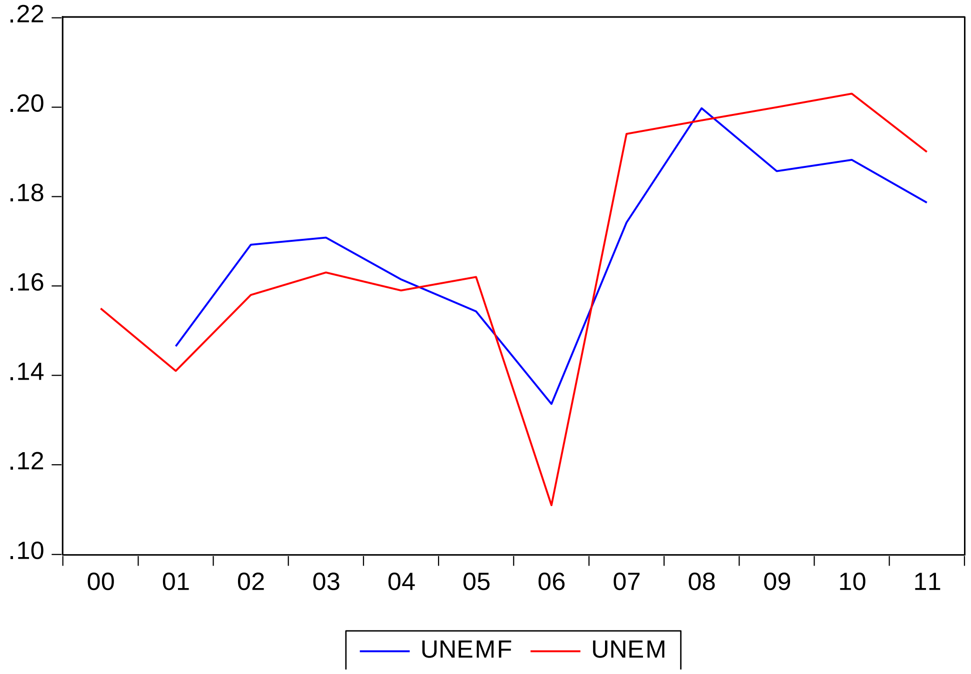


Table 38. Summary statistics for evaluating the historical simulation of the unemployment rate over the period 2000-2011

Root Mean Squared Error	0.021660
Theil Inequality Coefficient	0.062869
Bias Proportion	0.000000
Variance Proportion	0.206608
Covariance Proportion	0.793391

6.7.5 Sectors growth rates VAR model

Table 39 depicts the results obtained from the estimated sectors growth rates VAR model and the experts' responses. According to the coefficients of VAR model, the real oil price increase had a positive effect on the agricultural growth rate, which contradicted the views of the experts who participated in the Delphi method. Also, the negative real oil price has shown negative impact on the industrial growth rate based on the VAR model estimates, which was also not in line with the experts' responses. However, both methods have agreed on the positive impact on service growth rate when the real oil price goes up and negative impact on services growth rate when the real oil price goes down. Accordingly, the agricultural and industrial equations were used to simulate the historical series. Then the simulation of agricultural growth rate and the industrial growth rate was evaluated using four simulation evaluating criteria mentioned earlier in chapter five, section 5.5.

Table 39. Sectors growth VAR model and Delphi results comparison

Variables	Estimated VAR model results		Delphi results		Decision regarding results
	Positive real oil price shock	Negative real oil price shock	Positive real oil price shock	Negative real oil price shock	
Agriculture	Increase (+0.1179)	Increase (+0.1836)	Decrease*	Increase	Not validated
Industry	Decrease (-0.2118)	Decrease (-0.5608)	Decrease	Increase*	Not validated
Services	Increase (+0.0093)	Decrease (-0.7671)	Increase	Decrease	Validated

*indicate contradicting results.

Figure 33 shows the comparison between the simulated agricultural sector growth rate and the actual series. As can be seen from figure 33 the simulated series of the agricultural sector growth rate captured the general trend of the data quite well. Looking at the simulation evaluating measures, the RMSE is small which indicates good fit, Theil inequality was in the favourable range, bias and variance showed lower values as well (Table 40). All in all, the VAR model had, to a great extent, well simulated the actual values of the agricultural sector growth rate over the period 2000-2011. Hence, increase and decrease of real oil price were said to have a positive effect on the agricultural growth rate. Accordingly, the estimated VAR model was used for further analysis to investigate the relationship between real oil price shocks and the public budget variables.

Figure 32. Historical simulation of the agricultural sector growth rates versus actual values

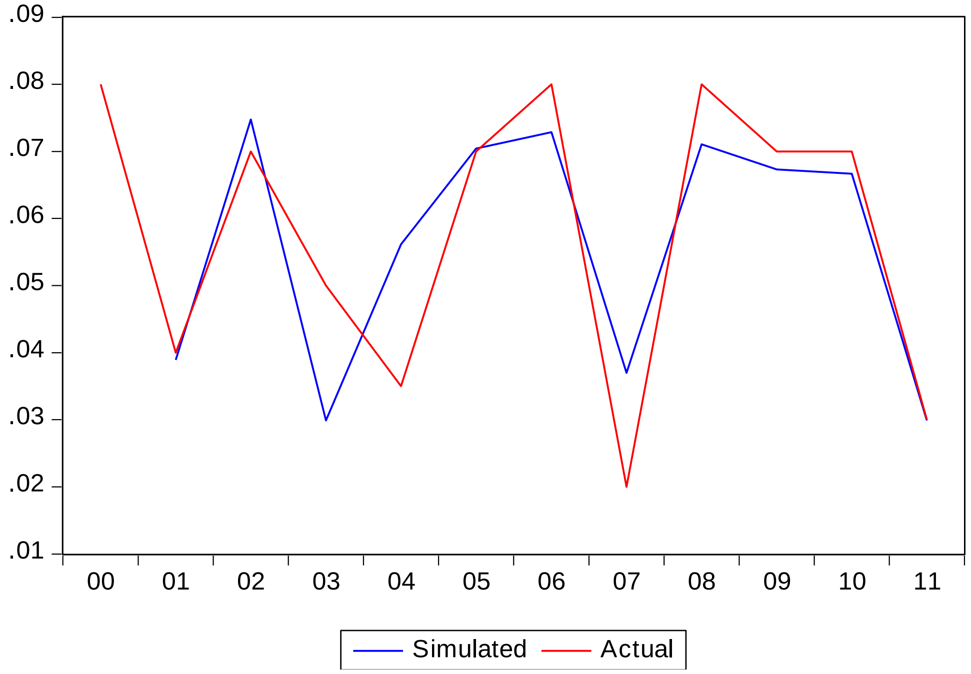


Table 40. Summary statistics for evaluating the historical simulation of the agricultural sector growth rates

Root Mean Squared Error	0.010926
Theil Inequality Coefficient	0.092506
Bias Proportion	0.000000
Variance Proportion	0.082968
Covariance Proportion	0.917032

Figure 33 shows the comparison between the simulated industrial growth rate and the actual series. The simulation was performed to evaluate the model's ability to replicate the actual data. The simulation timeframe was 2000 – 2011. It was virtually clear from Figure 33 that the simulated industrial growth rates well captured the trend and turns pattern of the actual series. Turning to the simulation evaluating measures, the RMSE was small which indicate good fit, Theil inequality measure was in the favourable range, bias portion and variance portion had shown lower values as well (table 49). Therefore, the final result was that the VAR model had well simulated the historical actual industrial sector growth series over the period 2000 to 2011. Accordingly, an increase and decrease of real oil price were said to have a negative effect on industrial sector growth rates.

Figure 33. Historical simulation of the industrial sector growth rates versus actual values

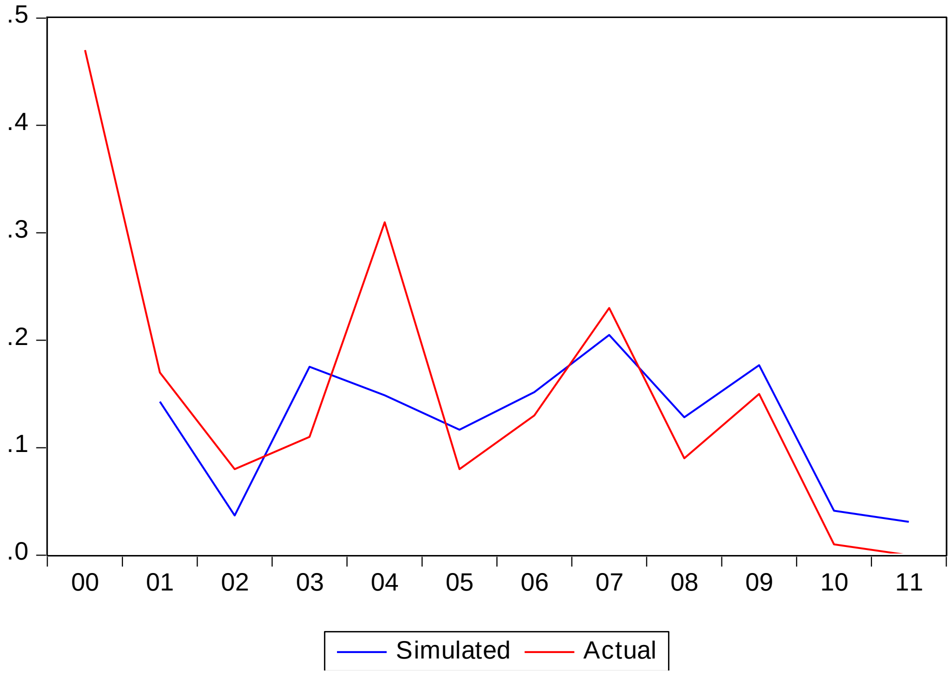


Table 41. Summary statistics for evaluating the historical simulation of industrial sector growth rate

Root Mean Squared Error	0.059888
Theil Inequality Coefficient	0.208717
Bias Proportion	0.000073
Variance Proportion	0.227722
Covariance Proportion	0.772205

6.8 Granger causality test

The Granger causality test was employed using exogeneity Wald tests. The research focus on the causality that running from the real oil price to other macroeconomic variables as oil prices is entirely determined in the global market. The null hypothesis was set to no causality between variables, if *p* value is found to be less than 5 per cent then the null hypothesis will be rejected.

6.8.1 Public budget VAR model

Table 42 shows the Granger causality test between the real oil price shocks and the budget variables. It is clear that decrease in real oil price Granger cause all budget variables, except tax revenues and development expenditure at 5 per cent significance level. The decrease in real oil price very significantly influences total revenues and current expenditure as it can be seen from the very small *p* value, while significantly Granger cause budget deficit with *p* value of 0.03 per cent. Furthermore, there is unidirectional causality running from tax revenues to total revenues, current and development expenditure. Interestingly, the increase in real oil prices does not Granger causes a single variable in the VAR model. This result is plausible in the case of Sudan, as the oil price was set to be fixed (bench mark price) during the preparation of the annual public budget. According to this policy, any increase in oil prices above the benchmark price would be deposited into the Oil Stabilization Account at the Central Bank of Sudan. This is why the increase in oil prices did not affect the public budget variables.

Table 42. Public budget VAR model: Granger causality test

Dependent variable: TAX

Excluded	Chi-sq	df	Prob.
PROILP	0.027190	1	0.8690
NROILP	2.019660	1	0.1553
D(REV)	0.175035	1	0.6757
D(CUREXP)	0.042710	1	0.8363
D(DEVEXP)	0.211762	1	0.6454
D(DEFICIT)	0.000773	1	0.9778
All	3.883029	6	0.6925

Dependent variable: D(REV)

Excluded	Chi-sq	df	Prob.
PROILP	1.121954	1	0.2895
NROILP	27.44327	1	0.0000
TAX	11.88882	1	0.0006
D(CUREXP)	0.672815	1	0.4121
D(DEVEXP)	1.487108	1	0.2227
D(DEFICIT)	1.265513	1	0.2606
All	55.08239	6	0.0000

Dependent variable: D(CUREXP)

Excluded	Chi-sq	df	Prob.
PROILP	0.423900	1	0.5150
NROILP	26.03115	1	0.0000
TAX	5.654300	1	0.0174
D(REV)	0.036351	1	0.8488
D(DEVEXP)	0.011127	1	0.9160
D(DEFICIT)	0.461449	1	0.4969
All	39.18501	6	0.0000

Dependent variable: D(DEVEXP)

Excluded	Chi-sq	df	Prob.
PROILP	0.684706	1	0.4080
NROILP	0.604217	1	0.4370
TAX	3.010569	1	0.0827
D(REV)	0.079265	1	0.7783
D(CUREXP)	6.84E-05	1	0.9934
D(DEFICIT)	0.052575	1	0.8186
All	5.810465	6	0.4448

Dependent variable: D(DEFICIT)

Excluded	Chi-sq	df	Prob.
PROILP	0.452718	1	0.5010
NROILP	3.078360	1	0.0793
TAX	0.962594	1	0.3265
D(REV)	0.512054	1	0.4743
D(CUREXP)	0.136406	1	0.7119
D(DEVEXP)	0.082524	1	0.7739
All	9.642057	6	0.1406

6.8.2 Selected macroeconomic VAR model

Table 43 reveals the causality analysis between the real oil price shocks and the selected macroeconomic variables. NROILP and PROILP do not influence any variable in the model; however, the inflation rate does influence money supply and statistically significant at 10 per cent. The other variables have not shown causality between them. This could be attributed to the heavy intervention of the government in the economic activities.

Table 43. Selected macroeconomic variables VAR model: Granger causality test results

Dependent variable: M2			
Excluded	Chi-sq	df	Prob.
PROILP	0.158688	1	0.6904
NROILP	0.867560	1	0.3516
INF	1.215797	1	0.0731
D(RER)	1.473064	1	0.2249
MUR	0.083117	1	0.7731
All	5.908967	5	0.3152
Dependent variable: INF			
Excluded	Chi-sq	df	Prob.
PROILP	1.592315	1	0.2070
NROILP	0.202698	1	0.6526
M2	0.001834	1	0.9658
D(RER)	0.288125	1	0.5914
MUR	1.994097	1	0.1579
All	6.089049	5	0.2977
Dependent variable: D(RER)			
Excluded	Chi-sq	df	Prob.
PROILP	0.341121	1	0.5592
NROILP	0.848058	1	0.3571
M2	0.197125	1	0.6571
INF	0.759010	1	0.3836
MUR	0.483310	1	0.4869
All	3.561319	5	0.6141
Dependent variable: MUR			
Excluded	Chi-sq	df	Prob.
PROILP	0.017191	1	0.8957
NROILP	0.072035	1	0.7884
M2	0.436858	1	0.5086
INF	0.000499	1	0.9822
D(RER)	0.234895	1	0.6279
All	1.106520	5	0.9535

6.8.3 Current account VAR model

Table 44 shows the Granger causality test between the real oil shocks and the different current account variables. It is clear that positive real oil price Granger caused imports and current account balance at 10 per cent significance level, but failed to reject the null hypothesis for the exports and trade balance. Similar result was obtained in study carried out in Malaysia by Le and Chang (2013). With regard to the negative real oil price, it Granger caused non-oil exports and current account balance at 5 per cent level of significance. It also found that there was bidirectional causality between imports and current account balance. Furthermore, imports and current account balance variables significantly Granger caused trades balance.

Table 44. Current account VAR model: Granger causality test results

Dependent variable: D(NOEX)

Excluded	Chi-sq	df	Prob.
PROILP	0.016553	1	0.8976
NROILP	3.820831	1	0.0506
D(IMP)	0.642818	1	0.4227
D(TB)	1.366937	1	0.2423
D(CAB)	0.092670	1	0.7608
All	3.975287	5	0.5530

Dependent variable: D(IMP)

Excluded	Chi-sq	df	Prob.
PROILP	2.789459	1	0.0949
NROILP	1.789643	1	0.1810
D(NOEX)	0.994573	1	0.3186
D(TB)	0.054652	1	0.8152
D(CAB)	3.918978	1	0.0477
All	9.353795	5	0.0958

Dependent variable: D(TB)

Excluded	Chi-sq	df	Prob.
PROILP	2.086070	1	0.1486
NROILP	0.935774	1	0.3334
D(NOEX)	0.303005	1	0.5820
D(IMP)	6.985519	1	0.0082
D(CAB)	6.319027	1	0.0119
All	12.63933	5	0.0270

Dependent variable: D(CAB)

Excluded	Chi-sq	df	Prob.
PROILP	3.020429	1	0.0822
NROILP	4.541126	1	0.0331
D(NOEX)	0.028841	1	0.8651
D(IMP)	9.452524	1	0.0021
D(TB)	0.008428	1	0.9269
All	15.65130	5	0.0079

6.8.4 GDP growth and unemployment rates VAR model

It is clear from Table 45 that positive real oil price and unemployment rate strongly influence real GDP growth at 5 per cent significance level. This was evidenced from the small *p* value. However, positive and negative real oil prices failed to cause unemployment rate at 5 per cent significance level.

Table 45. GDP and unemployment VAR model: Granger causality test results

Dependent variable: RGDPG

Excluded	Chi-sq	df	Prob.
PROILP	5.582082	1	0.0181
NROILP	0.186850	1	0.6656
UNEM	4.812837	1	0.0282
All	12.59132	3	0.0056

Dependent variable: UNEM

Excluded	Chi-sq	df	Prob.
PROILP	0.895336	1	0.3440
NROILP	0.072494	1	0.7877
RGDPG	0.804905	1	0.3696
All	2.277630	3	0.5168

6.8.5 Sectors growth rates VAR model

Table 46 displays the outcomes of the Granger causality test using Wald statistical test. It was obvious that positive and negative real oil price shocks significantly Granger cause the agricultural sector growth rate. It was also clear that negative real oil price significantly influenced the services sector growth rate at 5 per cent significance level. This was evidenced from the small *p* value. In contrast, real positive and negative real oil prices failed to significantly Granger cause industrial sector growth rate at 5 per cent significance level.

