Dynamic relationship between oil price and macroeconomic variables: evidence from oil exporting and oil importing countries in Africa.

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DYNAMIC RELATIONSHIP BETWEEN OIL PRICE AND MACROECONOMIC VARIABLES: EVIDENCE FROM OIL EXPORTING AND OIL IMPORTING COUNTRIES IN AFRICA

A thesis submitted in partial fulfilment of the requirements of Robert Gordon University for the degree of Doctor of Philosophy

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ABSTRACT

*This study examines the asymmetric long run and the short-run relationship between oil price and key macroeconomic variables within the context of net oil-exporting and importing countries in Africa. Using quarterly data ranging from 1996*q_1 *to 2016*q_4*, panel ARDL estimation is carried out to analyse how asymmetric changes in oil price affect macroeconomic activities in African countries and whether the effects are similar or different in oil importing and exporting African countries. The results show significant positive response of GDP to oil price in the long run and short run, in net oil exporting countries. While the response of GDP to oil price is negative and significant in net oil importing countries in the long run and short run. In the long run interest rate responded significantly and positively to oil price in net oil exporting and oil importing, while the short run response is insignificant in both net oil exporters and oil importers. The Granger-causality test shows that causality run from oil price to interest rates and exchange rates in both net oil exporting and importing countries. This study recommends significant policies and strategies for policymakers to construct effective and efficient short run and long run economic policies that may help in shielding macroeconomic variables from oil price shocks. Such policies and strategies include not only diversification of economic activities through exportation of non-oil products and increase in solar energy usage to reduce dependence on crude oil but also to enhance increase in manufacturing, infrastructural and agricultural development to enable increase in foreign earnings and GDP growth. This study recommends the use of mixed method to incorporate other exogeneous factors including political, social, environmental, and institutional factors to give further insight on oil price-macroeconomic relationship in the context of African countries.*

***Keywords**: Oil price, GDP, Interest rates, Inflation, Exchange Rates, Unemployment Rates, Food Supply, External Debt, Current Accounts, Foreign Reserves, panel ARDL model, net oil exporting countries, net oil importing countries, Africa.*

DECLARATION

I hereby declare that this thesis,

Dynamic relationship between oil price and macroeconomic variable: Evidence from oil exporting and oil importing countries in Africa.

This work is entirely mine, and where any material points to the ideas of others, it is thoroughly cited and referenced with appropriate acknowledgments given.

OKORO CHINEDU NNENNA

September 2021

DEDICATION

I dedicate this thesis to God Almighty for His infinite mercies and faithfulness that saw me throughout my PhD journey. I worship, praise, and honour you my Lord and Saviour Jesus Christ Amen!

To my loving late mum, Mrs Rosemary Okoro, my sister Chinyere Okoro, my brother Ikechukwu Okoro, my late uncle Tony Ozoemena and my aunty Regina Ibezim. Thank you all for your encouragement, prayers, and support. Love you all.

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LIST OF ACRONYMS

FSI Financial statistics institute

OECD Organisation for Economic Co-operation and Development

IIF Institute of International Finance

ASEAN Association of Southeast Asian Nations

FSI Financial Stress Index

EMEs. Emerging Market Economies

VAR vector autoregressive model

SUR Seemingly Unrelated Regressions model

GMM EGLS Generalized Method of Moments Estimated Generalised least square

BRICS countries BRAZIL, RUSSIA, INDIA, AND CHINA

ARDL Autoregressive Distributed Lag model

U.S United States of America

EGARCH Generalised Autoregressive Conditional Heteroskedasticity

GARCH generalized autoregressive conditional heteroscedasticity.

DCC dynamic conditional correlation

NARDL nonlinear autoregressive distributed lag

OPEC Organisation of Petroleum Economic Countries

NARDL nonlinear auto-regressive distributed lag

IMF International Monetary Fund

VECM Vector Error Correction Model.

TVP-VAR time-varying parameter vector autoregressive

TVP-SVAR-SV time-varying parameter structural vector autoregression

IRF impulse response function

APFR Average price of food

APF Aggregate price of food

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Chapter One

1.1 Introduction

Changes in oil prices have been recognized in the literature as the major contributor to shocks in macroeconomic variables and consequently shocks in economic activities (see Brown and Yucel 2002; Ahmed 2013; Trang et al. 2017; Akinsola and Odhiambo 2020). However, mixed evidence has been found in literature as the cause of changes in oil price which explain variations in macroeconomic variables (Chen and Chen 2006; Fueki et al. 2020). It is argued that some of these sources that validate changes in oil price is either oil demand shocks or oil supply shocks (Kilian 2009; Chen et al. 2016), and the effect could be either negative or positive (Chatziantoniou et al.2021).

The implication of these sources for example, oil demand shocks driven by economic activities validate increase in real GDP following an oil price increase. While the implication of oil supply shocks, however, differs across countries following an oil price increase. Net oil importing countries may experience decline in economic activities following an adverse oil supply shock, while the consequences in oil exporting countries is insignificant or even positive (Baumeister et al.2009).

Salisu and Isah (2017), Chatziantoniou et al. (2021) and Lin and Bai (2021) are of the view that changes oil price play a significant role predicting of variations in macroeconomic variables since it offers valuable information to policymakers, investors, firms, financial market participant, and consumers in making economic, investment and monetary decisions. Indeed, in a recent study, Kocaarslan et al. (2020) provide evidence that oil prices dynamics contain information that helps predict the asymmetric response of unemployment rate to uncertainty and shocks in oil price in the US.

Another important aspect of studying the oil price-macroeconomic relationship is understanding the asymmetric relationship. Asymmetric relationship between oil price and macroeconomic variables involves examining the impact of negative and positive effects of oil price on macroeconomic variables in the short run and in the long run. The long run and short run effect of oil price-macroeconomic relationship help in determining the degree and magnitude of the effect. Furthermore, categorizing oil price-macroeconomic relationship into long run and short run effect can help policymakers and investors determine the type of policy to employ to hedge macroeconomic variables against oil price shocks and make short run and long run investment decision respectively.

Asymmetric relationship between oil price and macroeconomic variables have been empirically analysed in literature. For example, Jibril et al. (2020) used SVAR model and decomposed oil price into oil supply shock and oil demand shocks and asymmetrically examined the effect of these oil shocks on external balances in net oil exporting and importing countries. Their result show asymmetries in the effect of oil demand and supply shocks on external balances in both net oil exporting and net oil importing countries. That is, positive and negative oil price changes have varying effect on macroeconomic variables. It then implies that, the asymmetries associated with oil demand and oil supply is a significant factor in causing variations in macroeconomic variables. As such policymakers should be concerned on this while formulating policies that will minimize shocks from oil price to external balances.

Kocaarslan et al. (2020) employed a nonlinear autoregressive distributed lag (NARDL) model to investigate the asymmetric effect of oil price uncertainty and interest rate on unemployment rates in the USA. The result shows that unemployment rates responded asymmetrically to oil price uncertainty. The implication of this result is that to curb unemployment rates policy aimed at reducing oil price uncertainty should be encouraged to lessen the negative effect of oil price volatility.

Salisu and Isah (2017) estimated the symmetric (not accounting for positive and negative changes in oil price) and asymmetric (accounting for positive and negative changes in oil price) relationship between oil price and stock price in the context of net oil-exporting and net oil-importing countries. They concluded that stock prices responded asymmetrically to shocks in oil price both in net oil-exporting and net oil-importing countries. Meaning that positive and negative changes in oil price have different effect on stock prices. However, they opined that the response is more evident in net oil exporters than in net oil importers. The implication of their finding is that the degree of oil price shocks on stock prices may not be the same for net oil exporting and net oil importing countries. And policymakers and investors can utilize the information contained in the finding for policy formulation and investment decisions making.