Table 46. Sectors growth VAR model: Granger causality test

Dependent variable: AGRICULTURE

Excluded	Chi-sq	df	Prob.
PROILP	4.263429	1	0.0389
NROILP	5.227200	1	0.0222
INDUSTRY	3.380333	1	0.0660
SERVICES	5.153253	1	0.0232
All	8.860749	4	0.0647

Dependent variable: INDUSTRY

Excluded	Chi-sq	df	Prob.
PROILP	0.315800	1	0.5741
NROILP	1.809969	1	0.1785
AGRICULTURE	0.531340	1	0.4660
SERVICES	1.205798	1	0.2722
All	4.010607	4	0.4046

Dependent variable: SERVICES

Excluded	Chi-sq	df	Prob.
PROILP	0.790889	1	0.3738
NROILP	8.050126	1	0.0046
AGRICULTURE	4.600690	1	0.0320
INDUSTRY	1.489672	1	0.2223
All	32.04864	4	0.0000

6.9 Impulse Response Functions (IRFs)

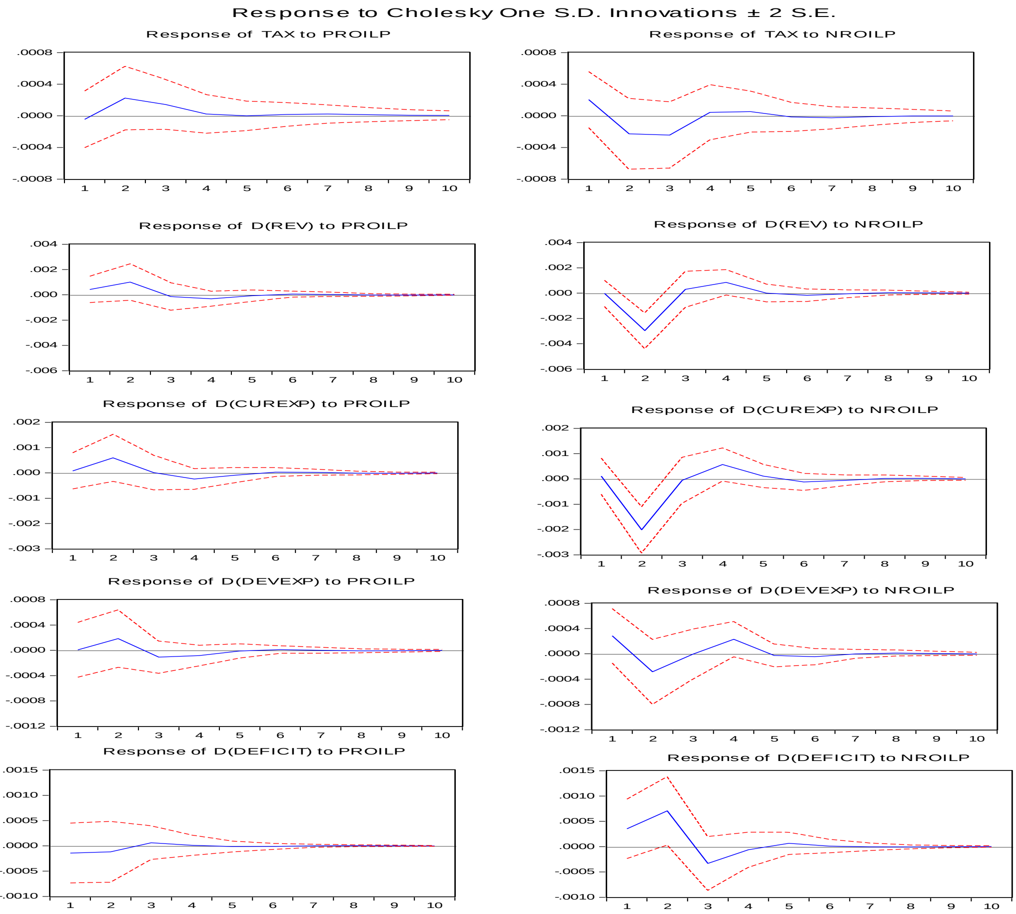
To understand the dynamic relationship between the real oil price shocks and the budget variables, the IRFs derived from the VAR model were used. A unit of standard deviation shock was applied to the error term in each equation and then the effect on the VAR system through 10 periods was traced. In order to identify orthogonalised innovation in each equation and the dynamic responses to these shocks, the Cholesky decomposition method was used, which had been proposed by Doan (1992). This method entails a selection of the ordering of the variables in the VAR model. The variables were arranged from the most exogenous to the less exogenous. It is worth mentioning that the dotted lines in the IRFs refer to the confidence bands and when the horizontal line (zero line) falls between the two confidence bands, the impulse response is said to be statistically insignificant (Dizaji, 2014; Farzanegan and Markwardt, 2009). Moreover, as all the variables are in per centage, the response will be on per centage change. Thus, Y axis (vertical axis) shows the per centage changes, while X axis (horizontal axis) shows the time horizon (Weinhagen, 2002).

6.9.1 Public budget VAR model

Figure 34 shows that the impulse response functions of the budget variables to the one standard deviation shock in both positive and negative real oil prices. The ordering of the variables is set as follows: PROIP, NROILP, TAX, REV, CUREXP, DEVEXP and DEFICIT. The initial response of the tax revenues to an increase in real oil price was positive and reached its peak with a magnitude of 0.02 per cent in the second quarter, after that it continued positive and faded away from the third quarter. In contrast, the response of the tax to decrease in real oil price was negative and statistically not significant up to the third quarter, and then it was fluctuating above and below the zero line and finally died out from the seven quarter.

For the total revenues, the increase in the real oil price resulted in positive effect lasted for two quarters, but it was not significant, reaching its peak of 0.01 per cent increase in the second quarter. Then the effect became negative and close to the baseline during the third and the fourth quarters before dying out from the fifth quarter. The positive relationship between the real oil price increase and government revenues was found in a similar study in Trinidad and Tobago (Lorde et al, 2009). In regard to the response of the total revenues to decrease in real oil price, a statistically negative response was reported, reaching its lowest point of -0.3 per cent in the mid of the second quarter, after that it was hovering around the baseline and the shock disappeared from the seventh quarter.

Figure 34 Public budget VAR model: IRFs of shock to positive and negative real oil prices



Moreover, the current expenditure responded positively to shock in increase of real oil prices up to the third quarter, reaching its peak of 0.05 per cent in the second quarter. During the fourth and the fifth quarter, the response of the current expenditure was negative and after that it faded away. A negative and statistically significant response was reported in current expenditure due to a decrease in real oil price over the first and second quarters. The drop of current expenditure was almost -0.2 per cent in the second quarter.

The response became positive during the third, the fourth and the fifth quarters, then again negative by the end of the sixth quarter. After that it showed a negative response for very short period before it died away from the eighth quarter. This finding is consistent with those of Jbir and Zouri-Ghorbel (2009) and Ibrahim and Mohamed (2012) in the Tunisian and Iranian economies, respectively. It is clear that current expenditure is very sensitive to oil price decrease, which has been reflected in a significant drop. Therefore, the government has to secure other sources during the oil price drop or performing a cut in current expenditure. This is evidence that impact of oil price shock in exporting countries pass through government expenditure. This finding corroborates that of Eltony and Al-Awadi (2001).

The response of the development expenditure to the increase in real oil prices was positive in the first and the second quarters but statistically not significant. It became slightly negative in the following quarter, then positive, but close to the baseline and faded away thereafter. On the other side of the coin, the initial response of the development expenditure to decrease in real oil price was declining in the first quarter and became negative in the second quarters, with magnitude of -0.05 per cent. Then the response turned to be positive during the third and fourth quarters. After that it declined during the fifth and the sixth quarters, and then the shock vanished through the rest of the period. This result was in line with those of Ibrahim and Mohamed (2012) in the Iranian economy.

The budget deficit initially shrank during the first and second quarters as a result of oil price increase and then slightly worsened during the third and the fourth quarters. This result was similar to those obtained by Omojolaiba and Eqwaikhide (2014) in some African oil exporting countries. Then slightly the budget deficit worsened during the third and fourth quarters, and after that the shock faded away from the fifth quarter. In contrast, the budget deficit increased by almost 0.07 per cent in the second quarter due to decrease in real oil price. This response continued up to the mid of the third quarter, then it was evolving around the zero line up and down till it faded away from the seventh quarter. From figure 20, it is clear that there is a delay of two months for the effect to take place. This result is very plausible in the case of Sudan as the government sells its crude oil and gets in return the export proceeds in the course of two months. Based on the above discussion, the government has to put in place policy measures that sustain the level of oil revenues used in the annual budget, broadening the tax base and lifting oil subsidies to improve fiscal stance. It is clear that the effect of oil price shock pass through the government expenditure to the economy. In other words, the effect passed into the economy through income transfer channel from oil importing countries to oil exporting countries (Brown and Yucel, 2002' Eltony and Al-Awadi, 2001). However, the effect of oil price increase was not fully captured due to incomplete pass through to domestic economy as result of fuel subsidy.

6.9.2 Selected macroeconomic VAR model

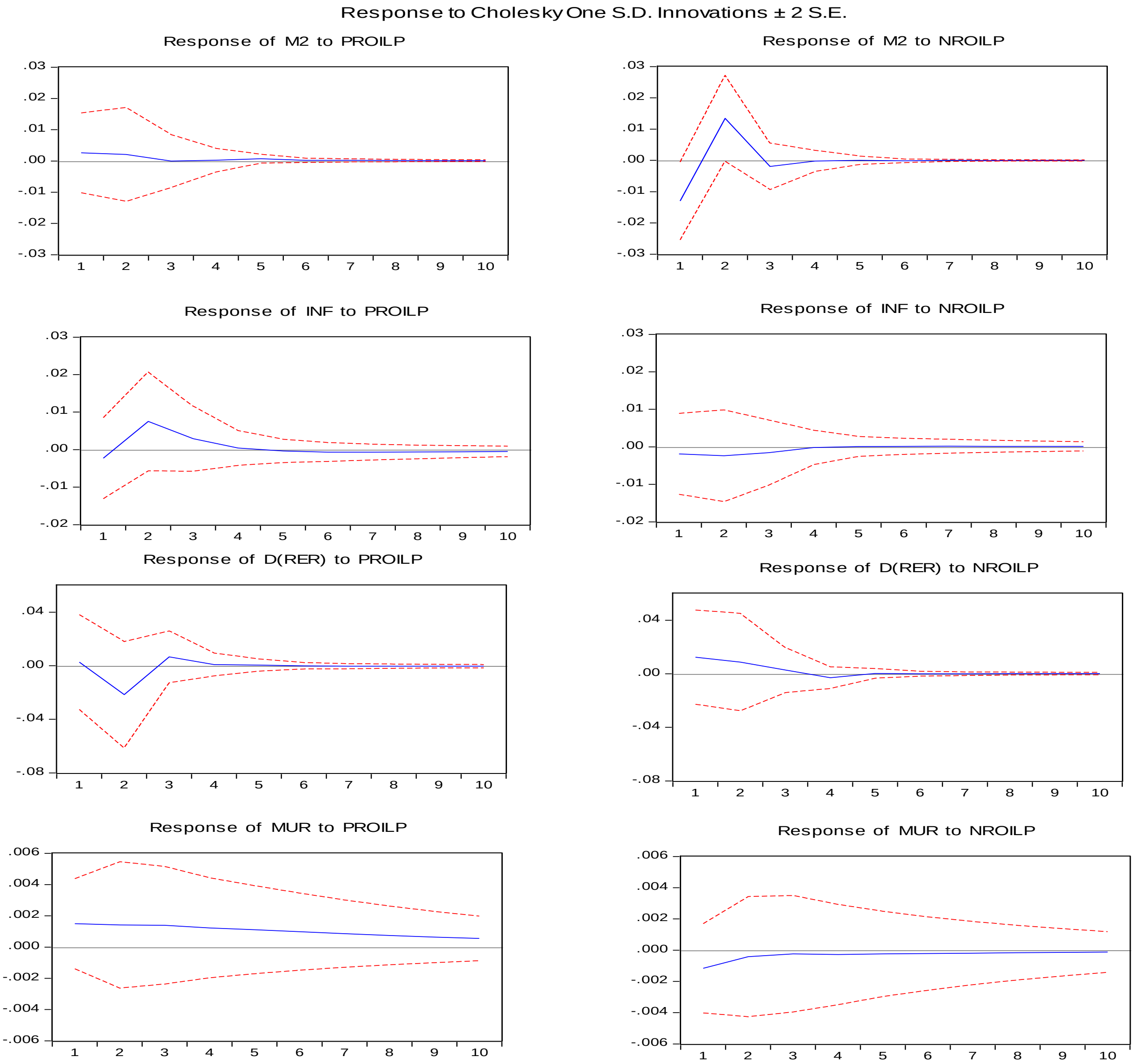
Figure 35 shows that the impulse response functions of the macroeconomic variables to the one standard deviation shock to both positive and negative real oil prices. The ordering of the variables is set as follows: PROIP, NROILP, M2, INF, RER and MUR. The initial response of the money supply to one unit shock in the positive real oil price is positive. The money supply increased by almost 0.03 per cent in the second quarter. This finding was consistent with those of Omojolaibi (2013) and Mohsen and Nooshin (2013) in the Nigerian and Iranian economies, respectively. However, the response was slightly negative in the fourth and the fifth quarters. Then the response started to die out from the sixth quarter. On the other hand, money supply showed a decline trend due to a unit shock to the negative oil price. It declined by almost 1.3 per cent in the first quarter. However, in the second quarter, the money supply became positive with an increase of 1.2 per cent. The response of the money supply faded away from the fourth quarter. The result showed that the monetary authority increased money supply during the era of oil price decrease to finance the budget deficit.

For the inflation rate, a shock to the positive real oil price led to an increase of inflation reaching its maximum of 0.7 per cent in the second quarter. This finding corroborates with those obtained by Bouchaour and Al-Zeaud (2012) and Ebrahim and Mohammed (2012) in the Algerian and Iranian economies, respectively. The positive response last for the first three quarters, then became slightly negative and continued that way to the end of the period. The negative effect could be explained by the fact that the government adopted an inflation target policy, which generally introduced on annual base. The response of the inflation to shock to the negative real oil price was negative throughout the first three quarters. That is, a unit standard deviation shock to the negative real oil price led to a decline in the inflation rate. The percentage change in the inflation rate was almost -0.2 per cent. Then it turned to be slightly positive in the fourth quarter and continued that way up to the end of the period. The increase might be attributed to the increase of money supply as mentioned earlier. Looking at the response of real exchange rate to positive oil price shock, it is apparent that the real exchange rate declined, which means a positive impact as domestic currency starts to be stronger against the US dollar. In other words, the exchange rate was appreciated by 2 per cent in the second quarter. After that the exchange rate showed mild positive response in the third and fourth quarter. Then, the exchange rate remained unchanged and closed to the zero line through the rest of the predicted period. On the other side of the coin, the real exchange rate increased as a result of the negative real oil price shock. It increased by almost 1.8 per cent in the first two quarters. Then the exchange rate showed a mild negative response in the fourth quarter and after that it exhibited mild positive response up to the end of the forecasted period. The increase of the exchange rate means that the Sudanese currency became weaker against the US dollar when oil prices go down. This finding was in line with those obtained by Farzanegan and Markwardt (2009) and Katsuya (2012) in the Iranian and Russian economies, respectively.

For the Murabaha profit margin rate, it can be seen that a positive oil price shock led to an increase of the Murabaha rate by 0.17 per cent in the first quarter and then continued positive up to the last quarter. Whereas, the Murabaha profit margin rate showed a mild persistent negative response to the negative real oil price shock through the entire period.

From the above discussion, it is obvious that real oil price shocks were transmitted to Sudan economy through terms of trade (Misati, Nyamongo and Mwangi, 2013). That is, increase of oil price appreciates exchange rate and thus harm the competitiveness of Sudan exports, while a drop in oil prices positively affected non-oil exports.

Figure 35. Selected macroeconomic VAR model: IRFs of shocks to positive and negative real oil price

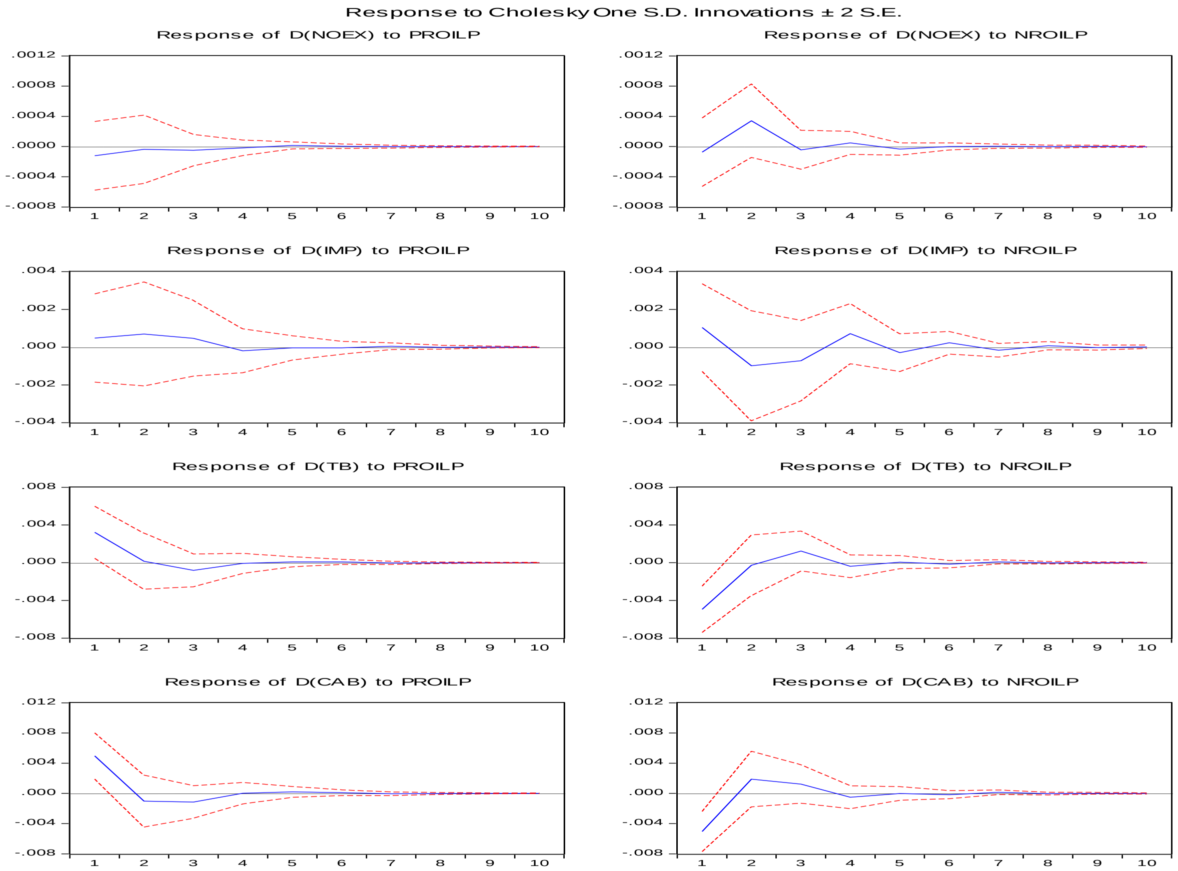


6.9.3 current account VAR model

Figure 36 shows that the impulse response functions of the current account variables to the one standard deviation shock in both positive and negative real oil prices. the ordering of the variables was as follows: PROIP, NROILP, NOEX, IMP, TB, and CAB. As can be seen from Figure 36, positive real oil price had a negative effect on the non-oil exports and last for five quarters, then the shock faded away from the sixth quarter. The non-oil exports were reduced by almost 0.1 per cent in the first quarter. This might be attributed to the appreciation of the local currency, which negatively affected the competitiveness of Sudan's non-oil exports. This also showed that the existence of some symptoms of the Dutch disease in the economy. On the other hand, non-oil exports responded positively to the negative real oil price shock. This was attributed mainly to the increase of the competitiveness of Sudanese exports due to the depreciation of the exchange rate. It's clear that the non-oil exports increased by 0.3 per cent in the second quarter. However, from the third quarter and thereafter the response of non-oil exports was small and fluctuating around the zero line.

With regard to the imports, it responded positively to positive real oil price shock during the first three quarters, with an increase of 0.5 per cent. In the fourth and fifth quarter the response was slightly negative and became positive again in the sixth and seven quarters before vanishing from the eighth quarter. Looking at the other side of the coin, negative real oil price shock influenced imports to decline and reached its lowest point in the second quarter, with a magnitude of 0.1 per cent. From quarter four and thereafter the response was swinging around the zero line throughout the remaining period. This decline in imports was due to the shortage of foreign exchange that emanated from the drop in oil revenues. This result is consistent with the findings of Frazanegan and Markwardt (2009) in the Iranian economy.

Figure 36. Current account VAR model: IRFs of shock to positive and negative real oil price



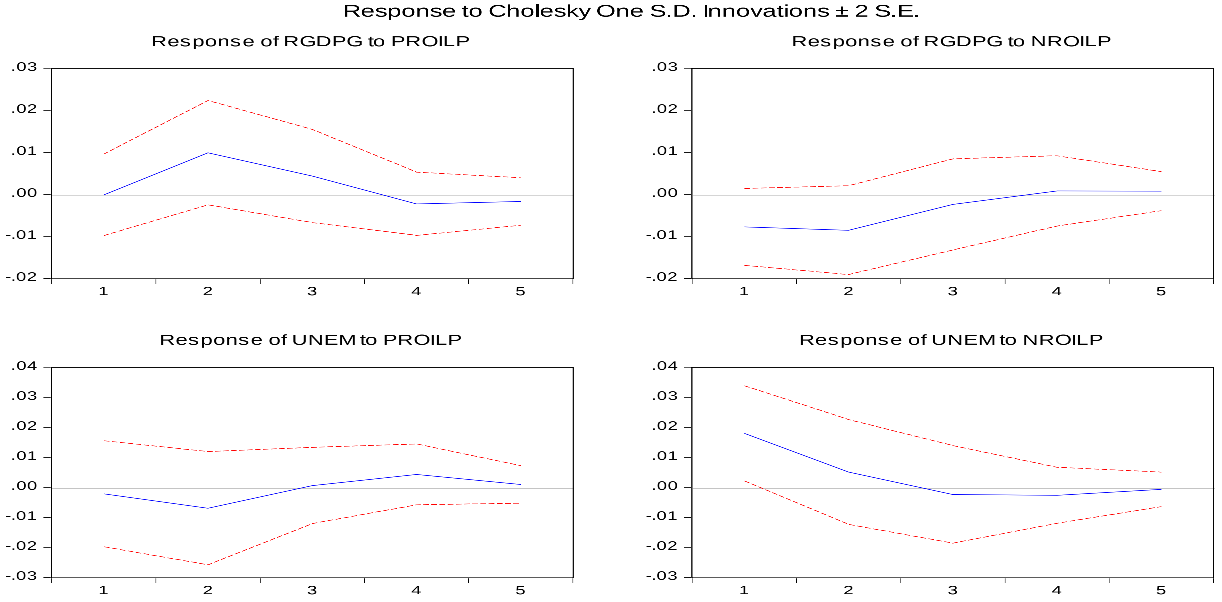
Turning to the trade balance, shock to the positive real oil price resulted in a positive effect during the first two quarters, with a magnitude of 0.3 per cent in the first quarter. It showed negative response in the third quarter, but became positive again from the fourth quarter and continued that way to the end of the period. However, the response of the trade balance to the negative real oil price shock was significantly negative in the first two quarters, worsening it by almost 0.5 per cent. Then it became positive in the third quarter and returned to exhibit a negative response thereafter. This analysis showed that Sudan was depending on the oil exports as a main source of foreign exchange and its trade balance deteriorated as a result of the drop in oil prices.

For the current account balance, its response to shock to the positive real oil price was positive and statistically significant in the first quarter, improving it by 0.5 per cent. This finding is in line with those of Allegret et al (2014) in some African oil exporting countries. In the second and the third quarter, the current account balance showed a negative response, then became positive in the fourth quarter and continued that way to the seventh quarter. On the flip side, the response of the current account balance to a decrease in real oil price sock was negative and statistically significant in the first quarter, increasing the deficit by almost 0.5 per cent. After that its response started to fluctuate up and down around the zero line. The analysis has shown that oil increase improved the trade and current account balance, but at the expense of non-oil exports, which mainly were agricultural and livestock products. Therefore, the government has to support agricultural and animal wealth sectors during the oil price boom, through investing part of the oil revenues in infrastructure, provision of production inputs, technology and research.

6.9.4 GDP growth and unemployment rates VAR model

Figure 37 shows the impulse response functions for the positive real oil price and the negative real oil price over five years' time horizon. Variables were arranged from the most exogenous to the less exogenous. Accordingly, the ordering of the variables was set as follows: PROIP, NROILP, RGDPG and UNEM. It is apparent from Figure 37 that the initial response of RGDPG to positive real oil price shock was positive reaching its peak in the second year. That is, one-unit standard deviation shock to the positive real oil price resulted in a 0.019 per cent increase in the real GDP growth rate. The positive response continued through the third year and the first quarter of the fourth year. These results were consistent with those findings of other studies (Berument et al., 2010; Mendoza and Vera, 2010; Omojolaibi, 2013; Al-Mulali and Che Normee, 2013). Then the response of RGDPG became negative and continued that way to the fifth year. However, negative real oil price shock negatively influenced RGDPG throughout the first three years and half. It retarded the RGDPG by almost 0.9 per cent in the second year. Similar results of the negative effect on GDP growth when the oil prices decrease was reported in Nigeria and Iran by Akin and Babajide (2011a) and Farzanegan and Markwardt (2009), respectively.

Figure 37. GDP and unemployment VAR model: IRFs of shocks to positive and negative real oil price



Turning to the unemployment rate, the positive real oil price shock caused a decline in the unemployment rate through the first two years and half, and then increased over the fourth and fifth years. The unemployment reduced by almost 0.8 per cent in the second year. Looking to the other side of the coin, unemployment rate initially responded positively to real oil price decrease. However, its response gradually started to decline during the first two years and half, and then turned to be negative thereafter and remained below the zero line up to the fifth year. That is, the unemployment rate increased during those periods and the magnitude of the effect was 1.9 per cent in the first year. These findings showed the stylized facts about the effect of oil price shocks on oil exporting countries. The above discussion showed that positive real oil price shock increased the RGDP growth rate and reduced the unemployment rate, whereas negative real oil price shock retarded RGDPG growth and increases unemployment rate. Also, negative real oil price shock found to have a greater effect on the real GDP growth and unemployment rates. Therefore, the government has to diversify its economy to escape the negative effects of the drop in crude oil prices.

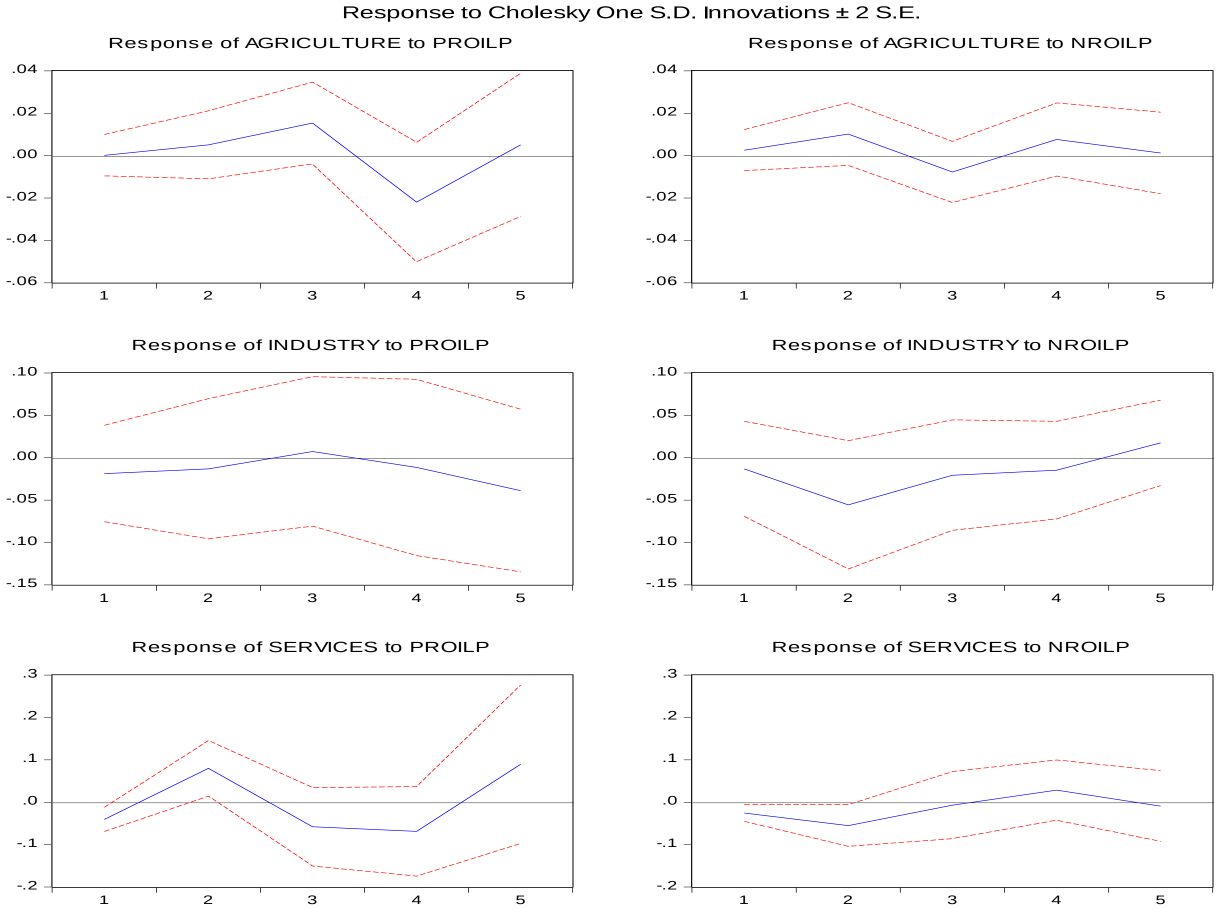
6.9.5 Sectors growth rates VAR model

Figure 38 shows the impulse response functions for the positive real oil price and the negative real oil price over five years' time horizon. A unit standard deviation shock was applied to the innovation of both positive and negative oil prices and the effect was traced out on the dependent variables. Variables were arranged from the most exogenous to the less exogenous. Accordingly, the ordering of the variables was set as follows: PROIP, NROILP, agriculture, industry and services sector's growth rate. It was apparent that the response of the agricultural sector growth rate to positive oil price shock was positive in the first three years. It reached its peak at 1.4 per cent in the third year. This finding is consistent with those obtained by Binuomote and Odeniyi (2013) in Nigeria. However, the response of agricultural sector growth rate became negative in the following year before turning to be positive in the mid of the fifth year. Interestingly, the negative real oil price shock had resulted in a boom in the agriculture sector over the first two years. The growth rate of the agricultural sector was increased by almost 1 per cent in the second year. After that the response of the agricultural sector growth rate to negative real oil price shock became negative in the third year, but turned to positive thereafter. This result was in line with the effect of the negative real oil price on non-oil exports, which were mainly agricultural products. This might be attributed to the depreciation of the exchange rate, which in turn makes agricultural exports more competitive in the global market.

Turning to the industrial growth rate, the positive real oil price shock caused the industrial sector to decline through the entire forecasted period, except in the last period of the third year. Looking at the other side of the coin, the decrease in real oil price influenced the industrial growth rate to decline throughout the first four years, before changing to positive in the fifth year. This result was consistent with those of Ahmed and Wadud (2011) in the Malaysian economy.

Finally, the initial response of the services sector growth rate to positive real oil price shock was negative, and then became positive with a magnitude of almost 0.8 per cent in the second year. Then, the service growth rate declined through the third and the fourth year, before turning to be positive again in the fifth year. On the other hand, the response of the services sector growth rate to negative real oil price shock in the first year and half was significantly negative, declining by almost 0.5 per cent in the second year. From the mid of the third year to almost the mid of the fifth year, the response of the services sector growth rate became positive before declining again thereafter.

Figure 38. Sectors growth rates VAR model: IRFs of shocks to positive and negative real oil price



6.10 forecast error variance decomposition analysis

Variance decomposition explains the proportion of the movement in the dependent variables as a result of their own shocks and shocks to the other variables in the VAR system. Similar to the impulse response function, ordering of the variables is very important. However, if the error terms are uncorrelated, ordering has no significant importance (Brooks, 2002). Therefore, the same order of the variables used in the IRFs was used in this analysis.

6.10.1 Public budget VAR model

Table 47 shows the decomposition analysis of the budget variable for ten quarters horizon. The decrease in real oil price was the most second determinant factor on changes in tax, after the shock of the tax variables itself, with an average contribution of 5 per cent. While the increase in real price had an insignificant effect on the tax revenues, contributed by 2.4 per cent on average throughout the entire period. For the total revenues, the average contribution of an increase in real oil price was 4.6 per cent, while a decrease in real oil price explained more than 32 per cent of the variation through the whole period. However, tax significantly explained the major variation in the total revenues by 36.4 per cent on average. This result showed that the government was dependent to a greater extent on the tax revenues as a main source of financing the public budget. For the current expenditure, the major determinants were the tax and decrease in real oil prices, with contribution on average of 22.5 per cent and 51 per cent, respectively. The increase in real oil price accounted on average for 3.6 per cent of the current expenditure.

Table 47. Budget VAR model: variance decomposition analysis

Variance Decomposition of TAX:							
Period	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
1	0.136823	2.979993	96.88318	0.000000	0.000000	0.000000	0.000000
2	2.489637	4.509465	86.32688	0.485529	0.360692	0.135260	5.692535
3	2.941145	6.212321	78.31526	1.004734	0.332503	0.204781	10.98925
4	2.688150	5.709031	75.84189	1.345643	0.374362	0.298185	13.74274
5	2.541382	5.492366	75.11173	1.333973	0.464886	0.291598	14.76407
6	2.477243	5.339141	74.83386	1.315997	0.503089	0.286451	15.24422
7	2.452600	5.271668	74.57783	1.317548	0.516391	0.286898	15.57706
8	2.435207	5.222995	74.40511	1.325299	0.523921	0.288693	15.79877
9	2.422674	5.191841	74.31432	1.328652	0.529566	0.289364	15.92359
10	2.415272	5.173560	74.26727	1.329256	0.533242	0.289427	15.99198
Variance Decomposition of D(REV):							
Period	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
1	1.515649	0.003227	41.81589	56.66523	0.000000	0.000000	0.000000
2	4.592905	33.87450	34.23003	26.46287	0.000239	0.211291	0.628159
3	4.475006	32.84003	33.52381	27.09655	0.325976	1.006290	0.732331
4	4.687229	34.44109	32.51219	26.28807	0.370366	0.982001	0.719053
5	4.695063	34.33727	32.41699	26.29008	0.373070	1.008840	0.878679
6	4.695766	34.36251	32.39188	26.23875	0.376088	1.007552	0.927458
7	4.694571	34.34529	32.42285	26.21880	0.378779	1.007063	0.932645
8	4.694173	34.34028	32.43147	26.21139	0.379104	1.006820	0.936764
9	4.694379	34.33759	32.43182	26.20773	0.379077	1.006798	0.942606
10	4.693986	34.33444	32.43304	26.20583	0.379117	1.006832	0.946757

Variance Decomposition of D(CUREXP):

Period	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
1	0.116343	0.213431	66.71811	2.701869	30.25025	0.000000	0.000000
2	3.364228	37.33574	40.04170	1.407380	15.72333	0.110225	2.017393
3	3.184469	35.34922	39.79186	3.252281	14.97216	0.714135	2.735876
4	3.566978	36.91806	38.48579	3.173106	14.50402	0.702337	2.649702
5	3.618508	36.85738	38.31335	3.250872	14.45308	0.729705	2.777106
6	3.617281	36.87993	38.25337	3.262257	14.41776	0.731781	2.837623
7	3.618762	36.86729	38.27477	3.259063	14.40620	0.731298	2.842616
8	3.618083	36.85881	38.28576	3.258533	14.40232	0.731230	2.845263
9	3.618728	36.85656	38.28508	3.258257	14.39976	0.731190	2.850425
10	3.618486	36.85300	38.28542	3.258558	14.39842	0.731275	2.854843

Variance Decomposition of D(DEVEXP):

Period	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
1	0.003347	3.932074	57.84686	0.069720	7.277734	30.87027	0.000000
2	1.275043	6.007867	56.92196	0.329103	7.171340	24.72866	3.566022
3	1.642882	5.775016	56.21960	1.575156	7.140532	24.18512	3.461687
4	1.848247	7.489594	54.88727	1.592769	6.989723	23.61365	3.578751
5	1.841407	7.470830	54.74289	1.674221	6.949957	23.51229	3.808402
6	1.839402	7.515845	54.72137	1.670964	6.933746	23.42122	3.897450
7	1.836506	7.504023	54.75478	1.668329	6.926910	23.38423	3.925225
8	1.836869	7.502837	54.75940	1.667321	6.921875	23.36399	3.947717
9	1.836825	7.500219	54.75721	1.667934	6.918800	23.35246	3.966553
10	1.836318	7.497863	54.75755	1.668284	6.917021	23.34524	3.977730

Variance Decomposition of D(DEFICIT):

Period	PROILP	NROILP	TAX	D(REV)	D(CUREXP)	D(DEVEXP)	D(DEFICIT)
1	0.521386	3.211899	5.375174	71.33436	2.016172	8.871069	8.669942
2	0.714830	13.10751	9.293269	60.52879	1.729932	7.252476	7.373194
3	0.768492	14.89145	9.805464	58.46270	1.741404	7.215072	7.115423
4	0.768500	14.92202	9.805129	58.36808	1.784880	7.254032	7.097351
5	0.771006	14.99161	9.800718	58.31366	1.784345	7.247279	7.091386
6	0.773825	14.99184	9.802331	58.30585	1.784151	7.246810	7.095189
7	0.773781	14.99107	9.803120	58.30265	1.784092	7.246422	7.098869
8	0.773830	14.99100	9.805497	58.29984	1.784098	7.246078	7.099654
9	0.773814	14.99066	9.806967	58.29854	1.784119	7.245916	7.099981
10	0.773835	14.99058	9.807505	58.29786	1.784111	7.245832	7.100272

With regards to the development expenditure, positive real oil price is marginally contributed to changes in itself, while a real oil price decrease showed better influence of 6.4 per cent on average through the entire period. Interestingly, tax significantly contributed to changes in development expenditure by 56 per cent on average. Finally, the total revenues significantly contributed to changes in budget deficit. It contributed by 71.3 per cent in the first quarter, and then declined gradually up to the fourth quarter, after that it remained unchanged at around 58.3 per cent. Similar to the previous results, decrease in real oil price had a greater contribution in the variation of the budget deficit compared to increase in real oil prices. The negative real oil price accounted for 14.1 per cent on average in the budget deficit changes, while positive oil price explained on average 0.76 per cent of changes in the budget deficit. However, the total revenues accounted for 66.7 per cent of the variation in budget deficit. The result of the decomposition analysis was consistent with those results obtained from the IRFs analysis. It is apparent that the effect of increase and decrease in real oil prices on the budget variables in the first quarter one was marginal, but increasing in the consecutive quarters. That is to say, there was a delay for the effect to take place on the budget variables. This could be attributed to the two months' delay in receiving the oil export proceeds.

6.10.2 Selected macroeconomic variables VAR model

The findings in Table 48 showed that positive real oil price had greater importance in explaining the variations in the macroeconomic variables than the negative real oil price shock. As can be seen from Table 48, the positive real oil price accounted for 0.09 per cent on average of the variation in the money supply, while negative real oil price responsible for 9.03 per cent on average in the variations of the money supply. The contribution of the positive real oil price shock in the variation of the money supply in the first quarter was less than the contribution of the negative real oil price shocks; however, as time passed its explanatory power increased slightly. This entails immediate precautionary measures to curtail or mitigate the impact of oil drops. It is clear that the shock to money supply has greater influence on itself. It is responsible on average 84.3 per cent of the variations in itself throughout the period. With regard to the inflation rate, the positive real oil price shock account for 0.43 per cent, 3.6 per cent and 3.9 per cent of the variations in the inflation rate in the first, second and third quarter, respectively. From the fourth quarter to the end of the period, it almost explained 3.7 per cent of the variation in the inflation rate. Turning to the negative real oil price shock, its contribution to the variation in the inflation rate was small and at the best contributed by 0.6 per cent. However, the shock in the inflation rate explained more than 87.1 per cent of the variation in itself. With regard to the real exchange rate, the positive real oil price contributed by 0.1 per cent and 3.2 per cent of the variations in the first and the second quarters, respectively. Then its contribution stood at 3.4 per cent during the remaining seven quarters. On the other hand, negative real oil price showed lesser contribution to the variation in the exchange rate, its contribution ranged from 0.9 per cent to1.6 per cent throughout the entire period. The variation in the real exchange rate was mostly explained by the shock to itself, with an average of 77.9 per cent over the entire period. With regard to the variation in the Murabaha rate, positive real oil price contributed 2.17 per cent on average throughout the period. While negative real oil price shock is responsible for 0.63 per cent on average in the variation of the Murabaha rate. However, shock on the Murabaha has considerable contribution to changes in itself. The decomposition analysis showed that shock to the variables had greater influence on their values.