Jiang and Gu (2016) employed MF-DCCA method with daily data from 2000:4:1 to 2014:31:12 to analyse the asymmetric relationship between oil price and exchange rates in net oil exporting and importing countries. They used structural oil shocks and oil price trend as an indicator to differentiate the asymmetries associated with changes in oil price in analyse oil price-macroeconomic relationship. They found that the asymmetric degree significantly varied. The implication is that discerning the sources oil price shocks is significant for policymakers and investors given that the interaction between oil price and exchange rate depended on it.

In contrast, Khan et al. (2019) found no evidence of an asymmetric short-run and long-run relationship between oil price and GDP in Philippines, Thailand, and Singapore, Malaysia, and Korea. In support of Khan et al. (2019) opinion, Chen et al. (2016) found that the relationship between oil price shocks and exchange rate in 16 countries which include Australia, Czech Republic, Canada, Denmark, Hungary, Iceland, Korea, Japan, New Zealand, Mexico Norway, Poland, Switzerland Sweden is not asymmetric

On the long run and short run asymmetric effect of oil price on macroeconomic variables, scholars including Abeysinghe (2001) found a long-run effect of oil price fluctuations on macroeconomic variables in the Asian economy. Chen et al. (2016) is of the view that 10%-20% of the long-run variation in 16 OECD currencies against the U.S dollar is forecasted by shocks in oil price. In contrast, Basnet and Upadhyaya (2015) reported no evidence of a long-run relationship between oil price changes and macroeconomic variables for Thailand, Indonesia, Philippines, Singapore, and Malaysia.

The literature on the relationship between changes in oil prices and variations in macroeconomic variables are mostly focused on developed countries of Europe, the US, Asia, and Arab countries. For example, Du and Wei (2010) focused on China's economy, Berument et al. (2010) investigated countries in the Middle East and North Africa (MENA) region, while Hanabusa (2009) examined the Japanese economy, Lescaroux, and Mignon (2008) analysed several groups of countries of net oil-exporting and net oil-importing countries. Jiménez-Rodríguez and Sánchez (2005) offered empirical evidence on some

OECD countries; Cunado and Perez-de Gracia (2003, 2005) examined many Asian and European countries.

In this study, the asymmetric relationship between oil price and macroeconomic variables in the context of net oil exporting and net oil importing countries in Africa is investigated using dataset covering 1996q_1 to 2016q_4. By using panel ARDL model, this study re-investigates if macroeconomic variables respond to asymmetric changes in oil price as has been documented in existing literature in Africa which comprises mainly country-specific level (Fowowe 2014; Chiwneza and Aye 2018), at net oil-exporting level (Omojolaibi and Egwaikhide 2013; Omolade et al.2019) and at net oil-importing level (Akinsola and Odhiambo 2020). That is, this study investigates how changes in oil price cause variations in macroeconomic variables in the long run and in the short run in the context of net oil exporting and net oil importing countries in Africa. Furthermore, this study examines the ability of oil prices to forecast future GDP growth rate, interest rates, inflation, exchange rates, unemployment rates, food supply, external debt, current accounts, and foreign reserves in accordance with panel ARDL statistical prediction regression model that examine the relationship between oil price and macroeconomic variables. See for example Salisu and Isah (2017), Kocaarslan et al. (2020) and Liu et al. (2021).

This study contributes to literature in the following ways. First, this study reviewed different oil price shock events covering 1996q_1 to 2016 q_4 using extended literature and analyse how the structural shocks in oil price forecasted macroeconomic variables including GDP, interest rate, inflation, exchange rates, unemployment rates, food supply, external debt, current accounts, and foreign reserves; in previous study in Africa close to this study only variable of interest rate, GDP and trade openness have been used (see for example, Akinsola and

Odhiambo 2020). The justification for using the variables mentioned above is well detailed in chapter 5 table 5.3. Second, this study reviewed the asymmetric relationship between oil price and macroeconomic relationship not only in the context of net oil exporting countries in Africa but also in the context of net oil importing countries in Africa. The sample period used in analysing the extended literature review enabled determining how different structural breaks of oil price shocks affect macroeconomic variables within the sample size covered. The findings present information to stakeholders on oil price-macroeconomic relationship in the context of net oil exporting and oil importing in Africa. This study fills this gap and explore the ability of oil price to explain variations in the key macroeconomic variables using panel ARDL model. This is significant because the information provided by this study which is not presented in previous studies with scholars such as Kibunyi et al. (2018), Akinsola and Odhiambo (2020) and Ogede et al. (2020), is now available in literature to enable policymakers to formulate long run and short run policies to hedge macroeconomic variables from oil price shocks in net oil exporting and oil importing countries in Africa. This information will also enable investors to make an informed long run and short run investment decisions.

This chapter is structured as follows: Section 1.1 puts forward the introduction. The background of the study is discussed in section 1.2. The aim of the study is presented in section 1.3 Section 1.4 put forward the originality of the study. Methodology overview is discussed in section 1.5. Section 1.6 discusses the contribution to knowledge. Section 1.7 summarised the structure of the thesis.

1.2 Background of the Study

Crude oil assumes significant importance in most African countries, as it is the leading source of revenue generation (Onigbinde et al.2014). For example, in Nigeria, Algeria, and Egypt, oil serves as a major source of foreign earnings (Hou et al.2015) and a source of raw material for production in Kenya and South Africa (Chiweza and Aye 2018; Kibunyi et al.2018). Over the years, crude oil has overwhelmingly accounted for the larger portion of export and imports for oil exporting and oil importing countries in Africa respectively (Omojolaibi and Egwaikhide 2013; Kibunyi et al.2018). As such, it is expected that economies with such significant involvement in crude oil export and import should be able to achieve effective and sustainable economic growth that will shield macroeconomic variables from oil price shocks (Essama-Nssah 2007). However, literature has shown that macroeconomic variables of the key African countries under study are vulnerable to oil price shocks (Olomola and Adejumo 2006; Onigbinde et al.2014).

Furthermore, following the increase in oil price between 2000 to 2013, Nigeria, Algeria, and Egypt generated huge foreign earnings from oil export (Wit and Crookes 2013; Zahran 2019). With such huge foreign revenue from oil, the economies of these countries are expected experience improved economic growth through government spending on capital projects and investment on infrastructural and agricultural development (Bouchaour and Al-Zeaud 2012; Onigbinde et al. 2014). Instead, the GDP of Nigeria, Algeria, and Egypt declined tremendously between 2015 and 2016. Nigeria, for example was classified as the 3rd poverty-driven country in the globe by World Bank (2019),65% of Algerian and 70% Kenyans are living in extreme poverty (World Bank 2019). Despite the solid natural resources base of these countries, especially the net oil-exporting countries such as Nigeria and Algeria, these countries have weakly performed in economic growth (Kibunyi et al. 2018; Onigbinde et al.2014).

Given the lack of sustainable economic growth and the continued dependence on crude oil as a significant source of revenue generation, the net oil-exporting countries in Africa especially Nigeria and Algeria have been described in the literature as representing an example of 'Dutch Diseases' (Olomola and Adejumo 2006 and Lardic and Mignon 2005). This has given birth to why and how fluctuations in oil price affect variations in GDP growth rate, given that the net oil-exporting countries have significant revenue from crude oil and the net oil-importing countries have significant trade involvement in crude oil. They have achieved so little in enhancing economic growth. Based on the World Bank estimation, about 90% of oil revenue is being mismanaged, especially in Nigeria, through corrupt practices, as such economic activities and growth are impacted (Kretzmann and Nooruddin 2005).