Table 48. Selected macroeconomic variables VAR model: Variance decomposition analysis

Variance Decomposition of M2:							
Period	S.E.	PROILP	NROILP	M2	INF	D(RER)	MUR
1	0.094052	0.043398	10.55938	89.39722	0.000000	0.000000	0.000000
2	0.096442	0.049943	9.056942	81.88821	5.936034	3.049994	0.018879
3	0.096930	0.074599	8.923108	80.73505	7.015608	3.065667	0.185968
4	0.097045	0.104343	8.869214	80.15371	7.293655	3.159850	0.419224
5	0.097128	0.103999	8.839929	79.88878	7.326774	3.180964	0.659556
6	0.097189	0.105749	8.818323	79.70508	7.322767	3.188175	0.859901
7	0.097234	0.108783	8.801948	79.57064	7.312938	3.190185	1.015508
8	0.097267	0.111767	8.789659	79.47147	7.303929	3.190671	1.132507
9	0.097291	0.114275	8.780549	79.39853	7.296794	3.190660	1.219194
10	0.097309	0.116234	8.773841	79.34504	7.291401	3.190521	1.282964

Variance Decomposition of INF:							
Period	S.E.	PROILP	NROILP	M2	INF	D(RER)	MUR
1	0.093658	0.436192	0.254580	1.926068	97.38316	0.000000	0.000000
2	0.101337	3.609119	0.610928	1.631311	93.07091	0.676450	0.401283
3	0.104270	3.907099	0.617773	1.567972	91.22194	1.254628	1.430584
4	0.104966	3.837229	0.606200	1.540736	89.97346	1.429759	2.612613
5	0.105100	3.787601	0.597945	1.570892	88.90107	1.503319	3.639170
6	0.105127	3.760583	0.592608	1.629025	88.03257	1.537501	4.447709
7	0.105133	3.745942	0.589229	1.689079	87.36305	1.555467	5.057235
8	0.105134	3.737522	0.587028	1.740378	86.86143	1.565895	5.507748
9	0.105135	3.732275	0.585535	1.780765	86.49105	1.572500	5.837877
10	0.105135	3.728789	0.584492	1.811354	86.21944	1.576942	6.078979

Variance Decomposition of D(RER):

Period	S.E.	PROILP	NROILP	M2	INF	D(RER)	MUR
1	0.035486	0.116307	0.976701	1.288012	19.67847	77.94051	0.000000
2	0.038595	3.179831	1.609737	1.203695	17.68722	76.20281	0.116708
3	0.038985	3.383065	1.623301	1.239896	18.43511	75.19458	0.124040
4	0.039130	3.389074	1.620853	1.239254	18.50425	75.08380	0.162768
5	0.039195	3.387295	1.619646	1.239701	18.51575	75.03427	0.203336
6	0.039243	3.385845	1.618906	1.241378	18.51247	75.00197	0.239437
7	0.039280	3.385037	1.618366	1.243663	18.50743	74.97723	0.268274
8	0.039309	3.384626	1.617977	1.245879	18.50294	74.95819	0.290394
9	0.039329	3.384402	1.617694	1.247755	18.49939	74.94379	0.306967
10	0.039345	3.384271	1.617488	1.249236	18.49671	74.93306	0.319237

Variance Decomposition of MUR:

Period	S.E.	PROILP	NROILP	M2	INF	D(RER)	MUR
1	0.036009	2.043622	1.378282	2.239303	1.728867	2.473220	90.13671
2	0.041608	2.042845	0.812138	4.504315	2.154793	3.806789	86.67912
3	0.042908	2.112960	0.654762	5.834639	1.897422	3.673315	85.82690
4	0.043372	2.149231	0.584137	6.630553	1.709230	3.614579	85.31227
5	0.043672	2.193360	0.548559	7.122293	1.578997	3.554233	85.00256
6	0.043897	2.226718	0.527676	7.441400	1.492995	3.510886	84.80032
7	0.044068	2.250533	0.514504	7.654411	1.435251	3.480221	84.66508
8	0.044196	2.267267	0.505779	7.799743	1.395788	3.458791	84.57263
9	0.044292	2.279063	0.499818	7.900599	1.368380	3.443727	84.50841
10	0.044362	2.287424	0.495661	7.971523	1.349100	3.433066	84.46323

6.10.3 Current account VAR model

Generally speaking, the findings in Table 49 are consistent with those from the IRFs presented and in figure 26. As can be seen from table 34, negative real oil price shock had a greater contribution to the variation in the current account variables compared to the shock in positive real oil price. The negative real oil price shock responsible for 0.2 per cent in non-oil exports in quarter one, however, it increased to 4.7 per cent in the third quarter and continued that way to the end of the period. While a unit standard deviation shock to the positive real oil prices responsible for 0.7 per cent on average throughout the period. This support the conclusion that negative real oil price had a considerable contribution in explaining the changes in the non-oil exports. However, most of the variation explained by the shock of the non-oil exports itself, which accounted for more than 88.8 per cent throughout the period. With regard to the variation in the imports, negative real oil price shock accounted for 1.8 per cent, 2.2 per cent and 2.3 per cent of the variance in the first, the second and the third quarter, respectively. Then its explanatory power slightly increased to 2.7 per cent in quarters, four and five, then remained unchanged at 2.8 per cent in the remaining periods. Turning to shock to the positive real oil price, its contribution to the variation in the imports range from approximately 0.4 per cent to 0.9 per cent in the first three quarters, then remained constant at 0.9 per cent over the rest of the period. Interestingly, shock in non-oil exports explained small portion of changes in the import, but as time passed, its contribution reached 8.3 per cent. This result may be attributed to the fact that foreign exchanges receive from the exporting of non-oil products enabled the government to import more. Again, the considerable change in the import was explained by the shock of the variable itself.

Table 49. Current account VAR model: error forecast decomposition analysis

Variance Decomposition of D(NOEX):							
Period	S.E.	PROILP	NROILP	D(NOEX)	D(IMP)	D(TB)	D(CAB)
1	0.081934	0.661100	0.245410	99.09349	0.000000	0.000000	0.000000
2	0.091986	0.631280	4.709339	91.08633	0.180666	3.249278	0.143107
3	0.096793	0.708749	4.691093	89.38344	0.185580	4.524634	0.506509
4	0.098262	0.717230	4.763490	89.03697	0.252260	4.550154	0.679901
5	0.098515	0.724528	4.795947	88.88076	0.331944	4.588030	0.678795
6	0.098579	0.724532	4.792379	88.83035	0.362885	4.607465	0.682392
7	0.098606	0.724493	4.791980	88.81862	0.375254	4.606761	0.682891
8	0.098615	0.724460	4.791730	88.81361	0.379916	4.606433	0.683852
9	0.098617	0.724443	4.791783	88.81182	0.381011	4.606297	0.684646
10	0.098617	0.724451	4.791910	88.81132	0.381188	4.606291	0.684835

Variance Decomposition of D(IMP):							
Period	S.E.	PROILP	NROILP	D(NOEX)	D(IMP)	D(TB)	D(CAB)
1	0.096512	0.382774	1.780695	0.173116	97.66342	0.000000	0.000000
2	0.104445	0.767181	2.205481	2.368513	87.61694	2.568390	4.473493
3	0.105204	0.862114	2.374069	6.666518	80.76711	3.259252	6.070942
4	0.105426	0.860846	2.725330	8.126660	78.94318	3.175842	6.168140
5	0.105505	0.853168	2.774222	8.315595	78.49893	3.237427	6.320655
6	0.105524	0.852064	2.810958	8.368083	78.31371	3.243266	6.411915
7	0.105527	0.853324	2.832962	8.382619	78.25221	3.254069	6.424814
8	0.105528	0.853223	2.836907	8.382442	78.23890	3.262346	6.426183
9	0.105529	0.853195	2.837413	8.382157	78.23663	3.264075	6.426525
10	0.105529	0.853198	2.837518	8.382131	78.23632	3.264363	6.426470

Variance Decomposition of D(TB):							
Period	S.E.	PROILP	NROILP	D(NOEX)	D(IMP)	D(TB)	D(CAB)
1	0.001508	11.68460	27.44173	0.105261	32.33339	28.43502	0.000000
2	0.001611	9.374860	22.03143	0.945275	31.49122	27.24233	8.914885
3	0.001627	9.371543	22.00826	3.973349	30.22304	25.65753	8.766270
4	0.001630	9.277333	21.89633	4.173308	30.15264	25.81368	8.686710
5	0.001631	9.265032	21.85343	4.171904	30.13949	25.78907	8.781067
6	0.001632	9.263702	21.85957	4.186152	30.11758	25.77058	8.802417
7	0.001632	9.262509	21.86215	4.187621	30.11250	25.77428	8.800946
8	0.001632	9.262261	21.86136	4.187820	30.11178	25.77610	8.800680
9	0.001632	9.262179	21.86118	4.187983	30.11205	25.77594	8.800667
10	0.001632	9.262149	21.86110	4.188016	30.11223	25.77585	8.800652

Variance Decomposition of D(CAB):

Period	S.E.	PROILP	NROILP	D(NOEX)	D(IMP)	D(TB)	D(CAB)
1	0.007760	21.43007	22.06835	0.000472	20.10120	16.93816	19.46175
2	0.009643	17.29799	19.49029	0.000704	22.74246	19.23885	21.22971
3	0.010397	16.70520	18.86365	3.442497	21.86081	19.02511	20.10274
4	0.010615	16.46510	18.75255	3.952389	22.00579	19.00914	19.81504
5	0.010671	16.43063	18.68688	3.956453	22.09951	18.97667	19.84985
6	0.010688	16.41281	18.68048	3.986295	22.08558	18.95223	19.88261
7	0.010692	16.40857	18.68689	3.997849	22.07811	18.95106	19.87751
8	0.010693	16.40765	18.68640	3.997704	22.07677	18.95471	19.87676
9	0.010693	16.40749	18.68633	3.997678	22.07665	18.95480	19.87706
10	0.010693	16.40745	18.68636	3.997662	22.07675	18.95478	19.87699

Looking at the trade balance variable, negative real oil price shocks had a prominent contribution compared to positive real oil price shock. Negative real oil price shock account for 27.4 per cent of the variation in the import in the first quarter, however, it declined to 22 per cent in the second and the third quarter. Then its contribution witnessed a slight drop in the fourth quarter and stood at 21.8 per cent during the remaining period. On the other hand, the positive real oil price shock responsible of approximately 11.9 per cent of the variation of the trade balance in the first quarter then started its declining journey from the second quarter. From the fourth quarter to the end of the period the positive real oil price accounted for 9.3 per cent of the variation. Looking at the components of trade balance, the non-oil exports accounted for less than 1 per cent of the variation in the trade balance over the first two quarters. Then increased to 3.9 per cent in the third quarter and to 4.5 per cent in the fourth quarter, and remained that way to the end of the period. Furthermore, shock to imports significantly contributed to the variation in the trade balance. Its contribution was 32.3 per cent in the first quarter, and then gradually declined in the second and the third quarter. From the fourth quarter its contribution stood at 30.1 per cent and continued that way for the rest of the periods. This result confirmed that an import was the key variable in explaining the variation in the trade balance as Sudan was heavily depending on imported commodities.

With regard to the current account balance, negative real oil price shock was responsible for 22.1 per cent of the variation in the current account balance in the first quarter, then its explanatory power declined to 19.5 per cent, 18.9 per cent, and 18.8 per cent in the second, the third and the fourth quarter, respectively. Through the remaining period, its contribution stood at 18.6 per cent. Whereas, the positive real oil price shock accounted for 21.4 per cent in the first quarter, and then dropped to 16.7 per cent in the third quarter. Its contribution further declined to 16.4 per cent and continued that way to the end of the period. On the other hand, the non-oil exports had an insignificant contribution to the current account balance during the first two quarters. However, it became accounted for 3.4 per cent though the rest of the period. Interestingly, shock in imports was found to have a greater contribution to the variation in the current account balance, ranging from 20.1 per cent to 22.1 per cent over the entire period. This result also substantiated the significant contribution of the imports in the variations of both the trade balance and the current account balance.

6.10.4 growth and unemployment rates VAR model

The variance decomposition of the real GDP growth (RGDPG) and the unemployment (UNEM) due to their own shock and shock to real oil price for five years' horizon is presented in table 50. As can be seen from Table 50, apart from the first year, the PROILP account for 18.9 per cent of the variations in the RGDPG in the second quarter. Then, its importance in explaining the variation gradually increased through the following four years, reaching 21.2 per cent at the end of the period. Unlike the ROILP, the NROILP was responsible for almost 23 per cent of the variation in the real GDP growth rate in the first year. That is, the initial variations in real GDP growth rate were higher when oil prices went down compared to an increase in real oil prices. In the second year, the contribution of the NROILP increased to 25.2 per cent, and then dropped to 23.9 per cent in the third year. Its contribution to the RGDPG variations stood at 23.4 per cent through the remaining period. This result showed that negative oil price shock had relatively greater explanatory power in the real GDP growth compared to the increase in real oil prices. On the other side of the coin, the shock of the RGDPG had a significant proportion of the variations in itself in the first year amounting to 77 per cent. But this explanatory power dropped by 50 per cent in the second year. The variation of the RGDPG in the remaining period remained unchanged at 37.5 per cent. For the UNEM, it did not contribute to the variations in RGDPG in the first year. However, it accounted for 17.6 per cent of the variations in the RGDPG in the second year, then its contribution increased slightly to 18.3 per cent. After that its contribution remained unchanged at 17.9 per cent over the last two years. Looking at the unemployment, the positive real oil price at the best was responsible for 5.5 per cent of the variations throughout the forecasted period, while negative real oil prices were accounted for more than 29.5 per cent over the five forecasted years.

Table 50. GDP and unemployment VAR model: error forecast decomposition analysis

Variance Decomposition of RGDPG:					
Period	S.E.	PROILP	NROILP	RGDPG	UNEM
1	0.121998	0.003142	22.96276	77.03410	0.000000
2	0.130383	18.89002	25.22782	38.27623	17.60594
3	0.134692	20.38553	23.78630	37.51488	18.31330
4	0.135673	20.85230	23.46890	37.69042	17.98838
5	0.136030	21.19935	23.42724	37.45864	17.91477
Variance Decomposition of UNEM:					
Period	S.E.	PROILP	NROILP	RGDPG	UNEM
1	0.101781	0.511952	37.90267	5.703966	55.88141
2	0.120221	4.466554	30.15925	12.18379	53.19040
3	0.123915	4.381814	29.80390	14.02390	51.79038
4	0.124791	5.791722	29.55200	13.65041	51.00586
5	0.125302	5.855729	29.49551	13.74156	50.90720

6.10.5 Sectors growth rates VAR model

The same order of the variables used in the IRFs was used in this analysis. The variance decomposition of the agricultural sector growth rate, industrial sector growth rate and services sector growth rate is shown in Table 51. As can be seen from Table 51 the PROILP account for 4.8 per cent of the variations in the agricultural sector growth rate in the second year. Then its importance in explaining the variation was gradually increased to 30.3 per cent in the third year, then it increased dramatically to 52.2 per cent in the last year. On the other hand, the NROILP was responsible for almost 2.4 per cent of the variation in the agricultural growth rate in the first year. That is, the initial variations in the agricultural growth rate were higher when oil prices went down compared to an increase in real oil prices. In the second year, the contribution of NROILP increased to 20.5 per cent, and then gradually decreased to 19.6 per cent in the third year. This result showed that negative real oil price shock had relatively lower explanatory power in the agricultural sector growth rate compared to the increase in the real oil prices. On the other side of the coin, shock to the agricultural growth rate had a significant proportion in its own variations, amounting to 97.5 per cent in the first year. But this explanatory power dropped to 22.6 per cent at the end of the forecasted period.

Table 51. Sectors growth rates VAR model: variance decomposition analysis

Variance Decomposition of AGRICULTURE:						
Period	S.E.	PROILP	NROILP	AGRICULTURE	INDUSTRY	SERVICES
1	0.123129	0.006066	2.466700	97.52723	0.000000	0.000000
2	0.130368	4.822500	20.47898	60.09204	14.51925	0.087225
3	0.150291	30.25757	19.62453	37.47703	12.44625	0.194623
4	0.162278	52.59530	16.07677	22.98312	8.224521	0.120296
5	0.204316	52.19891	15.52161	22.58521	9.534957	0.159310

Variance Decomposition of INDUSTRY:						
Period	S.E.	PROILP	NROILP	AGRICULTURE	INDUSTRY	SERVICES
1	0.108102	3.875554	1.947792	65.06566	29.11099	0.000000
2	0.119288	4.232942	26.51753	47.94292	21.27639	0.030216
3	0.134209	4.363483	28.04785	46.99938	20.56047	0.028811
4	0.141947	5.073593	28.05971	45.20268	21.61206	0.051963
5	0.161357	14.00840	26.66853	39.99710	19.25509	0.070871

Variance Decomposition of SERVICES:						
Period	S.E.	PROILP	NROILP	AGRICULTURE	INDUSTRY	SERVICES
1	0.016206	53.84221	21.09108	8.296740	15.77548	0.994490
2	0.023066	62.49794	28.97454	4.061438	4.204808	0.261277
3	0.029362	65.57672	21.65487	3.142787	9.364758	0.260864
4	0.037561	68.31078	19.29792	5.118584	7.013531	0.259188
5	0.038354	71.04249	13.70802	5.548594	9.502738	0.198160

For the industrial sector growth rate, positive real oil price was responsible for 3.8 per cent in the first year. Then its explanatory power increased gradually reaching 14 per cent at the end of the period. However, the negative real oil price shock accounted for 1.9 per cent in the first year, but from the second year its contribution in the variation of the industrial sector growth rate jumped to 26.5 per cent, and by the end of the period it reached 26.7 per cent. These results showed that negative real oil price shock had greater influence in the industrial sector growth rate compared to positive real oil price shocks. Interestingly, the agricultural sector had a considerable contribution in the variations of the industrial sector growth rate in the first year, amounting to 65.1 per cent. After that its power started to decline gradually reaching 40 per cent at the end of the forecasted period. This result was plausible in the case of Sudan, as the industrial sector depended to a great extent on the agricultural product as main production inputs.

Finally, positive real oil price accounted for 53.8 per cent and 62.5 per cent of the variations in the services sector growth rate in the first and the second year, respectively. Then the positive real oil price became responsible for 65.6 per cent of the variations in the third year. By the end of the fifth year, positive real oil price shock became responsible for 71 per cent of the variation in the services sector growth rate. This result showed that real oil price increase had a significant contribution to the variance of the services sector growth rate. On the other hand, the negative real oil price was responsible for 21.1 per cent of the variations in the services sector growth rate in the first year. However, its explanatory power increased to 30 per cent in the second year and then gradually declined to reach 13.7 per cent in the fifth year. It was clear that both real positive and negative oil prices had greater influence in the services sector growth rate compared to their effects on the agricultural and industrial sector's growth rate. This might be attributed to the fact that most services activities were associated directly or indirectly with the boom and bust in the oil sector.

6.11 Summary

This chapter has empirically assessed the impact of real oil price shocks on the economy of Sudan. To achieve that purpose The VAR model and Delphi methods were adopted under the framework of mixed methods approach. Consequently, five VAR models, namely, public budget model, selected macroeconomic variables model, current account model, GDP growth and unemployment model, and sectors' growth model. Each VAR were developed and estimated using ordinary least squares, and then adequacy tests were performed to check the validity of the estimated models. After performing the validation tests, a further external validation was applied using the results obtained from the Delphi method. Based on the external validation, it was found that there were some contradictions in the sign of the coefficient of five variables, namely inflation, Murabaha profit margin rate, unemployment rate, agriculture sector growth rate and industrial sector growth rate. Accordingly, historical simulation was performed for those variables and results were evaluated using the simulation evaluating measures. The outcome of the simulation evaluation was that the signs of the estimated coefficients obtained from the VAR model were correct. Subsequently, the Granger causality test, Impulse Response Functions and Variance decomposition analysis were conducted.