Auty (1998) argued that countries endowed with crude oil often experience decreased economic performance and growth compared to countries with little or no crude oil. Auty and Gelb (2001) supported this argument and pointed out that a developing political environment is related to poor economy as result of resource mismanagement. Equally noted is that significant importance is not placed on the economy for investment efficiency (Adamu 2019). Literature has argued that countries endowed with crude oil, especially in concentrated form, seem to battle for rental income (De Wit and Crookes 2013). Furthermore, this creates factional and rapacious conditions and a situation where rental income is distributed through indirect means (Auty and Gelb 2001). As such, economic activities are affected, thus, reduction in GDP growth rate.

Thus, there has been significant debate about how oil prices affect macroeconomic variables. Some scholars argued that oil price affect macroeconomic variables through reallocation effect (Doğrul and Soytas 2010), while other argued that the effect of oil price on macroeconomic variables is through uncertainty associated with oil price (Dixit and Pindyck 1994; Ferderer 1996). Furthermore, oil price is evidenced to predict variations in macroeconomic variables through real business cycle (Brown and Yucel 2002; González and Nabiyev 2009). Additionally, studies have shown that changes in oil prices affect macroeconomic variables through different channels (Yildirim and Arifli 2021). And these channels include supply-side effect channel, demand-side effect channel, real balance effect channel, terms of trade channel and inflation effect channel.

The effects of oil price on macroeconomic variables through any of these channels can cause increase in production cost (Nusair and Olson 2021), budget deficit (Alkhateeb et al. 2021; Jin and Xiong 2021), current account imbalances (Balli et al. 2021; Gnimassoun et al. 2017; Qurat-Ul-Ain and Tufail 2013), exchange rate dynamics (Tian et al. 2021; Qurat-Ul-Ain and Tufail 2013), Dutch Disease (Ma et al.2021), interest rate dynamics (Baek and Choi 2021; Polbin et al. 2020), loss of market share (Baffes et al.2015), reduction in foreign reserves (Khan et al. 2021), increase in the unemployment rate (Kocaarsslan et al. 2020), external debt dynamics (Kretzmann and Nooruddin 2005) to inflationary pressure (Zakaria et al. 2021; Liu 2021).

However, most of the studies in Africa that analysed how oil price affect variations in macroeconomic variables through the above mentioned channels are either country specific (Chiweza and Aye 2018; Kibunyi et al.2018), or are on net oil importing countries (Akinsola and Odhiambo 2020) or are on net oil exporting countries (Omolade et al. 2019; Ogede et al. 2020) , as such this studies will fill in the identified gap by analysing the asymmetric relationship between oil price and macroeconomic variables not only in the context of net oil exporting countries but also in the context of net oil importing countries in Africa. The findings will provide information to stakeholders including policy makers, investors and academia which is not provided by previous scholars who analysed this relationship in a country-specific level, or net oil exporting level or net oil importing level. In responding to these gaps and with recent development in oil price-macroeconomic relationship dynamics, this study will bridge these gaps not only using extended literature review to analyse how the structural breaks caused by oil price shocks affect macroeconomic variables of net oil exporting and oil importing countries in Africa within the period of study, but also this study employed panel ARDL model to analyse the asymmetric short run and long run relationship between oil price and key macroeconomic variables such as GDP, interest rates, inflation, exchange rates, unemployment rates, food supply, external debt, current accounts and foreign reserves in the context of net oil exporting but also in the context importing countries in Africa to present a comparative analysis.

1.3 Aim of the study

This study aims to investigate the dynamic relationship between oil price and macroeconomic variables in the context of net oil-exporting and net oil-importing African countries. To address the research aim, the following objectives are developed.

1. To examine if the asymmetric effect of oil price on macroeconomic variables is the same in the short and long run, in net oil exporting and oil importing countries in Africa.
2. To examine how oil price affect key macro-economic variables including economic growth rate, interest rate, exchange rate, inflation, unemployment rate, food supply, external debt, current account, and foreign reserves in net oil-exporting and net oil-importing African countries from 1996q_1 to 2016q_4.
3. To examine if the asymmetric effects of oil price on macroeconomic variables are the same in net oil-exporting and net oil-importing countries in Africa.

The first objective helps understand how fluctuations in oil prices affect macroeconomic variables in the short and long run. For example, Cunado and Gracia (2005) found the short-run effect of fluctuations in oil prices on macroeconomic variables in the Asian economy. In contrast, Abeysinghe (2001) found a long-run effect of oil price fluctuations on macroeconomic variables in the same Asian economy. Understanding whether the effect of oil price on macroeconomic variables is in the short run or long run will provide information for policymakers and investors to formulate adequate short run or long run policy and as well make an informed long run and short run investment decision.

The second objective will investigate the interplay between fluctuations in oil price and macroeconomic variables and how this relationship impacts economic activities and growth of net oil-exporting and net oil-importing countries. The finding of this objective will provide information for policymakers to formulate policy that is aimed at shielding macroeconomic variables from oil price shocks. As studies including Lescaroux and Mignon (2008), Baffes et al. (2015) and Lin and Bai (2021) were of the view that shocks in oil price affect macroeconomic variables in net oil exporting and net oil importing countries differently.

The third objective will help to present a comparative analysis and examine if changes in oil price have the same effect on the key macroeconomic variables in net oil-exporting countries and in net oil-importing countries in Africa. This is significant because policymakers and investors can utilize the information contained in the finding for policy formulation and investment decisions. As reviewed literature indicate that shocks in oil price affect macroeconomic variables differently in net oil exporting and oil importing countries. For example, Hou et al. (2015) and Lin and Bai (2021) concluded that oil price shocks affect macroeconomic variables differently in net oil exporting and oil importing countries. While other scholars including Salius and Isah (2017) conclude that shocks in oil price have the same effect in net oil exporting and net oil importing countries.

1.4 Significance of the Study

This study examines how changes in oil price relate to macroeconomic variables in the context of net oil-exporting countries of Nigeria, Algeria, Egypt, and net oil-importing countries of Kenya and South Africa. These countries were chosen given their level of oil export (net oil-exporting) and their level of oil consumption, and involvement in crude oil trade (net oil-importing and net oil-exporting). Literature has shown that macroeconomic variables of these selected economies are vulnerable to shocks in oil price, given their level of oil exportation and oil importation (Onigbinde et al.2014; Chisadza et al.2016). Several empirical analyses have been carried out to determine how macroeconomic variables respond to oil prices. Aliyu (2011), Gbatu et al. (2017), and Akinsola and Odhiambo (2020) analysed themes such as the reasons for the asymmetries in the oil price- macroeconomic relationship in economies of Africa. These studies focused on the lack of diversification, ineffective and efficient policy application, Dutch disease syndrome, inadequate utilization of revenues generated from oil windfall, corruption, and lack of investments in capital projects (Olomola 2006; Iwayemi and Fowowe 2010; Umar and Abdulhakeem 2010; Omojolabi and Egwaikhide 2013). Omojolabi and Egwaikhide (2013) suggest that gross investment is a crucial channel through which shocks in oil price affect macroeconomic variables in net oil-exporting countries in Africa, hence, understanding this view will help policymakers and investors to respectively make informed decisions on to shield macroeconomic variables from oil price shock and invest properly.

However, there is a lack of research in the context of net oil-exporting and net oil-importing countries, especially in Africa. Hence, focusing on net oil-exporting and net oil-importing countries in Africa, this study differs from the studies mentioned above and contribute to literature by not only using extended literature review covering the major oil price events from 1996q_1 to 2016q_4 to show how oil price forecasted macroeconomic variables in net oil exporters and oil importers in Africa but also, to give further insight on how the structural shocks in oil price within these sample periods influence macroeconomic variables in net oil exporting and net oil importing countries in Africa. Additionally, this study will capture the asymmetries and heterogeneity effects in the oil price-macroeconomic relationship using panel data of net oil-exporting and net oil-importing countries in Africa (see detail in chapter 2).

Furthermore, the findings from this study provide useful information that will enhance cautious evaluation of the fundamental dynamics between oil price and macroeconomic variables by investors, policymakers and monetary authorities at the regional level and international level. This information is significant to these stakeholders given that the frequently study variations in macroeconomic variables to make investment decisions and formulate policies for sustainable economic activities and growth. The information contained in this finding for sustainable economic development and growth include formation of efficient and effective monetary policy especially towards exchange rates and inflation that may shield macroeconomic variables from oil price shocks. Engaging in diversification strategies for example, if oil exporting countries pursue the strategy of exporting of non-oil products, this may not only enhance increase of their foreign earnings but also enhance employment rate and increase GDP growth. While diversification towards solar energy will not only enhance energy sustainability but also can reduce dependence on crude oil by net oil importing countries. Hence, the negative effect of oil price increase on GDP growth rate as opined by scholars including Hamilton (1996) and Lee et al. (1996) may be minimized. Encouragement in infrastructural, manufacturing, and agricultural development to help diversify the economy should be pursued. Thus, policies that will enable oil price decline to improve external and fiscal balance which will support economic growth should be pursued. This will boost savings and economic growth during oil price decline to reduce the effect of shocks coming from oil price increase on macroeconomic variables.

1.5 Methodology Overview

This section provides an overview of the research methodology adopted. Quantitative approach that hinges on applying measurable and numeric data in quantifying relationships alongside a statistical tool in analysing the correlational relationship and co-integration between and among variables (Crossman 2019; Healy and Perry 2000) is adopted. The justification of adopting quantitative approach is to objectively determine in quantitative terms the asymmetric relationship between oil price and macroeconomic variables. Given that the methodological stance is taken from the school of positivism which anchors on realism from ontological domain. Panel ARDL is used to analyse the unbiased and value free data as hypothesis testing is involved to quantitatively examine how shocks in oil price affect macroeconomic variables in net oil exporting and oil importing countries in Africa. The findings are measurable and quantifiable with statistical tools, meaning that the findings of this study can be generalised. The quarterly data for all the macroeconomic variables including GDP, inflation rate, interest rate, exchange rate, unemployment rate, food supply current account, external debt, and foreign reserves covering from $1996q_1$ to $2016q_4$ are all secondarily sourced from DataStream of International Monetary Fund (IMF) and Thompson Routers. Quarterly data for oil price covering from $1996q_1$ to $2016q_4$ is collected from Energy Information Administration (EIA) for this analysis.

The results from the panel ARDL model would be used to examine how cointegrated the variables are and well find out the asymmetries of these variables concerning the short-run and the long-run equilibrium relationships. The justification for analysing oil price-macroeconomic relationship in the context of asymmetries is to give insight in understanding how oil price has positive and negative effect on the key macroeconomic variables and as well to determine the long run and short run effect of oil price on macroeconomic variables in the context of net oil exporting and importing countries in Africa.

1.6 Contribution to Knowledge

This research contributed to the existing knowledge by reviewing not only the asymmetric relationship between oil price and macroeconomic variable in the context of net oil-exporting countries in Africa but also in the context of net oil-importing economies in Africa. This has presented information to stakeholders to spur a comparative analysis on oil price-macroeconomic relationship in the context of net oil exporting and oil importing countries of Africa. This is significant because the information provided by this study which is not present in previous studies including Akinsola and Odhiambo (2020) can help policymakers to formulate long run and short run policies to hedge macroeconomic variables from oil price shocks in net oil exporting and oil importing countries in Africa. The information will also enable investors to make informed investments decisions. The awareness of this seemly information can form a key aspect that could be addressed in future research.

This study also, contributed to existing literature in terms of the methodology adopted by using visual presentation of scattered diagram of regression analysis (see chapter 5) to give further insight of how oil price influenced the key macroeconomic variables negatively and positively. The visual diagram can enable readers to comprehend how oil price influence macroeconomic variables by mere looking at the diagram. This also will provide information for policy formulation and investment decision making.

Furthermore, extended literature review is used to capture the exposure of GDP including other variables to the dynamics of oil price. This is done by reviewing the finding of previous scholars on this relationship using various significant oil price shocks events which include the oil price boom of 1996 –1998 associated with OPEC policies, the 2002-2007 oil price increase related to industrial revolution in Asia, the 2007-2009 oil price decline associated with global financial crisis, the 2009-2013 oil price rise connected with continued increase in industrial revolution and the 2014 -2016 oil price decline associated with increase in unconventional oil production and appreciation of U.S dollar (see chapter 2). The extended literature review is structured in such manner to include the structural breaks of oil price shocks events within the period analysed. This is to enable understanding of how oil price affects macroeconomic variables of net oil exporting and oil importing countries in Africa within the period of study.

Additionally, different estimation analysis, including Granger Causality and Wald test, are considered for robustness purposes. This is to test the validity of the findings of formulated hypotheses from the panel ARDL model.

Again, this study provides room for further studies to academia given that varying differences and similarities were found at the same time in net oil exporting and oil importing countries. This characteristic has put forward information that can be adequately utilized by scholars to identify if there are other exogeneous variables that are significant in predicting variations in macroeconomic variables in African context.

Similarly, this study provides information that offers strategies to investors and policymakers who frequently study variations in macroeconomic variables to make investment decisions and formulate policies for sustainable economic activities and growth. This information reflects investment decisions, diversification strategies, fiscal and monetary policies frameworks.

1.7 Structure of the Thesis

The thesis is structured and presented in the following seven chapters:

Chapter one: This chapter provided an introductory section of the study which seeks to answer the question "Why the research," alongside the research background, the significance of the research, the aim and objectives, the methodological overview of the research, the contribution of the research to knowledge and finally, the organized outline of the overall thesis.

Chapter Two: This chapter provides a comprehensive research context and used different structural breaks in oil price to analyse how oil price affect macroeconomic variables of the countries under study using extended literature review. The structural breaks account for the major oil price events from 1996q_1 to 2016 q_4 that forecasted GDP growth rate including other macroeconomic variables in context of net oil exporting and oil importing countries in Africa for policy formulation and investment decision making.

Chapter Three: In this chapter, the thesis explored and reviewed the concepts of related literature on how fluctuations in oil prices affect changes in macroeconomic variables in the context of net oil-exporting and net oil-importing countries.