For the public budget VAR model, the Granger causality test results suggested that decrease in oil price significantly influenced oil revenues, current expenditure and budget deficit. However, the increase in real oil price did not Granger cause budget variables. Results from the impulse response functions and variance decomposition analysis suggested that oil price shocks had an asymmetric effect on the public budget. For the selected macroeconomic variables VAR model, the impulse response functions showed that real oil price shocks, to a certain degree, impacted other variables symmetrically. However, the variance decomposition findings suggested that negative oil price shocks accounted for greater variation compared to the positive real oil prices. Looking at the current account VAR model, the main findings were that negative and positive shocks impacted current account and trade balances in a symmetric fashion. Granger causality tests showed that real oil price increase had a significant effect on current account balance and imports, while oil real price decrease had a significant effect on non-oil exports and the current account balance. Impulse response functions showed that the initial response of the trade and current account balances to positive and negative real oil price shocks was statistically significant. Variance decomposition analysis suggests that negative real oil price shocks were responsible for the major variations in current account variables other than the variables own shocks. With regard to the real GDP growth and unemployment rates VAR model, the Granger causality test results suggested that oil price increase and unemployment statistically and significantly influenced real GDP growth. Results from the Impulse Response Functions and Variance Decomposition analysis suggested that real oil price shocks had shown a symmetric effect on GDP growth. However, the negative real oil price had a significant impact on the unemployment rate in the first year. Turning to the sectors growth rate VAR model, the Granger causality test results suggested that negative real oil price shocks significantly influenced the agricultural sector growth and services sector growth rates. Also, positive real oil price shocks significantly Granger caused the agricultural sector growth rate. In contrast, positive and negative real oil prices failed to significantly cause industrial sector growth rate at 5 per cent significance level. Impulse response functions showed that the agricultural sector growth rate responded positively to both positive and negative shocks. While the response of the growth rate of the industrial and services sectors to real oil price shocks was to some extent symmetrical. Furthermore, the variance decomposition findings suggested that both real positive and negative oil prices have greater influence in the services growth rate compared to their effects on the agricultural and the industrial sectors' growth rates.

Chapter seven: Conclusion and policy recommendations

7.1 Conclusion

Sudan's economy was agricultural-led before the commencement of crude oil production. The agricultural sector had a higher share of the Gross Domestic Product (GDP) (almost 48 per cent) and employed approximately 80 per cent of the labour force (BBC, 2013). However, the discovery of the crude oil and the advent of crude oil export in the third quarter of 1999 caused a notable change in Sudan's economic structure. In 2008, oil export earnings constituted 95 per cent of the total export proceeds, leading to crude oil revenues contributing 60 per cent of the total government revenues (International Monetary Fund, 2009). Since then, the economy has become reliant on crude oil revenues to finance the government budget and to pay the import bill as well. During the period 2000 – 2011, Sudan witnessed a higher growth rate of its Gross Domestic Product, driven mainly by the oil sector (World Bank, 2009). This situation has exposed the economy to the negative effects of fluctuations of oil prices in the global markets. It is worth noting that during the period under investigation, Sudan was a net oil exporter, this manifested in the quantities of crude oil produced compared to the domestic consumption. That is, crude oil supply outweighed domestic demand.

Furthermore, the government has not fully acknowledged the implications of instability in the world crude oil markets and their impact on the economic activities. The government priority was to increase the amount of foreign inflows through increasing crude oil production and exporting to finance its budget and other financial commitments. That is, the focus was on the oil revenues side rather than considering the effect of shocks in the global crude oil markets and how that could affect the macroeconomy. In this respect, although the government established an Oil Revenues Stabilization Fund (ORSF) to cater for the drop in the crude oil prices, the amount of crude oil revenues that was deposited in the ORSF has been poorly managed, thus the Fund failed to serve its intended purpose.

Most of the resources of that Fund were utilized in financing the growing government current expenditure (Abdulwahab, 2012). Moreover, the persistent interventions of the central bank to stabilize the exchange rate in the foreign exchange market accelerated the depletion of the Oil Revenue Stabilization Fund resources and foreign reserve. Despite the high dependency on crude oil revenues and given that Sudan is a price taker; no effort was exerted to study the relationship between the movements of crude oil prices and the key macroeconomic variables in Sudan. This was the main motivating factor for undertaking this research in order to enable the government to clearly understand the effect of fluctuations of crude oil price on macroeconomic variables. Accordingly, the government will be in a better position to prudently adopt the appropriate economic policy response to enhance further the positive effects and to put in place precautionary measures to mitigate the negative impacts of the crude oil price drops as well.

The overall objective of this thesis was to assess the impact of oil price shocks on the government budget, selected macroeconomic variables, current account, real GDP growth and unemployment rates, and the growth rates of the agricultural, industrial and services sectors during the period 2000 – 2011. In addition to identify a potential gap in methodologies and techniques in the literature. To attain these objectives, the following were questioned is answered:

How is crude oil price shocks transmitted to the Sudanese economy as measured by:

f) The public budget?

g) key macroeconomic variables?

h) The current account?

i) Real GDP growth and unemployment rates?

j) The growth rate of agricultural, industrial and services sectors?

Also, the gap in research methodologies and techniques is identified.

Chapter two presented a brief background on the economic activities of Sudan. The economy has shown a steady growth since the advent of oil production, thanks to increase in crude oil production and the associated high oil prices up to mid-2008. According to Nour (2010), Sudan was amongst the fastest growing economy in Sub-Saharan Africa, achieving GDP growth of 9 per cent on averages, occupying the third rank in terms of crude oil production in Sub-Saharan Africa after Nigeria and Angola. Concerning the sectoral level, the share of the agriculture sector in the GDP declined, which showed some signs of Dutch disease in the economy, while industrial and services sectors had increased over the study period. The increasing contribution of the industrial sector to the GDP was mainly triggered by the increase in oil production and prices. Moreover, the inflation rate was in the range of 5-9 per cent up to 2007, and then started to climb due to the increase of money supply. The real exchange rate was relatively stable with an appreciation and depreciation in few years of the sample period. This might be attributed to managed float exchange regime adopted by the Central Bank of Sudan. Murabaha profit margin rate had shown a descending trend over the sample period. However, Money supply, in nominal terms, had steadily increased during the study period. Likewise, the government total revenues increased dramatically, thanks to crude oil revenues, which contributed on average 48.6 per cent of the total government revenues. Similarly, government expenditure increased, which resulted in worsening the budget deficit. This typically showed the consequences of adopting expansionary fiscal policy during the oil boom. On the other hand, the overall balance of payments performance improved as a result of increase in oil production, the surge in crude oil prices and an increase in Foreign Direct Investment inflows. Despite the improvement in the performance of some macroeconomic variables, Sudan's external debt grew at an accelerated rate due to the build-up of arrears. Although Sudan was eligible for the Highly Indebted Poor Countries (HIPCs) initiative and fulfilled all technical conditions, other political factors hindered it from benefiting from the initiative.

Chapter two, an exhaustive overview of studies that had investigated the relationship between oil price shocks and the macroeconomy were carried out. The effect of oil price shocks on economic activities was to a great extent identified and explained in the literature. Generally speaking, net-oil exporting countries are found to exhibit positive effects on their economies when oil prices mount, while net-oil importing countries suffer. On the contrary, the net-oil importing countries benefit from the drop in oil prices and their counterparts witness a negative economic impact. These results did not remain true through time due to differences in the development stages, economic structure and counter monetary and fiscal policies to oil price shocks. Nevertheless, some variations in research findings might be attributed to numerous factors, among which are oil price specifications, type of data used and using different timeframes. With regard to the pass through of oil price shocks to the economy, six transmission mechanisms of oil price shock were acknowledged in the literature with some changes in the name of the channel and minor differences with regard to their interpretation.

A short glimpse of the oil sector evolution was provided in chapter three. The oil exploration operations were limited to the western and south-central parts of Sudan due to civil war. Oil productions started in the early 1990s with assistance from Asian companies, but oil exports started in late 1999. Since then, oil production has shown an upward trend, reaching approximately 461 thousand barrels per day in 2007. This production is supported by well-established oil infrastructure, in terms of pipelines, central processing units, storage facilities and refineries, which entirely are exist in the north of the country.

As a consequence of the separation of South Sudan from the Government of Sudan a remarkable decline in GDP growth was witnessed. However, from 2013 the economy started to gradually recover from the shock and achieved a GDP growth of 3.6 per cent up from 1.6 per cent in 2012. Furthermore, another leap of 4.4 per cent GDP growth rate was achieved in 2014. The main reason of the notable good performance might be attributed to the increase in non-oil exports, gold export proceeds and foreign inflows from the Transitional Financial Arrangements with the government of South Sudan. Likewise, some other macroeconomic indicators had shown slight improvement in their performance.

Chapter four shed light on the proven reserves of crude oil in the world, global crude oil demand and supply, debate about the peak oil theory, pricing mechanism of crude oil, various factors that affect crude oil prices, a glimpse of the historical oil price shocks and the recent plunge in crude oil prices. It is apparent that the world proven oil reserves showed an increase of 29.4 per cent over the last ten years. In this context, the peak theory introduced by M. King Hubbert in 1956 was criticized by a number of scholars. Although the theory in principle was sound, the timing was difficult to predict due to lack of accurate data about oil reserves and unexplored areas, among other factors. With regard to the world crude oil supply, it steadily increased through the period 2000 – 2009, but dropped by approximately 4.9 per cent in 2009. This fall was attributed to cutting in oil output by the OPEC countries to boost prices. On the other hand, in the last fifteen years, the average growth rate of world crude oil demand was almost 2.6 per cent. It was observed that the surge in the world demand was mainly driven by increasing consumption in developing and emerging countries. Pricing of crude oil has witnessed significant changes throughout history. The Seven Sister companies were the major determinants of crude oil prices up to 1970s, followed by the OPEC era. In the early 1980s, a new system of pricing was presented, in which prices were determined as a differential to certain benchmark or reference prices (e.g. Brent, WTI and Dubai). Notwithstanding crude oil prices were generally determined by demand and the supply conditions. Other factors play a significant role in crude oil prices. For example, geopolitical events, speculative activities, environmental conditions and the US dollar exchange rate. These factors caused a series of oil price shocks in the past. Recently, the drop of crude oil prices can be attributed to a number of factors, similar to those that occurred in earlier times. However, the newest factor is the increase of crude oil from the non-conventional sources e.g. oil shale and oil sands.

In chapter five, the research methodology was developed under the philosophical framework of pragmatic paradigm. In view of that, the Convergent Parallel Mixed Methods Design was used, in which quantitative and qualitative data were collected concurrently, analysed separately and then compared to each other (Creswell & Plano Clark, 2011). It is worth noting that the thesis used mixed methods design for corroboration and validation. This chapter explained the various steps and tests used in analysing the quantitative and qualitative data. The starting point was to develop five VAR models to analyse the quantitative data. Then, a number of specification tests for the five VAR models were articulated, namely, checking the stationarity of time series through the most common tests (ADF, PP and KPSS) and selecting the optimal lag length using HQIC, AIC and SBIC. The next step was the use of ordinary least squares methods to estimate the VAR model followed by adequacy tests for internal validation. Likewise, Delphi method was expounded in addition to the steps of designing the semi-structured questionnaire, selecting the panel of experts and analysing the qualitative data. Then the chapter elucidated how the outcomes of the Delphi method will be used as an external validation for the VAR model estimates. Also, the historical simulation technique was explained as an alternative tool for validation whenever a contradiction observed in the results obtained from the estimated VAR model and the Delphi method. Finally, in investigating the impacts of oil price shocks on the macroeconomy, three tests were explained, namely, Granger causality test, impulse response function and Variance Decomposition analysis.

Chapter six was devoted to empirically examining the effects of real oil price shocks on the various macroeconomic variables in Sudan. In doing so, five VAR models, namely, public budget model, selected macroeconomic variables model, current account model, GDP growth and unemployment model, and sectors' growth model were developed and estimated using ordinary least squares, and then adequacy tests were performed to check the validity of the estimated VAR models. After performing the adequacy tests, a further external validation was conducted using the results obtained from the Delphi method. Based on the external validation, the sign of five variables coefficients obtained from the Delphi method were in contradiction to those of the VAR model estimates. The five variables were Murabaha profit margin rate, unemployment rate, inflation, agriculture sector growth rate and industrial sector growth rate. For that reason, historical simulation was performed for those variables and its results were evaluated using the simulation evaluating measures. The outcomes of the simulation evaluation measures using the Root Mean Squared Error, Theil equity coefficient, bias proportion, variance proportion and covariance proportion were that signs of the estimated coefficients obtained from the VAR model were correct. Then the Granger causality test, impulse response functions and variance decomposition analysis were conducted. The main findings were summarized as follows:

- With reference to the public budget VAR model, the results of the Granger causality test suggested that the decrease in oil price significantly influenced oil revenues, current expenditure and budget deficit. In contrast, the increase in real oil price did not Granger cause budget variables. This was attributed to the predetermined oil price during the preparation of the annual government budget. Results from the impulse response functions and variance decomposition analysis suggested that oil price shocks had an asymmetric effect on the public budget. That is, the magnitude of the impact of oil price decrease was greater than the oil price increase. The response of total revenues and current expenditure to shock in oil price decrease was negative and statistical significant. This result showed the vulnerability of the country to negative oil price shock. It also reveals that negative oil price shocks pass through the government budget to the economy. Therefore, the policy makers have to plan ahead by putting in place efficient precautionary measures.

- As regards the selected macroeconomic variables VAR model, Granger causality test results did not show a significant relationship between oil price shocks and the selected macroeconomic variables. The impulse response functions showed that real oil price shock impacted other variables to some extent symmetrically. However, the magnitude of the positive real oil price shock was greater in the case of inflation and exchange rate. In the same manner, the magnitude of the response of money supply to negative real oil price shock was greater than in the case of positive real oil price shock. However, the variance decomposition results suggested that negative oil price shocks accounted for greater variation compared to the positive real oil prices. The increase in the money supply when the oil price drop was attributed to extensive borrowing from the central bank to finance the budget deficit.
- With regard to the current account VAR model, the main findings were that negative and positive oil price shocks impacted current account and trade balances in a symmetric fashion. The results of the Granger causality test depicted that real oil price increase had a significant effect on the current account balance and imports, while oil real price decrease had a significant effect on non-oil export and the current account balance. Impulse response functions showed that the initial response of the trade and current account balances to positive and negative real oil price shocks were statistically significant. That is, as a result of increase in oil price, trade and current account balances were significantly improved, while a decrease in oil price had worsened them. The variance decomposition analysis suggested that negative real oil price shocks were responsible for the major variations other than the variables own socks. That is to say, the current account is highly sensitive to changes in oil prices. Moreover, the oil price shocks were assumed to be passed to the economy through the current account.
- Turning to the real GDP growth and unemployment rates VAR model, Granger causality test results suggested that oil price increase and unemployment statistically and significantly influenced real GDP growth. However, there was no significant

relationship between oil price shocks and the UNEM variable. Results from the Impulse Response Functions suggested that real oil price shocks had shown a symmetric effect on GDP growth. However, the negative real oil price had a significant impact on the unemployment rate in the first year. In contrast, variance decomposition analysis showed that the contribution of negative real oil price shock in the variations of real GDP growth and unemployment rates were greater than those of oil price increase.

– As for the sectors growth rate VAR model, the results of the Granger causality test depicted that negative real oil price shock significantly influenced the agricultural sector growth and service sector growth rates. Also, positive real oil price shock significantly Granger caused the agricultural sector growth rate. In contrast, positive and negative real oil price shocks failed to significantly cause industrial sector growth rate at 5 per cent significance level. On the other hand, impulse response functions showed that the agricultural sector growth rate responded positively to both positive and negative oil price shocks. This unexpected effect could be attributed to increase of oil revenue during oil boom which in turns enable the government to support the irrigated agricultural sub-sector. On the other hand, the drop of oil price depreciates Sudanese currency, thus increasing the competitiveness of the non-exports which were mainly agricultural products. Therefore, the agricultural sector has to be supported in order to cushion oil price shocks in the future. The response of the growth rate of the industrial and services sectors to real oil price shocks was to some extent symmetrical. Furthermore, the variance decomposition findings suggested that both positive and negative real oil prices have greater influence in the services growth rate compared to their effects on the agricultural and the industrial sector growth rates.

7.2 Contribution to knowledge

This thesis attempted to contribute to the existing knowledge from different perspectives: exploring the relationship between oil price shock and the macroeconomy in Sudan, applying an existing technique in a new context (new research area), bringing technique together that have not been put together before and complementing the existing knowledge with regard to oil price shocks and the macroeconomy relationship in oil exporting developing economies. These elements of contribution to knowledge are explained as follows:

1. Since the start of oil production and up to the secession of South Sudan in July 2011, the government tended to deal with the economic instabilities with discrete policies. Thus, no consideration was paid for the dynamic effect of oil price shocks on the macroeconomic variables within the economic system. That is, Sudan has been neglected from serious studies related to oil price shocks. Therefore, this research attempted to thoroughly investigate the impact of oil price shocks on Sudan's economy over the period 2000: q1 – 2011: q2. As a matter of fact, there was only one research paper which used four variables VAR model to assess the impact of oil price shock on the Sudan, during the period 2000-2008. That research had been criticized on a number of technical grounds as mentioned in chapter four, section 4.3.1. To the best of my knowledge, this is the first comprehensive empirical study that assessed the impact of oil price shocks on the macroeconomy over the entire period when Sudan was a net oil exporter.
2. All previous studies conducted elsewhere used quantitative methods only to assess the relationship between oil price shocks and the macroeconomy. This research, however attempted to employ the convergent parallel mixed method design (quantitative and qualitative approach) to investigate the research questions using the VAR model and Delphi method. Under this framework, bringing Delphi method with the VAR model in

one research is another element of innovation. To the best of my knowledge, no previous studies had empirically used Convergent Parallel Mixed design to assess the relationship between oil price shocks and the macroeconomy with Delphi used as an external validation method.

3. This research also complemented and contributed to the expansion of the existing knowledge on the impact of oil price shocks on developing countries in general and in oil producing and exporting countries in particular. Generally, speaking there is paucity of researches in developing exporting countries compared to the huge studies carried out in developed oil importing countries such as the US and OECD countries.

7.3 Policy recommendations

Based on the aforementioned concluding remarks and in order to mitigate the negative impact of oil price shocks on the Sudan's economy a prudent economic policy has to be adopted and adhered to in the short and medium term. Therefore, the following set of policy recommendations were proposed to help in containing the adverse effects of oil price shocks:

7.3.1 Efficient Oil Revenue Fund

An effective and efficient management system of the Oil Revenues Stabilization Fund (ORSF) has to be in place to better manage the oil windfalls and support the public budget during periods of low oil prices. Accordingly, the government is supposed to have a benchmark price for the oil during the process of the preparation of the annual national budget. If oil prices are higher than the benchmark price, the surplus should be deposited in the ORSF. However, the government has to adopt a conservative approach in determining the benchmark oil price that will be used in the public budget to avoid persistent withdrawals from the bank and non-bank sources. To attain that, the government has to thoroughly study the movement of crude oil prices in the global markets. In other words, the estimation of oil price to be used in the government budget has to be based on solid scientific prediction. There are a number of oil producing countries that have successfully managed their oil revenue funds, but the most prominent is the Norwegian Oil's Fund. The other option is to prudently manage the oil revenue by moving it out from the budget and channelling oil revenues directly to the fund similar to Norway' practice. However, this option requires a concrete legislative framework to govern the financial resources in an efficient, accountable and transparent manner. Decoupling oil revenues from budget revenues will help maintain the stability of fiscal stance and protect it from external shocks.