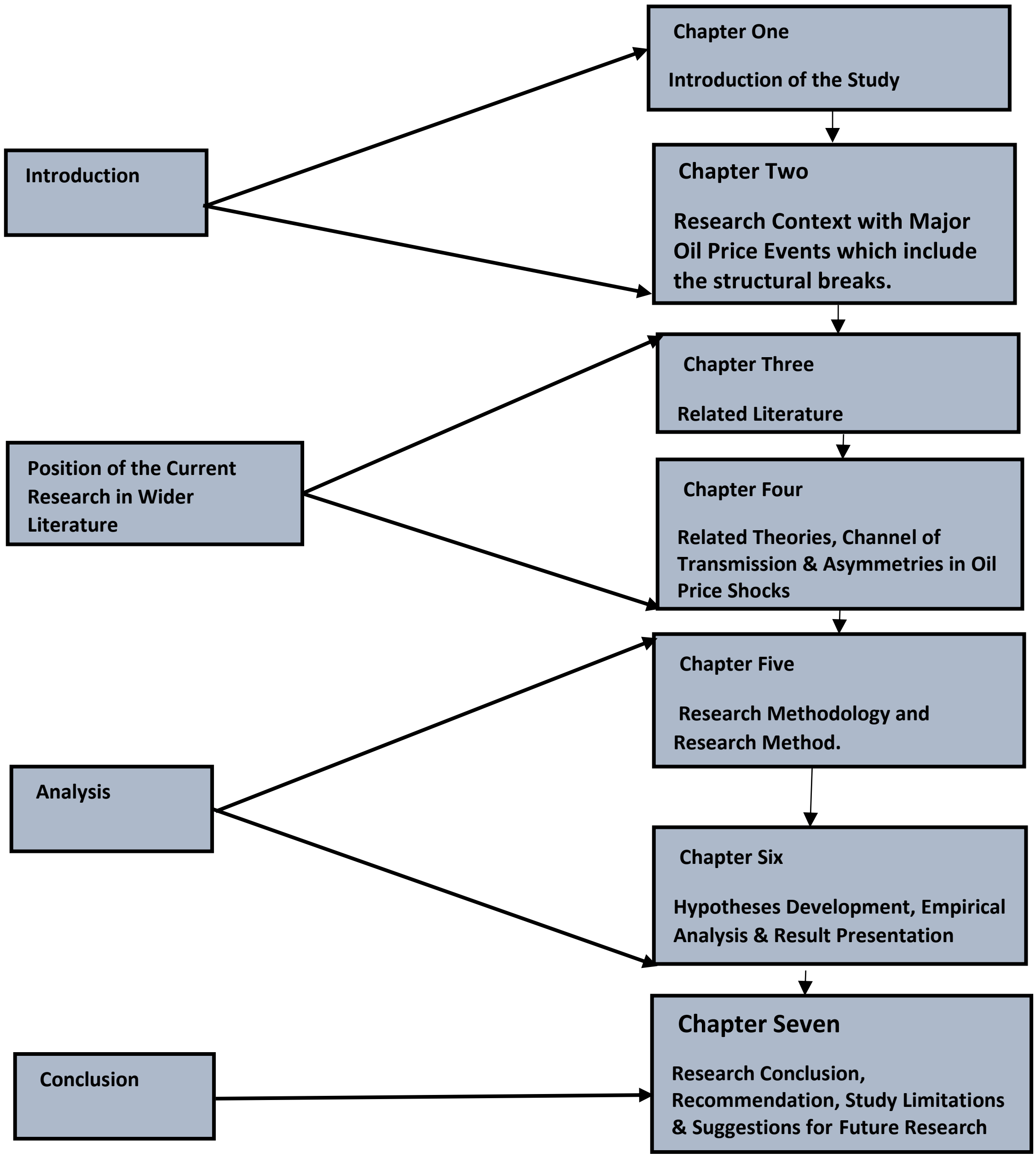
Chapter Four: In this chapter, the conceptual review of related theories, asymmetries, and the channels through which changes in the oil price are transmitted into the macroeconomic variables were described and reviewed.

Chapter Five: In this chapter the research methodology, the research methods, data collection technique and sample size and justification of variable selection were duly presented. Also provided in this chapter is an overview of the econometric analysis, panel unit root test overview as well as cointegration test overview.

Chapter Six: This chapter presents the descriptive data analysis, correlation matrix, hypotheses development, empirical analysis using panel ARDL model, diagnostics, and robustness check alongside discussion of findings.

Chapter Seven: This chapter summarises the main research findings, the practical relevance, the research contribution and the policy implications, the study limitations, and suggestions for further research.

Figure 1.1 Structure of The Thesis



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Chapter Two

An Overview of Research Context

2.0 Introduction

This chapter presents a detail insight of the context of the study. Gadderfors and Anderson (2019) argued that research context is the backbone upon which studies are carried out and this provided the basis for analyzing the relationship between fluctuations in oil price and changes in macroeconomic variables within the context of net oil exporting and net oil importing countries in Africa. Supporting this view, several studies have recognized the significance of context (Fawowe 2014; Huang and Guo 2007) in understanding how fluctuations in oil price affect movements in macroeconomic variables to proffer solutions in terms of policy formulation (Akinsola and Odhiambo 2002; Kocaarslan et al. 2002) and strategies (Salisu and Isah 2017) to shield macroeconomic variables from the vulnerability to shocks in oil price. The research context in which macroeconomic variables are impacted by the fluctuations in oil price in net oil exporting and net oil importing countries is characterized by unsustainable economic activities and growth in Africa (Didia and Ayokunke 2020).

It is argued that the context in which fluctuations in oil price affect changes in macroeconomic variables is vital and significance as the effect of fluctuations in oil price on macroeconomic variables is assumed to be country specific (Iweyemi and Fowowe 2010). Thus, this chapter is set out to review the **changes in main macroeconomic variables, including GDP performance, foreign reserves, inflation, exchange rate, food supply, interest rate, unemployment rate, current accounts, and external debt with respect to the major global oil price event in the context of chosen net oil exporting and net oil importing**

countries in Africa. This enables the understanding of how the structural breaks within the major oil price events affect macroeconomic variables in the context of net oil exporting and net oil importing countries in Africa**.** This study separates oil importing and oil exporting countries not only because literature believe that the response of macroeconomic variables to changes in oil price is country specific (Iwayemi and Fowowe 2010) but also the response of macroeconomic variables to changes in oil price is assumed to be a function of portfolio preference of both net oil exporting and net oil importing countries and distribution of oil imports across net oil importing countries (Fowowe 2014; Huang and Guo 2007)

The research context is structured as follows: Sections 2.1 and 2.2 provide an overview of net oil exporting and net importing countries. Also, presented in this chapter is the overall trend of shocks in oil price and relate these shocks to each country's performance in terms of GDP and other variables within the context of the global major oil price events. The event of the major oil price changes under consideration incorporate data from 1996q_1 to 2016$q_{4.}$ to include the initial oil price increase between 1996 to 1999, oil boom-period of 2002-2008, the financial crisis of 2007-2009, the oil-supply disruption associated with Arab Spring and increased industrial revolution in Asia countries of 2009-2013, as well as the oil price plunge between 2014 to 2016. This is to find the different levels of effect of oil price on macroeconomic variables within this period and presents comparative analysis within the context of net oil exporting and importing countries in Africa.

As earlier mentioned, this chapter is divided into sections 2.1 and 2.2 which is further divided into subsections. Section 2.1 presents the net oil exporting countries and the associated response of macroeconomic variables to shocks in oil price. Section 2.2 put forward the summary of macroeconomic variables response to oil price shocks in net oil importing countries. Section 2.3 describes the pathways through which shocks in oil price affected selected Africa oil exporting and n oil importing countries. Section 2.4 put forward the summary of the chapter.

2.1 The Net Oil Exporting Countries

Nigeria, Algeria, and Egypt are three major oil producers and exporters in Africa (Onigbinde et al.2014). These countries, Nigeria and Algeria are both OPEC members. Although Egypt is not an OPEC member, however, she is considered as one of the largest non-OPEC oil exporters (EIA2017). The existing studies show a mixed results on the impact of macroeconomic variables to oil price fluctuations (Aliyu 2011; Omojolaibi and Egwaikhide 2013; Rotimi and Ngalawa 2017). For example, a negative impact of oil price on macroeconomic variables in net oil exporting countries was reported by Mohsen and Mehrara (2008) and Berument et al. (2010), Dabrowski and Bruegel (2015) and Omolade et al. (2019). While positive impact of oil price on macroeconomic variables is reported by several studies including Mork et al. (1994), Bjornland (2000), Jiménez-Rodríguez and Sánchez (2004), Farzanegan Markwardt (2009), Madueme and Nwosu (2010), Akinleye and Ekpo (2013), Emamgholi (2017) and Kibunyi et al. (2018).

The literature also recognizes that the fluctuations in oil price is a function of supply or demand shocks, acknowledging this, provides information that help forecast the response of macroeconomic variables to oil price volatility. For example, González and Nabiyev (2009) and Kocaarslan et al. (2020) argued that decrease in availability of basic input for production which validates decline in production and reduced output growth is a function of oil supply shock. On the other hand, Kilian (2014) argued that the oil demand shock is felt through consumption and investment. Continued increase oil price can validate decline in total consumption and investment and this may ultimately affect GDP growth rate (Ahmed 2013; Brown and Yucel 2002).

Another issue that has drawn the interest of academia, policy makers and investors is whether macroeconomic variables react asymmetrically to changes in oil price. The recognition of asymmetries in the adjustment process is important because for example, the unexpected changes in oil price can cause changes in the equilibrium allocation of production across the economy's different sectors and this may cause shocks in macroeconomic variables (Nusair and Olson 2021). There is no consensus among empirical findings on the asymmetric response of macroeconomic variables to fluctuations in oil price Lescaroux and Mignon (2008), Mehrara (2008), Moshiri and Banihasem (2012) and Reboredo and Rivera-Castro (2014) and Nusair and Olson (2021). Most of the existing findings focus mainly on the economies of USA, Europe, and Asia. This study will examine the asymmetries associated with relationship between oil price and macroeconomic variables in the context of selected African countries. However, the main focus of the relationship between oil price and macroeconomic variables will be on GDP, current accounts and foreign reserves for most of the countries under consideration.

2.1.1 Nigeria and Oil Price Shocks

Nigeria is a country in west Africa that is rich in natural resources including crude oil (Kretzmann and Nooruddin 2005). Nigeria is the sixth largest crude oil exporter of OPEC members (EIA 2014; Akpan 2009). Crude oil was discovered in commercial quantity in Nigeria in 1956 (Umar and Abdulhakeem 2010), and since then her economy has been dominated by oil. In Nigeria, oil accounts for about 90% of exports, 80% of foreign revenue and 25% of GDP in 2013 (Onigbinde et al.2014). Thus, any slight change in the price of oil can significantly affect Nigerian economy given that the economy is not diversified (Onigbinde et al. 2014). For example, $1 USD increase in oil price in the early 1990s saw an increase in Nigeria foreign earnings by about $650 million USD and that is about 2% increase in GDP (Umar and Abdulhakeem 2010).

Reviewed literature identified shocks in oil price as a function of demand and supply effect (Akinsola and Odhiambo 2020; Kocaarslan et al.2020; Salisu and Isah 2017; Odhiambo 2010; Iwayemi and Fowowe 2010 and Hamilton 1996). Most of the fluctuations in oil price has been traced to have risen from supply disruptions to include OPEC supply quotas, surge in unconventional oil production, geopolitical risk, activities of militant groups in oil producing states in Nigeria. The shocks are classified to be positive with increase in oil price or negative with a fall in the price of oil (Akpan 2009).

Five oil shocks can be observed in Nigeria during the sample period ranging from 1996q_1 to 2016q_4.The shocks in oil prices are all related to changes in macroeconomic activities in Nigeria. For example, 1996 to 1998 increase in oil price were associated with OPEC policies and Asian crisis (Hamilton 2013). Period of 2002 – 2007 saw an increase in oil prices followed by industrial revolution in Asian economies (Hamilton 2013). Within the period 2007-2009, there was a slight decline in oil price closely related to global financial crisis (Akpan 2009; Sill 2007). The period of 2009 – 2013 saw the continued increase in oil price due to continued industrial growth in Asian countries (Hamilton 2013). However, the period of oil price declined between 2014 and 2016 is assumed to be a function of increase in unconventional oil production in U.S and the activities of non-OPEC (Baffes et al.2015). The response of macroeconomic variables to the major oil price shocks in Nigeria is presented in tables 2.1. The analysis is visually supported with figures 2.1 and 2.2 where the response of macroeconomic variables especially GDP and current accounts to the major oil price shocks from 1996q_1 to 2016q_4 in Nigerian economy is evidenced. Fluctuations in oil price an asymmetric response of GDP and current accounts in Nigeria economy. For example, in 1996q_1 to 1996q_4 as oil price slightly increase, GDP is evidenced to increase slightly as well. Equally noted is an asymmetric response of GDP in 2003q_2 to 2005q_1 to an increase in oil price within this period. As oil price decline between 2014q_4 to 2016 q_4, GDP equally decreases. Current account is evidenced to inversely related to oil price decline between 2008q_4 to 2009q_3. Also, a sharp decline in current accounts is witness in 2012q_1 to 2013q_1 as oil price increases. The decline in current account may be attributed to increase in the value of food import from 442million naira in 1996 to 36 billion naira in 2013, an increase of over 15% per annum over the 17year period (De wit and Crookes 2013). The continuous importation of food caused a neglect in the agricultural sector which affected the overall economy. However, between 2015q_3 to 2016q_2, oil price and current account seems to have the same slight upward fluctuating trend.

Table 2.1 Related Major Oil Price Shocks & Their Effects on Macroeconomic Variables in Nigeria