7.3.2 Encourage non-oil exports

In fact, Sudan was historically dependent on raw agricultural products and livestock exports proceeds as main sources of foreign exchange. However, since the advent of oil, a radical change occurred in the economic structure. That is, the oil sector started to lead the rest of the economy. As noticed from the findings, non-oil exports deteriorated as a result of appreciation of the exchange rate. In Trinidad and Tobago, Lorde et al. (2009) elucidated the negative impact of net exports on the ground of appreciation of the exchange rate, which drive imports to increase and reduce non-oil exports. To overcome this negative effect, there is a need for a policy that advocates diversification of the economy through boosting the non-oil exports. This policy would help the government to absorb any shocks in the oil sector in the future. In this respect, the government of the Sudan has to restore the role of the agricultural sector in the economy through creating an enabling investment environment and providing special incentives to the domestic private sector to encourage them to invest in this sector. Also, the government should encourage the domestic national banks (private and public) to provide farmers with the required funds at a reasonable cost of finance to meet the cost of cultivation and harvesting and marketing. Similarly, the central government has to put in place legislations that prohibit state and local authorities from imposing taxes and other fees on agricultural activities in their regions. Furthermore, the government needs to subsidize oil products that are used in the agricultural production. In short, the government has to invest oil revenues in the real sector to broadening and diversifying the productive base of its economy, which in turn sustain the economic growth when the oil price drops. Some developing countries have adopted exports diversification policy which resulted in an improvement of current account balance, reducing of unemployment, stabilizing export earnings and attaining high economic growth (Adesoji and Sotubo, 2013).

7.3.3 Curtailing non-productive imports

A rational import policy is highly recommended in which a priority should be given to the import of production inputs. That is, import of consumables and luxurious goods needed to be curtailed by imposing higher tariff and import customs to save foreign exchanges for other productive sectors and to reduce the demand for foreign exchanges. Also, restraining the import of intensive energy consumption appliances is important to rationally use the oil resources. Furthermore, having these policies in place, would improve the trade balance and the current account. Some developing countries imposing restriction in importing unnecessary imported goods Such as India, Nigeria and Kenya to reduce trade deficit and increase foreign exchange reserves (Somashekar, 2003: 349).

7.3.4 Adoption of efficient public expenditure management policy

Government should give more attention to its spending behaviour through prioritizing the projects and programs with focus on activities that have greater value added to the economy. A serious step towards reducing current expenditure in favour of development expenditure has to be adopted. Without having an effective management of government expenditure, the public budget will witness persistent deficit. The problem is that increasing government expenditure through borrowing from the central bank will result in an inflationary effect, which in turn harms the economic stability. Therefore, current expenditure has to be controlled and cut down to improve the fiscal balance stance. Also, the composition of public expenditure has to be revisited and geared towards increasing the financial resources to development spending. In similar study in Turkey, Korhan et al., (2015) emphasised the importance of directing the expenditure towards productive sectors, infrastructure and education to achieve higher economic growth rate.

7.3.5 Lifting subsidies and voiding tax exemptions

The government had partially started to implement a fuel subsidy cut in September 2013, but still there are considerable subsidies in place (Laura, 2014). Lifting of subsidies on oil products and voiding of tax exemptions will rectify the existing distortions in the market. This in turn would induce rational behaviour of consuming the oil products. Furthermore, subsidies cut, especially on crude oil sold to a refinery, will help assess the efficiency of refinery operations compared to similar plants in neighbouring countries. Because the selling of crude oil at a price lower than its real market rate to the refinery will result in some elusive profitable indicators of all refinery processes, whereas in reality it is not. Furthermore, low cheap fuel will promote smuggling to neighbouring African countries with higher domestic prices. However, this policy should be preceded by meticulous cost analysis for the subsidized items and products. Then, dynamic pricing mechanism has to be adopted to de-politicize oil products prices from continuing interventions of politicians. However, necessary measures have to be introduced to mitigate the devastating negative effect of lifting subsidies on the large low income individuals in the society. On the other side of the coin, this policy would enable the government to allocate these huge financial resources for other productive sectors. Furthermore, a prudent tax policy should be put in place to broadening the tax base rather than increasing tax rates during the periods of oil price drop. According to Persley and Boqiang (2016), removal of fuel subsidies in Ghana generated benefits in terms of budget deficit, reduce the government financial burden and curbed wasteful consumption.

7.4 Future research

This research focused on the period where Sudan was a net-oil exporter and a unified country (e.g. before the separation of South Sudan) That is, the research was undertaken covering the period before the separation of the southern Sudan. As a result of the secession of the South Sudan, the north (Government of Sudan) lost approximately 70 per cent of the existing oil producing fields, one fifth of the land and almost 23 per cent of the total population. This situation will have a greater impact on the structure of the economy. However, the loss of oil revenue has been relatively compensated by a persistent increase in gold production. One the other hand, according to the IMF (2013) the crude oil production in Sudan stood at 133 thousand barrels per day as of 2012 and it is expected to increase to 325 thousand barrels per day by 2017 as new concessions were already signed, with substantial incentive for international oil companies to explore in the new areas. In this respect, six agreements were signed in 2012 for the following blocks: 18, 15, 14, 12-B, 10, 9 and 8 (Sidahmed, 2014). Therefore, a further analysis of the impact of crude oil price shocks after the separation is crucial. It also helps compare the results that will be obtained from analysing of the post sample period (after 2011) with those before the separation.

Furthermore, the findings of this thesis have shown that the full pass through of oil price shocks was not observed on domestic prices due to fuel subsidy. Therefore, upon removal of the fuel subsidy as recommended earlier, the effect of lifting subsidy from fuel oil on the consumer price index, budget deficit, and consumption of refined oil product will need to be investigated. These variables are selected to help in examining the improvement in the fiscal stance, discourage wasteful consumption due to low prices and effect on household income after fuel subsidy removal.

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Appendices

Appendix 1. List of experts participated in the Delphi method

	Title	Qualifications	Experience	Department	Institution
1	Senior economic advisor	MSc Economics	32 years	-	The Council of Ministers
2	Ex-State Minister of Finance	PhD, Economics	35 years	-	MoFNE*
3	Deputy Undersecretary	MSc, Economics	30 years	Policies and planning	MoFNE
4	Deputy Director General	MSc, Economics	28 years	Policies and Planning	MoFNE
5	Director General	MSc, Development Economics	30 years	International Financial Cooperation	MoFNE
6	Director	PhD, Economics	24 years	Macroeconomic Models	MoFNE
7	Director	MSc, Economics	20 years	Petroleum unit	MoFNE
8	Director	PhD, Economics	26 years	Research and Development	Central Bank of Sudan
9	Chief Economist	MSc, Economics	24 years	Research and Development	Central Bank of Sudan
10	Director General	MSc, Economics	26 years	Sudan External Debt Unit	Central Bank of Sudan
11	Chief Economist	PhD,	18 years	-	The World Bank,

		Economics			Country Office
12	Chief Economist	PhD, Economics	26 years	-	International Monetary Fund (IMF), Country Office
13	Chief Economist	MSc, Economics	18 years	-	African Development Bank, Country Office
14	International Expert	PhD, Economics	14 years	-	Intergovernmental Authority on Development (IGAD)
15	Senior Economist	MSc, Economics	16 years	Minister's Office	MoFNE

*Ministry of Finance and National Economy (MoFNE)

Appendix 2. Delphi method questinnaire

Assessing the impact of crude oil price Shocks on Sudan’s Economy

Respondent No.______

Sending Date __/___/________ **Receiving Date____/____/________**

Purpose of the questionnaire:

This questionnaire intends to collect data for assessing the impact of world oil price shock on different macroeconomic variables. It also aims at exploring its effects on the economic sectors during the period 2000:Q1 – 2011:Q2. In addition to reaching an agreement on the list of the macroeconomic variables that will be included in the VAR model.

Section 1: Impact of crude oil price shocks on selected macroeconomic variables

1. Please tick the appropriate relationship between crude oil price shocks (increase and decrease) and the listed macroeconomic variables?

	Oil price increase			**Oil price decrease**		
Macroeconomic variables	**Positive**	**Negative**	**Neutral**	**Positive**	**Negative**	**Neutral**
money supply						
Interest rate /Murabaha						
inflation rate						
Real exchange rate						

Comment, if any

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Section II: Impact of oil price shocks on the current account

2. Please indicate in the table below the impact of the crude oil price shocks (increase and decrease) on the listed current account items?

	Crude oil price increase			**Crude oil price decrease**		
Macroeconomic variables	**Positive**	**Negative**	**Neutral**	**Positive**	**Negative**	**Neutral**
Non-oil exports						
Import						
Trade balance						
Current account balance						

Comments, if any

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Section III: Impact of crude oil price shocks on the GDP growth and unemployment rates.

3. What was the impact of oil price shocks (increase and decrease) on the GDP growth and unemployment rates during the period 2000-2011?

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Section IV: Impact of crude oil price shocks on the public budget

4. Please indicate in the table below the impact of crude oil price shocks (increase and decrease) on the listed public budget variables?

	Crude oil price increase			**Crude oil price decrease**		
Items	**Positive**	**Negative**	**Neutral**	**Positive**	**Negative**	**Neutral**
Total revenues						
Development expenditure						
Current spending						
Tax revenues						
Budget deficit						

Comments, if any

………………………………………………………………………………

……………………………………………………………………………

Section V: Impact of crude oil price shocks on the sectors' growth (agriculture, industry and services sectors)

5. Would you please explain how the crude oil price shocks (increase and decrease) impacted the following sectors?

   Agricultural sector

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ………………………………………………………………………………

   Industrial sector

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ………………………………………………………………………………

   Services sector

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

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Section VI: Macroeconomic Variables

The following list of the macroeconomic variables has been selected from similar empirical studies (impact of oil price shocks on oil-exporting and oil-importing countries).

Please declare whether you agree or disagree to the inclusion of these macroeconomic variables in the proposed econometric model of this study.

Macroeconomic Variables	**Agree**	**Disagree**
Real oil Price		
Inflation rate		
Money Supply		
Unemployment rate		
Interest rate/ Murabaha		
Non-oil Export		
Import		
Current account balance		
Trade Balance		
Real exchange rate		
Growth Domestic Product		
Total Revenue		
Development Expenditure		
Recurrent Spending		
Tax Revenue		
Budget Deficit		
Agricultural sector growth rate		
Industrial sector growth rate		
Services sector growth rate		

Other macroeconomic variables need to be included, please specify

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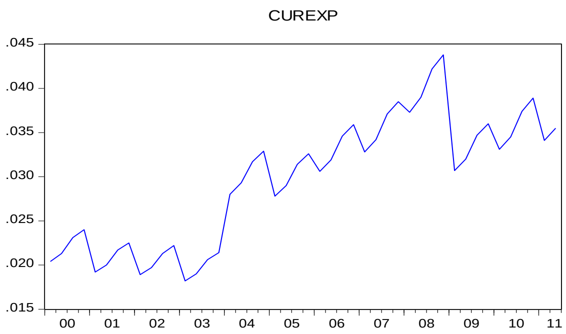
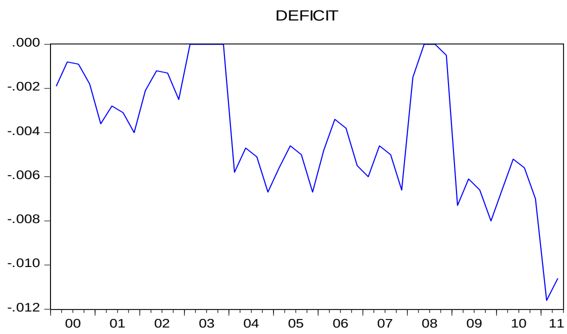
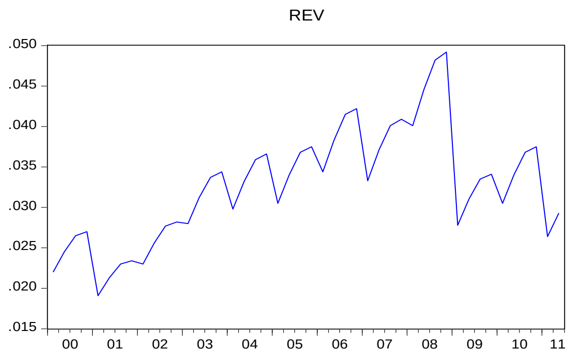
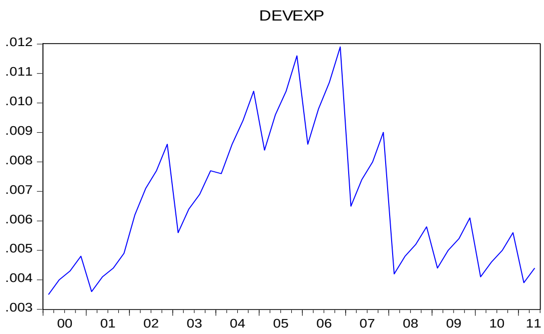
Thank you so much for your cooperation

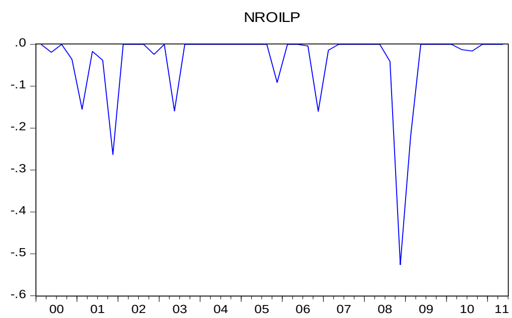
Appendix 3. Public budget VAR model: plotting of the time series data

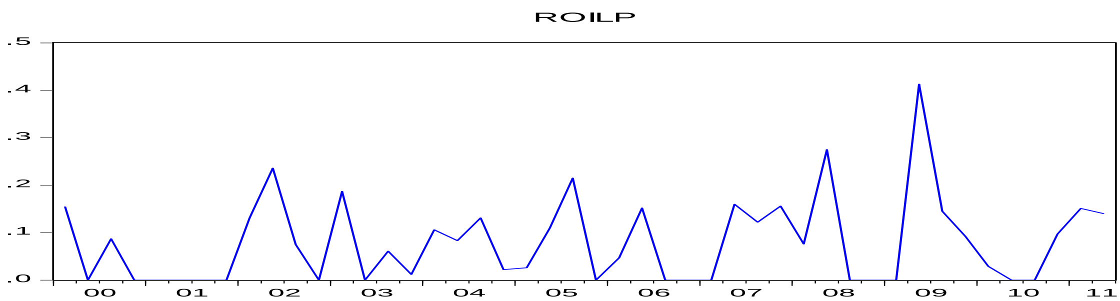












Appendix 4. Public Budget VAR model equations

proilp = 0.156293147782*proilp(-1) - 0.0636457046524*nroilp(-1) + 3.82236019615*tax(-1) - 4.75487227916*d(rev(-1)) - 10.5112220772*d(curexp(-1)) - 0.67920705338*d(devexp(-1)) + 3.05244312484*d(deficit(-1)) + 0.0196578261921

nroilp = -0.180339069277*proilp(-1) + 0.247670514276*nroilp(-1) - 1.90114032866*tax(-1) + 4.07900450353*d(rev(-1)) + 4.97861666567*d(curexp(-1)) - 8.38550898317*d(devexp(-1)) - 2.76452923528*d(deficit(-1)) + 0.069849846529

tax = 0.000575130142222*proilp(-1) - 0.00462488670762*nroilp(-1) + 0.67197186808*tax(-1) + 0.0550511207356*d(rev(-1)) - 0.0373765064087*d(curexp(-1)) - 0.118749509329*d(devexp(-1)) - 0.00436537097178*d(deficit(-1)) + 0.00495321439068

d(rev) = 0.00658263779031*proilp(-1) - 0.0303762755248*nroilp(-1) - 0.813119853211*tax(-1) + 0.0069887339302*d(rev(-1)) - 0.264322432821*d(curexp(-1)) - 0.560704365441*d(devexp(-1)) + 0.314619003929*d(deficit(-1)) + 0.0124997552537

d(curexp) = 0.00293118654958*proilp(-1) - 0.0214319996386*nroilp(-1) - 0.406232009905*tax(-1) + 0.0323828064978*d(rev(-1)) - 0.168279014597*d(curexp(-1)) - 0.0351351333604*d(devexp(-1)) + 0.137630022056*d(deficit(-1)) + 0.00680483989437

d(devexp) = 0.00237068992221*proilp(-1) - 0.00207789279738*nroilp(-1) - 0.188633920004*tax(-1) + 0.030430523872*d(rev(-1)) - 0.00122886026035*d(curexp(-1)) - 0.302133122215*d(devexp(-1)) + 0.0295631795321*d(deficit(-1)) + 0.00260148247653

d(deficit) = -0.00304043547351*proilp(-1) + 0.00739751408203*nroilp(-1) - 0.168235007574*tax(-1) + 0.121990371489*d(rev(-1)) + 0.0865391103275*d(curexp(-1)) + 0.0960420860525*d(devexp(-1)) - 0.108731585992*d(deficit(-1)) + 0.00245365153495

Appendix 5. Statistics of the diagnostic tests for the public budget VAR model

1 Autocorrelation

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 09/20/15 Time: 20:37
Sample: 2000Q1 2011Q2
Included observations: 44

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	19.05943	NA*	19.50267	NA*	NA*
2	47.53963	0.5325	49.33908	0.4596	49
3	92.65571	0.6335	97.75633	0.4879	98
4	145.7044	0.5147	156.1099	0.2879	147

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

2. Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/20/15 Time: 20:40
Sample: 2000Q1 2011Q2
Included observations: 44

Component	Skewness	Chi-sq	df	Prob.
1	0.196819	0.284077	1	0.5940
2	3.188807	74.56892	1	0.0000
3	-0.568867	2.373138	1	0.1234
4	-1.006421	7.427803	1	0.0064
5	2.050099	30.82130	1	0.0000
6	0.052288	0.020049	1	0.8874
7	-0.009029	0.000598	1	0.9805
Joint		115.4959	7	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	2.621725	0.262335	1	0.6085
2	16.25335	322.0275	1	0.0000
3	2.719555	0.144190	1	0.7042
4	5.899856	15.41681	1	0.0001
5	9.134445	68.99092	1	0.0000
6	7.982682	45.51640	1	0.0000
7	4.708878	5.353820	1	0.0207
Joint		457.7120	7	0.0000

Component	Jarque-Bera	df	Prob.
1	0.546412	2	0.7609
2	396.5964	2	0.0000
3	2.517328	2	0.2840
4	22.84461	2	0.0000
5	99.81222	2	0.0000
6	45.53644	2	0.0000
7	5.354418	2	0.0688
Joint	573.2079	14	0.0000

3. Heteroskedasticity test

Null Hypothesis: VAR Residuals are Homoscedasticity
Date: 09/20/15 Time: 20:44
Sample: 2000Q1 2011Q2
Included observations: 44

Joint test:

Chi-sq	df	Prob.
421.9492	392	0.1429

Individual components:

Dependent	R-squared	F(14,29)	Prob.	Chi-sq(14)	Prob.
res1*res1	0.310541	0.932995	0.5376	13.66378	0.4750
res2*res2	0.211525	0.555706	0.8767	9.307121	0.8109
res3*res3	0.495020	2.030572	0.0523	21.78088	0.0832
res4*res4	0.165066	0.409521	0.9596	7.262913	0.9241
res5*res5	0.417266	1.483242	0.1795	18.35969	0.1909
res6*res6	0.358049	1.155343	0.3571	15.75417	0.3286
res7*res7	0.230642	0.620982	0.8258	10.14823	0.7513
res2*res1	0.544532	2.476482	0.0190	23.95940	0.0463
res3*res1	0.214098	0.564306	0.8704	9.420322	0.8032
res3*res2	0.147310	0.357857	0.9770	6.481625	0.9529
res4*res1	0.414047	1.463716	0.1874	18.21807	0.1970
res4*res2	0.298822	0.882782	0.5838	13.14815	0.5149
res4*res3	0.227114	0.608694	0.8359	9.993021	0.7627
res5*res1	0.199386	0.515871	0.9040	8.772985	0.8453
res5*res2	0.169179	0.421803	0.9546	7.443893	0.9162
res5*res3	0.388626	1.316726	0.2568	17.09956	0.2509
res5*res4	0.164276	0.407175	0.9605	7.228143	0.9256
res6*res1	0.324751	0.996225	0.4817	14.28906	0.4284
res6*res2	0.196299	0.505935	0.9103	8.637170	0.8536
res6*res3	0.423119	1.519310	0.1658	18.61724	0.1801
res6*res4	0.362258	1.176637	0.3423	15.93934	0.3171
res6*res5	0.341740	1.075396	0.4166	15.03656	0.3757
res7*res1	0.468563	1.826356	0.0832	20.61675	0.1119
res7*res2	0.585404	2.924827	0.0071	25.75777	0.0278
res7*res3	0.139067	0.334598	0.9829	6.118938	0.9634
res7*res4	0.145695	0.353266	0.9783	6.410582	0.9551
res7*res5	0.221435	0.589143	0.8515	9.743134	0.7807
res7*res6	0.223828	0.597346	0.8450	9.848428	0.7732

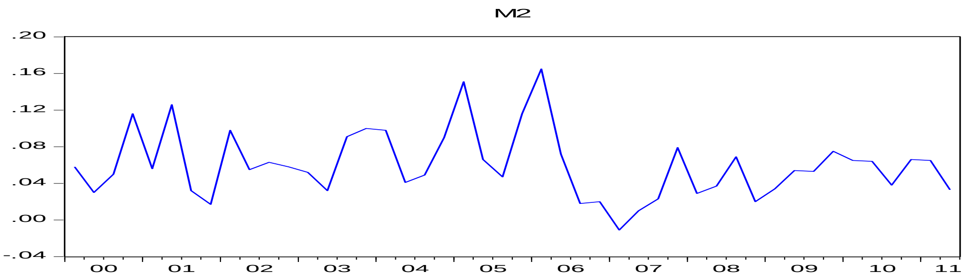
4. Stability test

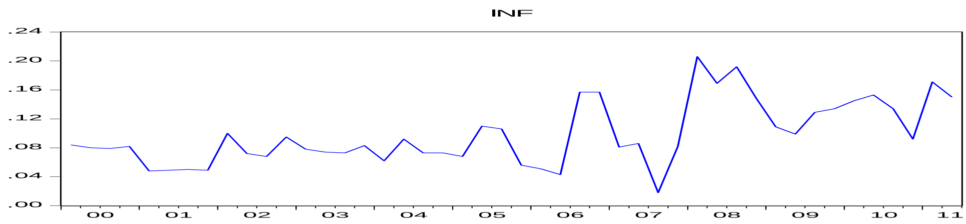
Roots of Characteristic Polynomial
Endogenous variables: ROILP ROILN TAX D(REV) D(CUREXP) D(DEVEXP) D(DEFICIT)
Exogenous variables: C
Lag specification: 1 1
Date: 09/20/15 Time: 20:47

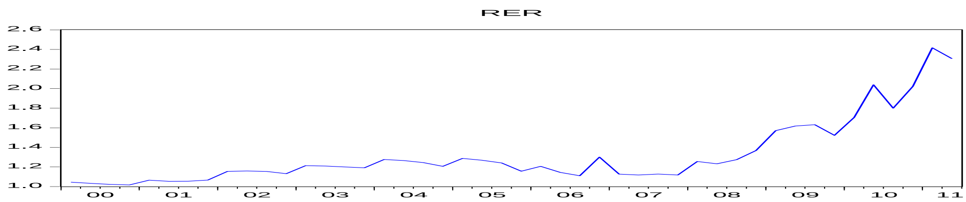
Root	Modulus
0.771482	0.771482
0.122229 - 0.512767i	0.527134
0.122229 + 0.512767i	0.527134
-0.202311 - 0.247666i	0.319794
-0.202311 + 0.247666i	0.319794
0.316411	0.316411
-0.156602	0.156602

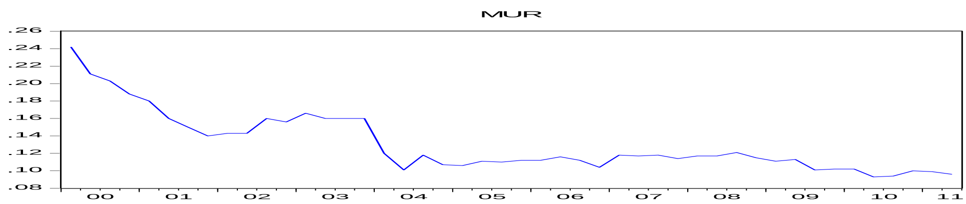
No root lies outside the unit circle.
VAR satisfies the stability condition.

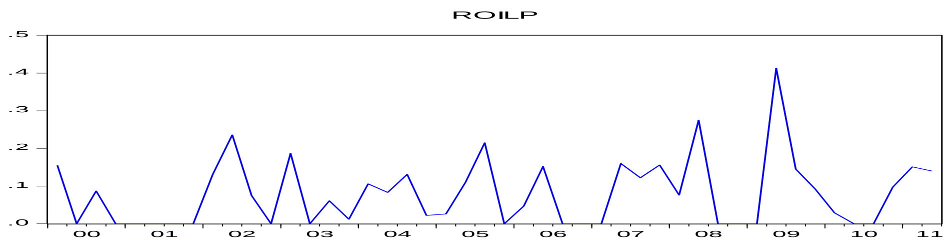
Appendix 6. Selected macroeconomic variables VAR model: plotting of the time series data

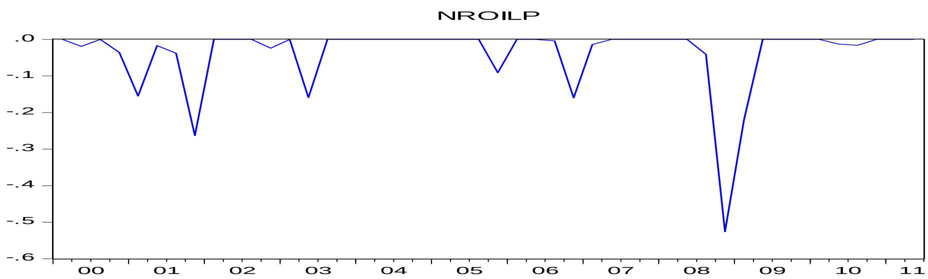












Appendix 7. selected macroeconomic variables VAR model equations

proilp = - 0.0218016565027 * proilp(-1) - 0.046899081745 * nroilp(-1) - 0.358369892556 * m2(-1) - 0.335485385362 * inf(-1) + 0.169109055645 * d(rer(-1)) - 0.697584807877 * mur(-1) + 0.222890011197

nroilp = - 0.0762949475269 * proilp(-1) + 0.195317620138 * nroilp(-1) + 0.264074990549 * m2(-1) + 1.05458187742 * inf(-1) - 0.128314019006 * d(rer(-1)) + 0.788413681187 * mur(-1) - 0.177718615589

m2 = 0.0262684356322 * proilp(-1) + 0.0602547732168 * nroilp(-1) + 0.291940357581 * m2(-1) - 0.168486169931 * inf(-1) - 0.0638702542692 * d(rer(-1)) + 0.0582900289495 * mur(-1) + 0.0495622201735

inf = 0.084437*proilp(-1) - 0.029555*nroilp(-1) - 0.007259*m2(-1) + 0.472901*inf(-1) + 0.028664*d(rer(-1)) - 0.289721*mur(-1) + 0.084338

rer = - 0.128046*proilp(-1) + 0.198063*nroilp(-1) + 0.246574*m2(-1) + 0.442595*inf(-1) - 0.303167*d(rer(-1)) - 0.467315*mur(-1) + 0.042272

mur = + 0.002335*proilp(-1) - 0.004688*nroilp(-1) - 0.029814*m2(-1) + 0.000922*inf(-1) - 0.006887*d(rer(-1)) + 0.866348*mur(-1) + 0.016151

Appendix 8. Statistics of the diagnostic tests for the selected macroeconomic variables VAR model

1. Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 09/22/15 Time: 10:35
Sample: 2000Q1 2011Q2
Included observations: 44

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	6.778514	NA*	6.936154	NA*	NA*
2	50.34374	0.0567	52.57591	0.0366	36
3	80.12240	0.2395	84.53350	0.1482	72
4	114.0675	0.3262	121.8731	0.1707	108

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

2. Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/22/15 Time:10:39
Sample: 2000Q1 2011Q2
Included observations: 44

Component	Skewness	Chi-sq	df	Prob.
1	0.851526	5.317370	1	0.0211
2	2.536448	47.17950	1	0.0000
3	-1.033857	7.838302	1	0.0051
4	0.296890	0.646388	1	0.4214
5	1.224540	10.99633	1	0.0009
6	-1.298219	12.35940	1	0.0004
Joint		84.33729	6	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	3.816600	1.222532	1	0.2689
2	11.70723	138.9957	1	0.0000
3	4.245068	2.842022	1	0.0918
4	4.330587	3.245844	1	0.0716
5	6.400449	21.19893	1	0.0000
6	8.458399	54.62255	1	0.0000
Joint		222.1276	6	0.0000

Component	Jarque-Bera	df	Prob.
1	6.539903	2	0.0380
2	186.1752	2	0.0000
3	10.68032	2	0.0048
4	3.892232	2	0.1428
5	32.19525	2	0.0000
6	66.98196	2	0.0000
Joint	306.4649	12	0.0000

3. Heteroskedasticity tests

Null Hypothesis: VAR Residuals are Homoscedasticity
Date: 09/22/15 Time: 10:41
Sample: 2000Q1 2011Q2
Included observations: 44

Joint test:

Chi-sq	df	Prob.
250.6218	252	0.5127

Individual components:

Dependent	R-squared	F(12,31)	Prob.	Chi-sq(12)	Prob.
res1*res1	0.399756	1.720469	0.1102	17.58924	0.1287
res2*res2	0.364905	1.484297	0.1830	16.05580	0.1887
res3*res3	0.269950	0.955238	0.5089	11.87781	0.4555
res4*res4	0.294171	1.076663	0.4114	12.94350	0.3732
res5*res5	0.454721	2.154304	0.0425	20.00773	0.0669
res6*res6	0.192760	0.616871	0.8115	8.481436	0.7465
res2*res1	0.264223	0.927696	0.5326	11.62582	0.4762
res3*res1	0.324065	1.238533	0.3025	14.25886	0.2845
res3*res2	0.384899	1.616518	0.1380	16.93555	0.1520
res4*res1	0.196647	0.632356	0.7985	8.652469	0.7323
res4*res2	0.199945	0.645610	0.7872	8.797571	0.7201
res4*res3	0.205277	0.667275	0.7684	9.032185	0.7002
res5*res1	0.278479	0.997068	0.4740	12.25310	0.4256
res5*res2	0.330137	1.273177	0.2824	14.52603	0.2684
res5*res3	0.242552	0.827243	0.6227	10.67229	0.5572
res5*res4	0.389702	1.649570	0.1285	17.14688	0.1442
res6*res1	0.188355	0.599503	0.8257	8.287620	0.7623
res6*res2	0.229662	0.770171	0.6752	10.10511	0.6067
res6*res3	0.187611	0.596589	0.8281	8.254890	0.7649
res6*res4	0.133761	0.398907	0.9532	5.885480	0.9217
res6*res5	0.320055	1.215994	0.3162	14.08242	0.2955

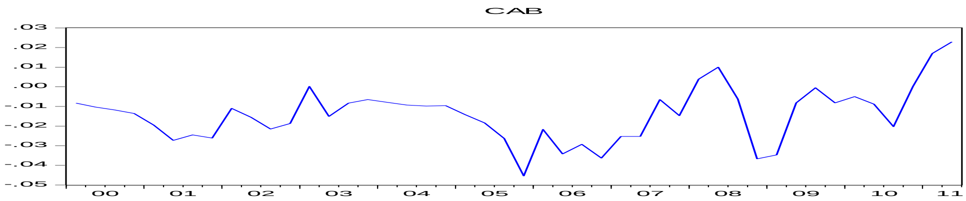
4. Stability test

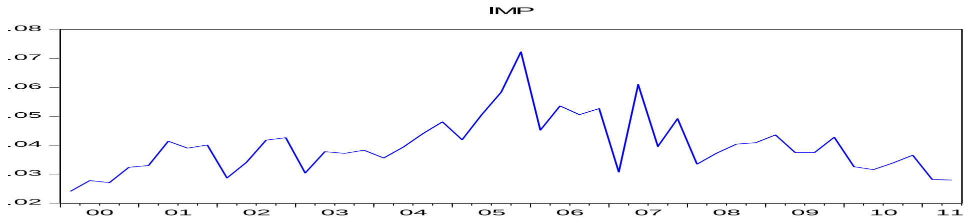
Roots of Characteristic Polynomial
Endogenous variables: PROILP NROILP D(NOEX) D(IMP) D(TB) D(CAB)
Exogenous variables: C
Lag specification: 1 1
Date: 09/22/15 Time: 10:44

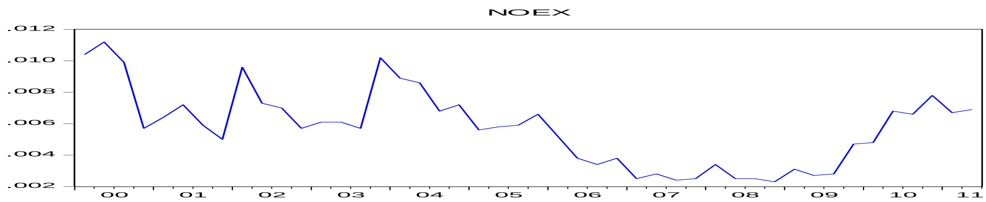
Root	Modulus
0.862844	0.862844
0.468764	0.468764
0.001417 - 0.345430i	0.345433
0.001417 + 0.345430i	0.345433
-0.235992	0.235992
-0.070248	0.070248

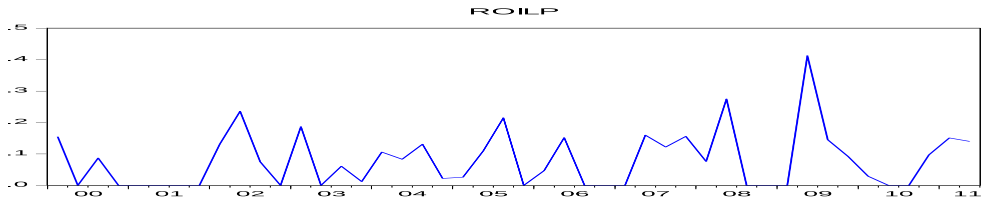
No root lies outside the unit circle.
VAR satisfies the stability condition.

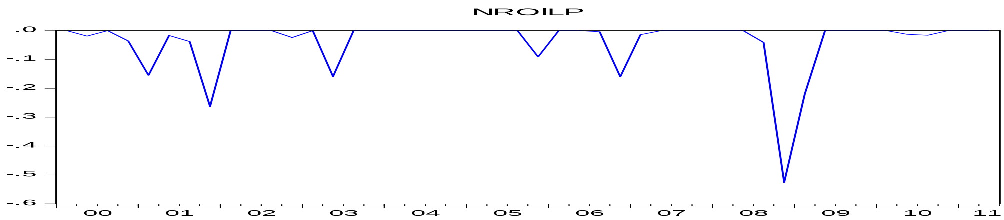
Appendix 9. Current account VAR model: plotting of time series data

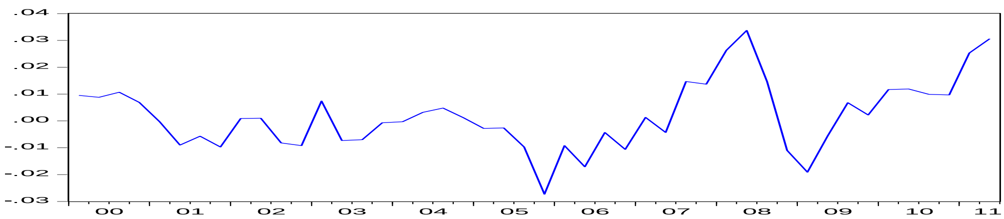












Appendix 10. Current account VAR model equations

proilp = - 0.110505082478 * proilp(-1) + 0.235471474125 * nroilp(-1) + 9.65614446912 * d(noex(-1)) + 0.91464857448 * d(imp(-1)) - 1.73159526329 * d(tb(-1)) + 6.32907254713 * d(cab(-1)) + 0.0770156896079

nroilp = 0.0225296734904 * proilp(-1) - 0.0752371268372 * nroilp(-1) - 7.55085689228 * d(noex(-1)) - 3.70797810304 * d(imp(-1)) - 5.05450460559 * d(tb(-1)) - 0.642244185694 * d(cab(-1)) + 0.0436128879396

d(noex) = - 0.000398755571808 * proilp(-1) + 0.0062602963437 * nroilp(-1) - 0.242502138599 * d(noex(-1)) + 0.0312882330848 * d(imp(-1)) + 0.0690536902227 * d(tb(-1)) - 0.0128738905796 * d(cab(-1)) - 0.000363177229504

d(imp) = 0.0266323398288 * proilp(-1) - 0.0220434145525 * nroilp(-1) - 0.791622224327 * d(noex(-1)) - 0.84140310068 * d(imp(-1)) + 0.0710389655487 * d(tb(-1)) - 0.430731430538 * d(cab(-1)) - 0.000917823769147

d(tb) = - 0.0279962634121 * proilp(-1) + 0.0193761477749 * nroilp(-1) + 0.531141851581 * d(noex(-1)) + 0.645063212864 * d(imp(-1)) - 0.139985600546 * d(tb(-1)) + 0.664862072947 * d(cab(-1)) + 0.00151852211656

d(cab) = - 0.0383325068682 * proilp(-1) + 0.0485691967379 * nroilp(-1) - 0.186461313344 * d(noex(-1)) + 0.853835165025 * d(imp(-1)) + 0.0385857001258 * d(tb(-1)) + 0.63895232325 * d(cab(-1)) + 0.00125498794577

Appendix 11. Statistics of the diagnostic tests for the current account model:

1. Autocorrelation

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 09/24/15 Time: 13:14
Sample: 2000Q1 2011Q2
Included observations: 44

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	3.992713	NA*	4.085567	NA*	NA*
2	34.25438	0.5518	35.78827	0.4786	36
3	60.68888	0.8266	64.15700	0.7333	72
4	76.83351	0.9899	81.91609	0.9710	108

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

2. Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/24/15 Time: 13:17
Sample: 2000Q1 2011Q2
Included observations: 44

Component	Skewness	Chi-sq	df	Prob.
1	0.884787	5.740880	1	0.0166
2	2.461439	44.43032	1	0.0000
3	0.485654	1.729636	1	0.1885
4	-0.411234	1.240166	1	0.2654
5	-0.322994	0.765049	1	0.3818
6	1.557839	17.79698	1	0.0000
Joint		71.70303	6	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	4.158460	2.460386	1	0.1168
2	11.15528	121.9324	1	0.0000
3	6.363619	20.74222	1	0.0000
4	3.541804	0.538178	1	0.4632
5	4.061808	2.066968	1	0.1505
6	7.946957	44.86603	1	0.0000
Joint		192.6062	6	0.0000

Component	Jarque-Bera	df	Prob.