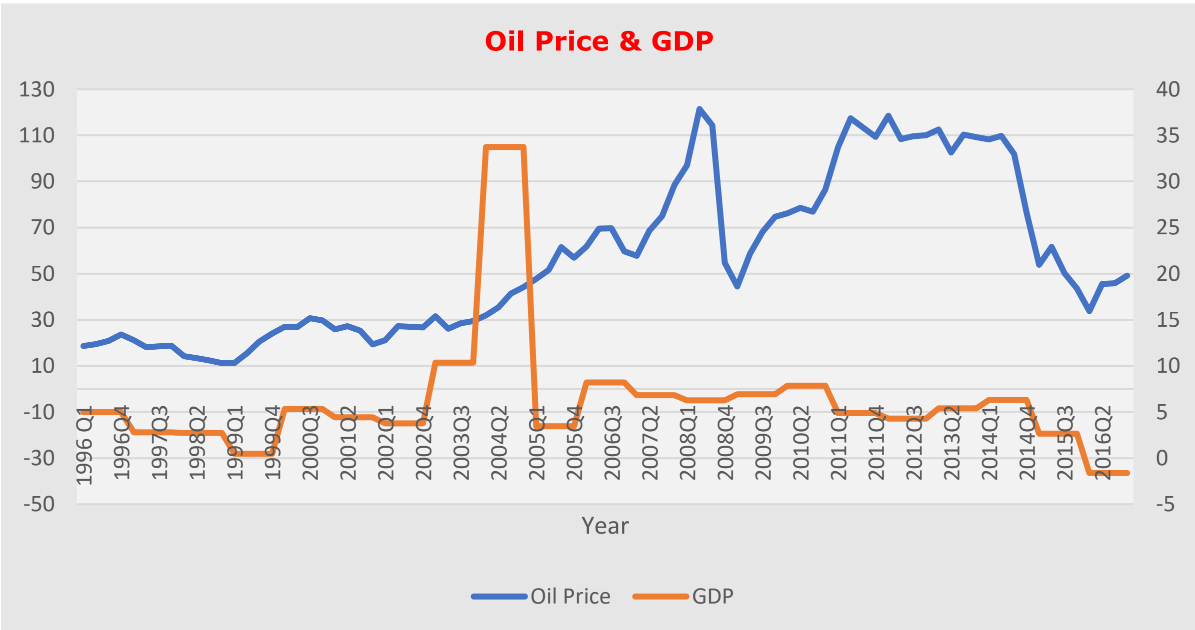
Time period	Oil price fluctuations	Related event	Changes in macroeconomic variables in Nigeria
1996 to 1998	1% increase in oil price	Asian crisis and changes in OPEC policies (Akpan 2009; Hamilton 2013) The east Asian crisis of 1997 which caused currency and financial stress on these economies saw oil price to decline. However, this was short lived as there was a renewed growth industrialization in the region (Hamilton 2011). OPEC policies on production quota added to the increase in oil price (Hamilton 2011).	export increased by about 650%; terms of trade increased from 19.6 in 1996 to 56.4 by 1998 (Akpan 2009). Foreign reserves stood at 9% of GDP in 1996 and increase to 25% in 1998 (Akpan 2009; Onigbinde et al.2014). Government spending increased as crude oil receipts were monetized through investment on education, transport, public health and import substituting industries (Nnanna and Masha 2003)

2002 to 2007	1% increase in oil price	Industrial revolution in Asian economies (Hamilton 2011). The transition of countries from agricultural to modern industrial economies made a tremendous change in the global oil market. China especially had 6.3% annual growth rate for petroleum consumption (Hamilton 2013). Again, the Venezuelan unrest and second Persian Gulf War equally aided the increase in oil price as Venezuelan oil production reduced constituting oil supply decline in the global oil market	Nigeria recorded 80% increase in oil share of GDP in 2002 to 85.7% in 2007 (Akpan 2009). External debt increases from $4.3 billion in 1998 to $11.2 billion in 2003, foreign earnings fall from $10.billion to $1.23 billion (De Wit and Crookes 2013). However, during the first oil price increase in 1996 including the subsequent ones, Nigeria was characterised by weak institutions which were ill equipped to implement key investment projects with the needed rate of returns, thus weakening her ability to repay external debt (Dada 2011). Nigeria's external debt increase from $4.3 in 1998 billion which is a representation of 6.6% of GDP to $11.2 billion in 2003, foreign earnings fall from $10.billion to $1.23 billion within the same period (De Wit and Crookes 2013). Nigeria external debt has since continued to increase, in 2004, her external debt to GDP stood at 38.8% (Perry et al.2010).
2007 to 2009	1% decrease in oil price	The growing demand and stagnant supply due to OPEC policies saw another increase in oil price. However, this did last due to the global financial crisis from 2007 and 2009 (Akpan 2009).	The global financial crisis saw an effect in the banking sector, inflation increase, job loss and depreciation of domestic currency (Ogochukwu 2016). The adverse effect of changes in oil rice to Nigerian economy is attributed to lack of export diversification (Akpan 2009). However, Perry et al. (2010) viewed the effect of changes in oil price to macroeconomic variables in Nigeria at this period is due to Dutch disease syndrome.
2009 to 2013	1% increase in oil price	Continued increase in industrial growth saw an increase of oil price from $43.36 in January 2009 to $105.48 in December 2013 (Igberaese 2013)	The increase in oil price at this period substantially added to values of oil export in Nigeria which had some economic development (Igberaese 2013). The oil boom of this period and the subsequent periods were responsible for increased rent-seeking activities and political corruption in Nigeria (Onuoha and Elegbede 2018). Due to increased political corruption, the realized revenue from oil boom was not utilized for laudable economic projects, hence a drastic investment reduction occurred leading to negative rates of returns (Onuoha and Elegbede 2018) and Nigeria monetary policy remained intensely impacted by the business cycles associated with oil price dynamics (Igberaese 2013).

2014 to 2016	1% decrease in oil price	The fall in oil price could be attributed to factors including U.S reduction in demand of Nigeria's crude oil, the unprecedented increase in unconventional oil production which led to increase in oil supply in the global oil market, appreciation of U.S dollars, geopolitical risks, weakening global demand, significant shift in OPEC policy and activities of non-OPEC members (Baffest et al.2015)	Nigeria's foreign income decreased after fall in oil price between 2014 and 2016 as her oil export suffered a serious setback (Hou et al.2015). Nigeria's foreign exchange reserves depleted, and her fiscal position worsened, exerting pressure on naira's exchange rate to U.S dollar (Hou et al.2015). Nigeria foreign reserves decreased by more than 30% from \$42.2 billion in 2014 to \$15.5billion in 2016, a 47% depreciation in exchange rate was recorded within half of 2016 and this led to inflated imported goods and services (Hou et al.2015; Onuoha and Elegbede 2018). Capital inflows in Nigeria reduced by 41.2% from its \$6.5 billion in third quarter of 2014 to \$4,499.74 million in the first quarter of 2016 (Onuoha and Elegbede 2018). The fall in capital inflows is stimulated by the expected continued decline of oil profits in the global oil market and this made investment less attractive causing a decline in portfolio investment (Hou et al.2015). Also experienced by Nigeria is loss of market share (Baffes et al.2015).

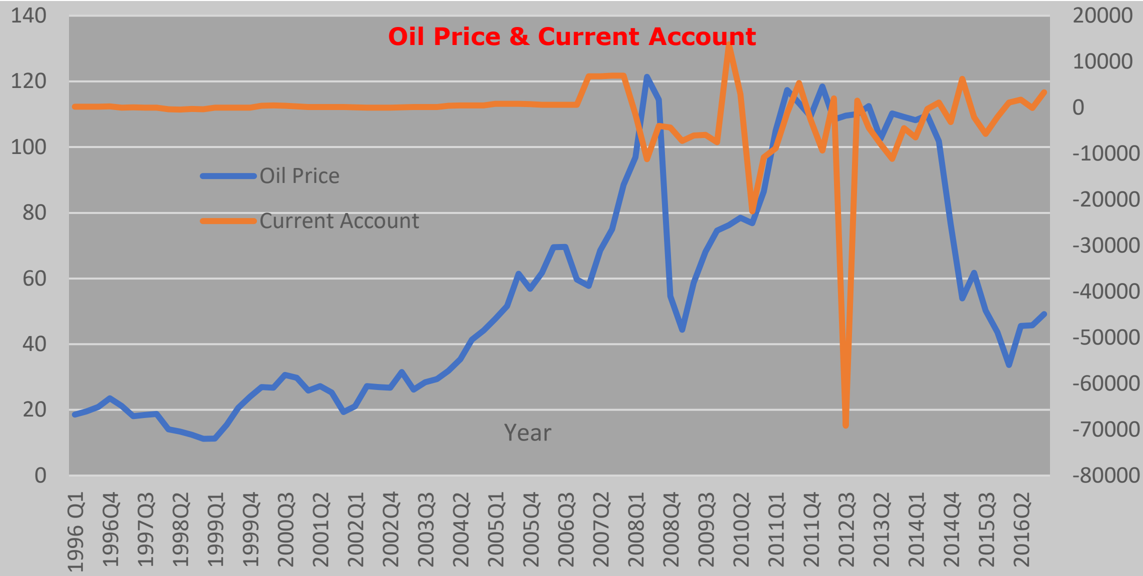
Sources: Author generated 2021

Figure 3.1: The Response of GDP to Oil Price Fluctuations in Nigeria from 1996q_1 to 2016q_4