1	8.201266	2	0.0166
2	166.3628	2	0.0000
3	22.47185	2	0.0000
4	1.778345	2	0.4110
5	2.832017	2	0.2427
6	62.66301	2	0.0000
Joint	264.3093	12	0.0000

3. Heteroskedasticity test

Null Hypothesis: VAR Residuals are Homoscedasticity
Date: 09/24/15 Time: 13:21
Sample: 2000Q1 2011Q2
Included observations: 44

Joint test:

Chi-sq	df	Prob.
237.9954	252	0.7277

Individual components:

Dependent	R-squared	F(12,31)	Prob.	Chi-sq(12)	Prob.
res1*res1	0.288031	1.045101	0.4356	12.67336	0.3932
res2*res2	0.487611	2.458410	0.0218	21.45489	0.0441
res3*res3	0.142232	0.428360	0.9397	6.258219	0.9025
res4*res4	0.332130	1.284685	0.2760	14.61372	0.2632
res5*res5	0.491269	2.494657	0.0201	21.61582	0.0421
res6*res6	0.375141	1.550936	0.1589	16.50622	0.1691
res2*res1	0.181521	0.572926	0.8467	7.986905	0.7862
res3*res1	0.149718	0.454874	0.9258	6.587588	0.8836
res3*res2	0.472173	2.310951	0.0301	20.77563	0.0538
res4*res1	0.093053	0.265052	0.9909	4.094346	0.9817
res4*res2	0.239663	0.814284	0.6346	10.54518	0.5682
res4*res3	0.142698	0.429994	0.9388	6.278691	0.9014
res5*res1	0.103880	0.299464	0.9847	4.570704	0.9708
res5*res2	0.524367	2.848021	0.0094	23.07213	0.0271
res5*res3	0.390927	1.658086	0.1262	17.20079	0.1422
res5*res4	0.395627	1.691067	0.1175	17.40757	0.1349
res6*res1	0.119069	0.349171	0.9717	5.239048	0.9495
res6*res2	0.533432	2.953554	0.0075	23.47102	0.0240
res6*res3	0.518200	2.778504	0.0109	22.80080	0.0295
res6*res4	0.393970	1.679382	0.1205	17.33468	0.1374
res6*res5	0.478750	2.372706	0.0263	21.06502	0.0494

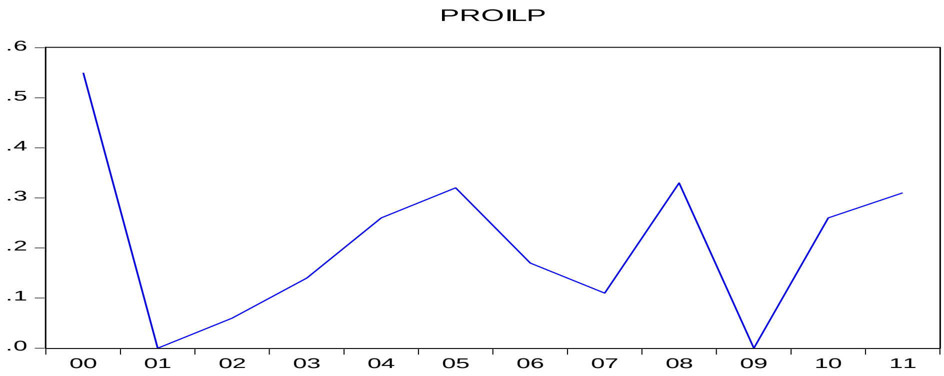
4. Stability test

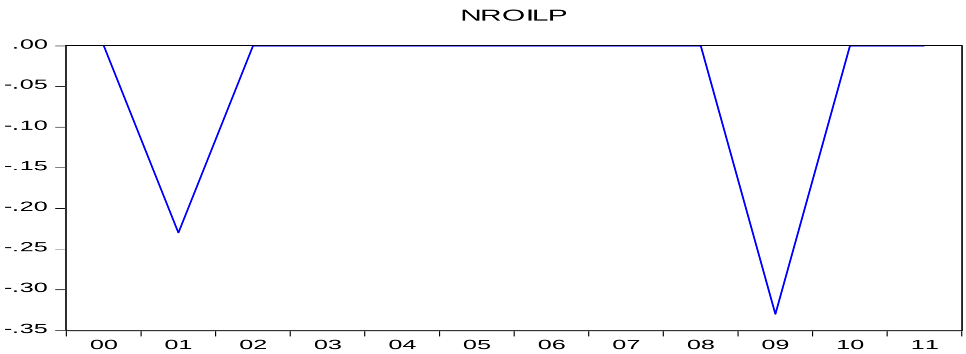
Roots of Characteristic Polynomial
Endogenous variables: ROILP ROILN D(NOEX) D(IMP) D(TB) D(CAB)
Exogenous variables : C
Lag specification : 1 1
Date : 09/24/15 Time : 13 :25

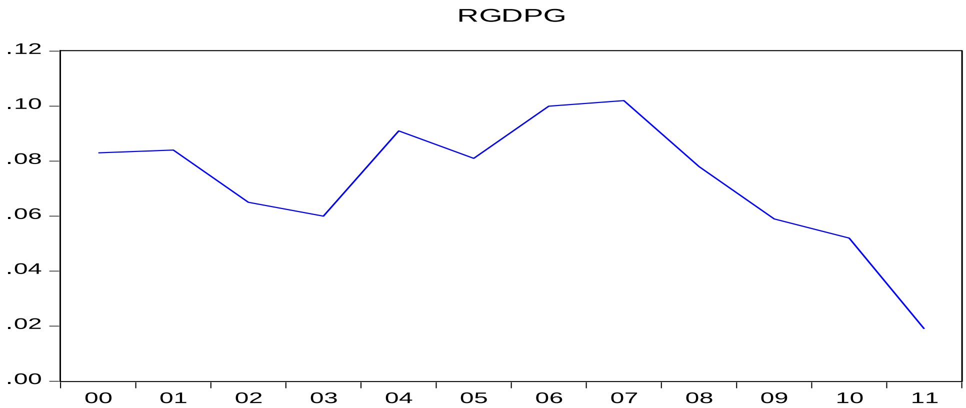
Root	Modulus
-0.522423 - 0.180316i	0.552666
-0.522423 + 0.180316i	0.552666
0.109662 - 0.456056i	0.469055
0.109662 + 0.456056i	0.469055
0.154218	0.154218
-0.099378	0.099378

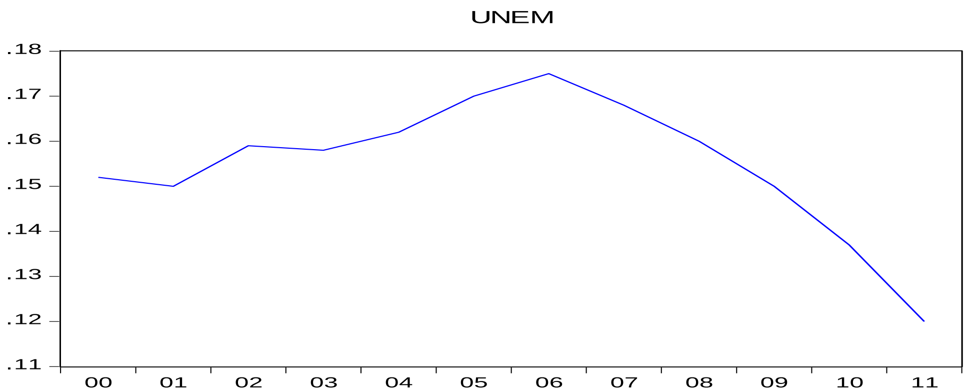
No root lies outside the unit circle.
VAR satisfies the stability condition.

Appendix12. GDP and unemployment growth rates VAR model: plotting of time series data









Appendix 13: GDP and Unemployment VAR model equations

proilp = -0.483811732548*proilp(-1) - 0.43252952413*nroilp(-1) - 1.21192559953*rgdpg(-1) + 1.60248782459*unem(-1) + 0.117055042402

nroilp = 0.564394014032*proilp(-1) + 0.191685439985*nroilp(-1) + 1.20447655266*rgdpg(-1) + 1.10392575949*unem(-1) - 0.344722272759

rgdpg = 0.0914295916588*proilp(-1) - 0.0240546035972*nroilp(-1) + 0.24013818716*rgdpg(-1) - 0.438174517026*unem(-1) + 0.106351713885

unem = -0.0665619637913*proilp(-1) - 0.0272363177941*nroilp(-1) + 0.414283939096*rgdpg(-1) + 0.542559047238*unem(-1) + 0.0642425497467

Appendix 14. Statistics of the diagnostic tests for the GDP growth and unemployment rates VAR model

1. Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 09/26/15 Time11:31
Sample: 2000 2011
Included observations: 11

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	8.448762	NA*	9.293638	NA*	NA*
2	26.55489	0.0667	31.42335	0.0519	16
3	35.54731	0.3048	43.78793	0.0800	32
4	49.01526	0.4322	64.95185	0.0519	48

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

2. Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 09/26/15 Time: 11:35
Sample: 2000 2011
Included observations: 11

Component	Skewness	Chi-sq	df	Prob.
1	-0.785344	1.130736	1	0.2876
2	-0.169065	0.052402	1	0.8189
3	-0.198323	0.072108	1	0.7883
4	0.847775	1.317659	1	0.2510
Joint		2.572906	4	0.6316

Component	Kurtosis	Chi-sq	df	Prob.
1	2.968816	0.000446	1	0.9832
2	2.124237	0.351523	1	0.5533
3	2.007431	0.451547	1	0.5016
4	2.973616	0.000319	1	0.9857
Joint		0.803835	4	0.9379

Component	Jarque-Bera	df	Prob.
1	1.131182	2	0.5680
2	0.403926	2	0.8171
3	0.523656	2	0.7696
4	1.317978	2	0.5174
Joint	3.376741	8	0.9085

3. Heteroskedasticity tests

Null Hypothesis: VAR Residuals are Homoscedasticity
Date: 09/26/15 Time: 11:41
Sample: 2000 2011
Included observations: 11

Joint test:

Chi-sq	df	Prob.
88.00000	80	0.2531

Individual components:

Dependent	R-squared	F(8,2)	Prob.	Chi-sq(8)	Prob.
res1*res1	0.356284	0.138370	0.9839	3.919124	0.8643
res2*res2	0.742767	0.721880	0.6956	8.170433	0.4170
res3*res3	0.931173	3.382271	0.2482	10.24290	0.2484
res4*res4	0.599452	0.374146	0.8709	6.593976	0.5810
res2*res1	0.604912	0.382770	0.8661	6.654029	0.5744
res3*res1	0.769700	0.835539	0.6490	8.466696	0.3893
res3*res2	0.553403	0.309789	0.9062	6.087434	0.6374
res4*res1	0.875368	1.755913	0.4128	9.629053	0.2920
res4*res2	0.655428	0.475537	0.8155	7.209706	0.5142
res4*res3	0.682200	0.536659	0.7834	7.504201	0.4833

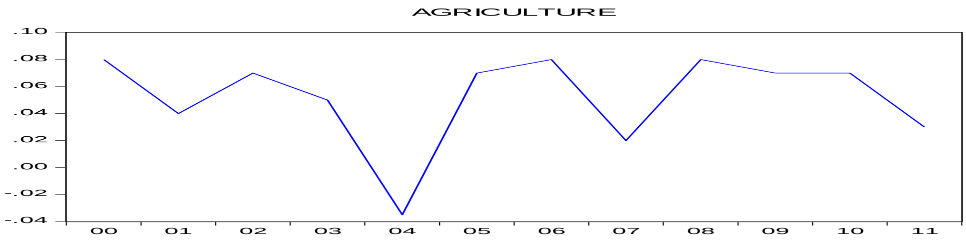
4. Stability test

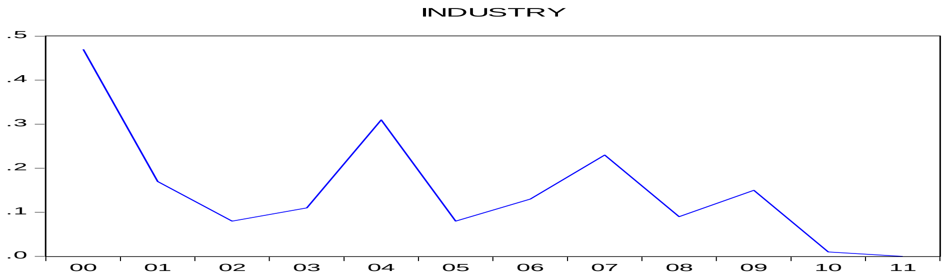
Roots of Characteristic Polynomial
Endogenous variables: PROILP NROILP RGDPG UNEM
Exogenous variables: C
Lag specification: 1 1
Date: 09/26/15 Time: 11:45

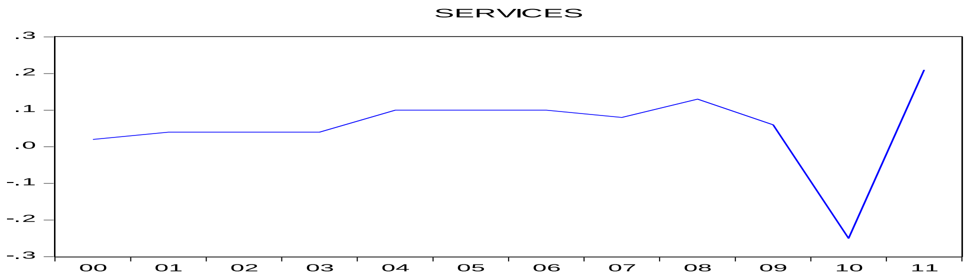
Root	Modulus
-0.043109 - 0.523495i	0.525267
-0.043109 + 0.523495i	0.525267
0.288394 - 0.379164i	0.476378
0.288394 + 0.379164i	0.476378

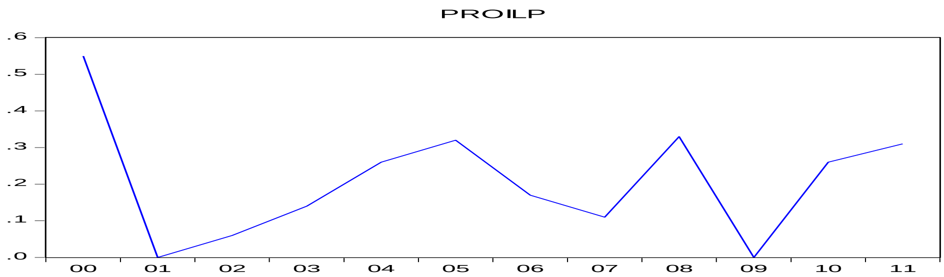
No root lies outside the unit circle.
VAR satisfies the stability condition.

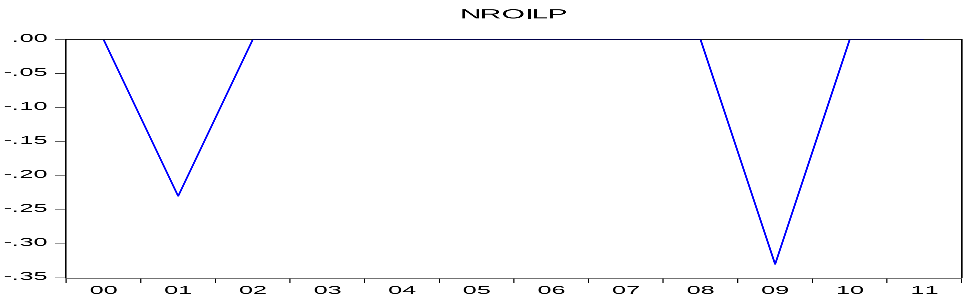
Appendix 15: Sectors growth rates VAR model: plotting of time series data











Appendix 16: Sectors growth rates VAR modle

proilp = - 0.0704474244489*proilp(-1) - 0.0929111979269*nroilp(-1) - 3.70898987947*agriculture(-1) - 0.176872882068*industry(-1) - 0.405009350805*services(-1) + 0.467588595457

nroilp = 0.554439972432*proilp(-1) + 0.24531129488*nroilp(-1) + 0.893540949912*agriculture(-1) - 0.0960420269071*industry(-1) + 0.329851237401*services(-1) - 0.12430196874

agriculture = 0.136930017959*proilp(-1) + 0.154060935637*nroilp(-1) - 0.942738146823*agriculture(-1) - 0.118380664363*industry(-1) + 0.122965906064*services(-1) + 0.0922248184697

industry = - 0.218744487074*proilp(-1) - 0.532115189639*nroilp(-1) + 1.51743239825*agriculture(-1) + 0.153281152676*industry(-1) + 0.349135030099*services(-1) + 0.0626384736076

services = 0.202161195328*proilp(-1) - 0.655360526539*nroilp(-1) - 2.60761423951*agriculture(-1) - 0.269381262287*industry(-1) - 0.30066687633*services(-1) + 0.267053200683

Appendix 17: Statistics of the diagnostic tests for the sectors growth rates VAR model

1. Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 10/04/15 Time: 21:33
Sample: 2000 2011
Included observations: 12

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	21.94096	NA*	23.62872	NA*	NA*
2	42.52628	0.0658	47.64494	0.0541	25
3	56.81200	0.2362	65.82676	0.0660	50
4	81.93148	0.2731	100.9940	0.0744	75

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

2. Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 10/04/15 Time: 21:39
Sample: 2000 2011
Included observations: 12

Component	Skewness	Chi-sq	df	Prob.
1	-0.680043	0.847840	1	0.3572
2	0.051215	0.004809	1	0.9447
3	-0.296953	0.161665	1	0.6876
4	0.342097	0.214556	1	0.6432
5	0.148977	0.040689	1	0.8401
Joint		1.269559	5	0.9380

Component	Kurtosis	Chi-sq	df	Prob.
1	3.437923	0.087897	1	0.7669
2	3.306204	0.042974	1	0.8358
3	2.970777	0.000391	1	0.9842
4	2.752176	0.028149	1	0.8668
5	3.085656	0.003363	1	0.9538
Joint		0.162775	5	0.9995

Component	Jarque-Bera	df	Prob.
1	0.935738	2	0.6263
2	0.047783	2	0.9764
3	0.162057	2	0.9222
4	0.242705	2	0.8857
5	0.044052	2	0.9782
Joint	1.432334	10	0.9991

3. Heteroskedasticity test

Null Hypothesis: VAR Residuals are Homoscedasticity
Date: 10/04/15 Time: 21:43
Sample: 2000 2011
Included observations: 12

Joint test:

Chi-sq	df	Prob.
84.01741	80	0.3576

Individual components:

Dependent	R-squared	F(8,5)	Prob.	Chi-sq(8)	Prob.
res1*res1	0.727246	1.666443	0.2975	10.18145	0.2525
res2*res2	0.441462	0.493992	0.8209	6.180465	0.6270
res3*res3	0.433022	0.477336	0.8316	6.062313	0.6403
res4*res4	0.808855	2.644771	0.1495	11.32397	0.1840
res2*res1	0.640814	1.115046	0.4736	8.971397	0.3447
res3*res1	0.390866	0.401046	0.8796	5.472117	0.7061
res3*res2	0.257236	0.216452	0.9720	3.601307	0.8912
res4*res1	0.418219	0.449287	0.8496	5.855059	0.6635
res4*res2	0.348733	0.334668	0.9181	4.882260	0.7701
res4*res3	0.791614	2.374236	0.1779	11.08259	0.1971

4. Stability test

Roots of Characteristic Polynomial
Endogenous variables: PROILP NROILP AGRICULTURE INDUSTRY SERVICES
Exogenous variables: C
Lag specification: 1 1
Date: 10/04/15 Time: 21:48

Root	Modulus
0.749187	0.749187
-0.683892	0.683892
-0.170177 - 0.531431i	0.558013
-0.170177 + 0.531431i	0.558013
-0.368613	0.368613

No root lies outside the unit circle.
VAR satisfies the stability condition.