Sources: Author generated 2021

Figure4.2: The Response of Current Accounts to Oil Price Fluctuations in Nigeria from 1996q_1 to 2016q_4



Sources: Author generated 2021

2.2.2 Algeria and Oil Price Shocks

Algeria is a country rich in crude oil and hydrocarbon located in the Northern part of Africa. Algeria, an OPEC member, is one of largest crude oil exporters in Africa with crude oil export accounting for about 98% of exporting earning in 2011 (Elmezouar et al.2014). The high dependence of Algerian economy on crude oil for revenue generation and economic growth resulted in the economy becoming vulnerable to oil price volatility (EIA 2019). The drop in oil price between 2014 and 2016 had effect on Algeria's fiscal revenue and exports, translating into external and domestic imbalances (Lopez-Calix and Touqeer 2016).

During the fluctuations in oil price e.g., between 1996-1998, 2002-2007, 2009-2013 and 2014-2016, Algeria's economic growth rate was close to 3% during oil price shock period of 2014 to 2015 compared with 2008 to 2009 (Lopez-Calix and Touqeer 2016). In post global financial crisis between 2007 and 2009, countercyclical policies helped the economy to recover from oil price shocks. Economic growth declined to about 2%, for example, in 2009 and about 3% in

2015 (Lopez-Calix and Touqeer 2016). Table 2.2 highlighted the response of macroeconomic variables to the major oil price shocks between 1996 to 2016 in Algeria. More visible illustration of the response of macroeconomic variables especially GDP and current account to fluctuations in oil price in Algeria from $1996q_1$ to $2016q_4$ is shown in figures 2.3 and 2.4 respectively to support the analysis in table 2.2. Evidenced from figure 2.4 is a continued decline in current account in Algeria from $1996q_1$ to $2010q_4$ despite the increase in oil price. However, between $2011q_1$ to $2011q_4$ there was steep growth in current account which subsequently decline sharply from $2011q_4$ to $2016q_2$. The impact of oil price not only affected the Algerian current account but also the foreign direct investment (FDI). The decrease in foreign direct investment related to the level of investment in the extractive oil and gas sector (Lopez-Calix and Touqeer 2016). The fluctuating effect of oil price caused variations in Algerian GDP growth rate as can be evidenced in figure 2.3.

Table 2.2 Related Major Oil Price Shocks & Their Effects on Macroeconomic Variables in Algeria

Time period	Oil Price Fluctuations	Related Events	Changes in Macroeconomic Variables
1996 to 1998	1% increase in oil price	The currency and financial stress in Asian and changes in OPEC policies between 1997 to 1998 saw oil price to fluctuate (Hamilton 2013).	The nominal effective exchange rate depreciated slightly by 7%, although, exchange rate appreciated by up to 13% in the nine months (Elmezouar et al.2014).
2002 to 2007	1% increase in oil price	Increase industrial revolution, OPEC production cut and Isreal-Labanon war of July 2006 (Bouchaour et al. 2012)	The oil price shocks of 2007 - 2009 came with a sensible appreciation of U.S. dollar and reflected no decrease in output of Algerian key trade partners that could explain in part the external imbalances (Bouchaour et al.2012).
2007 to 2009	1% decrease in oil price	Global financial crisis between 2007 and 2009 and supply disruption in Libya in 2009 (Lopez-Calix and Touqeer 2016).	Algeria trade balance to percentage of GDP reduced from 23.6% in 2008 to 5.6% in 2009 (Lopez-Calix and Touqeer 2016). Exchange rate depreciated by 7%, deterioration of current account as percentage of GDP from

			20.15% in 2008 to -2.93% (Lopez-Calix and Touqeer 2016). An inflationary pressure was experienced in Algeria in 2008 (Bouchaour et al.2012).
2009 to 2013	1% increase in oil price	Continued increase in industrial revolution.	Algeria experienced a substantial economic growth as GDP is improved by 4.5% GDP in 2013 (Elmezouar et al.2014).
2014 to 2016	30% decrease in oil price	Decline in oil price due to combination of factors including demand and supply dynamics, unconventional exploration of crude oil, appreciation of U.S dollar, geopolitical conflicts in oil producing areas (Baffes et al. 2015)	Algeria GDP deteriorates from -7.7% in 2014 to -15.9% in 2015, Algeria, experienced a substantial negative economic impact in the form of lower output growth, fall in value of oil production, expenditure reduction, dinar depreciation (which resulted in expenditure switching), reduced inflow of FDI (which is attributed to be below 2% of GDP compared to previous episodes of oil price shocks (Hou et al.2015). Loss of export revenue by $12,704,879 which is about 0.06% of GDP, deterioration of external debt to about 10.2% of GDP in 2015. (Hou et al. 2015; Lopez-Calix and Touqeer 2016). Algeria equally experienced loss of market share (Baffes et al.2015).

Sources: Author generated 2021

Figure 2.3: The Response of GDP to Oil Price Fluctuations in Algeria from 1996q_1 to 2016q_4

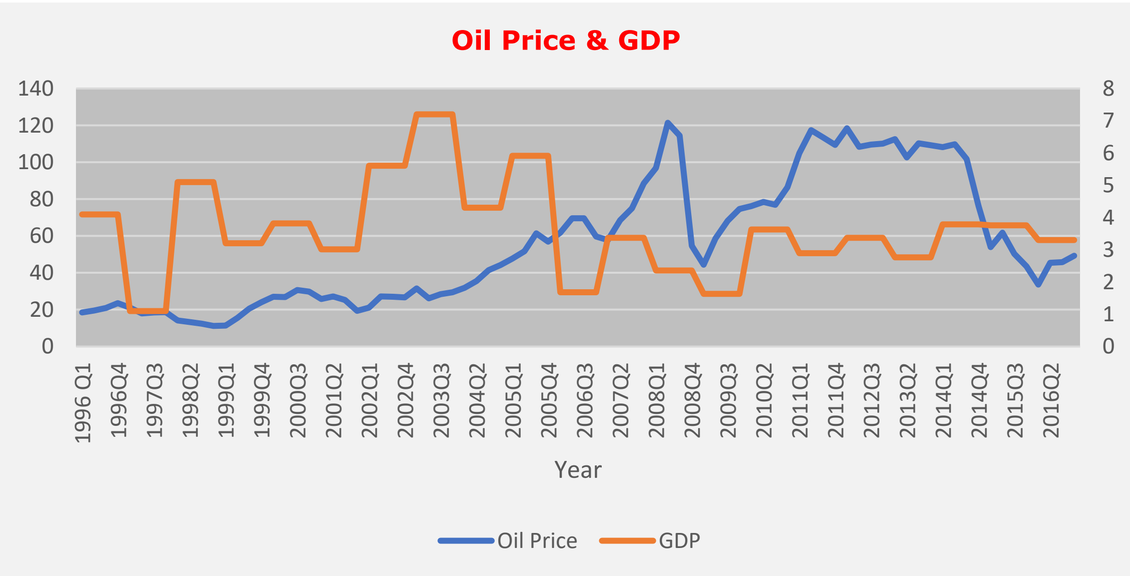


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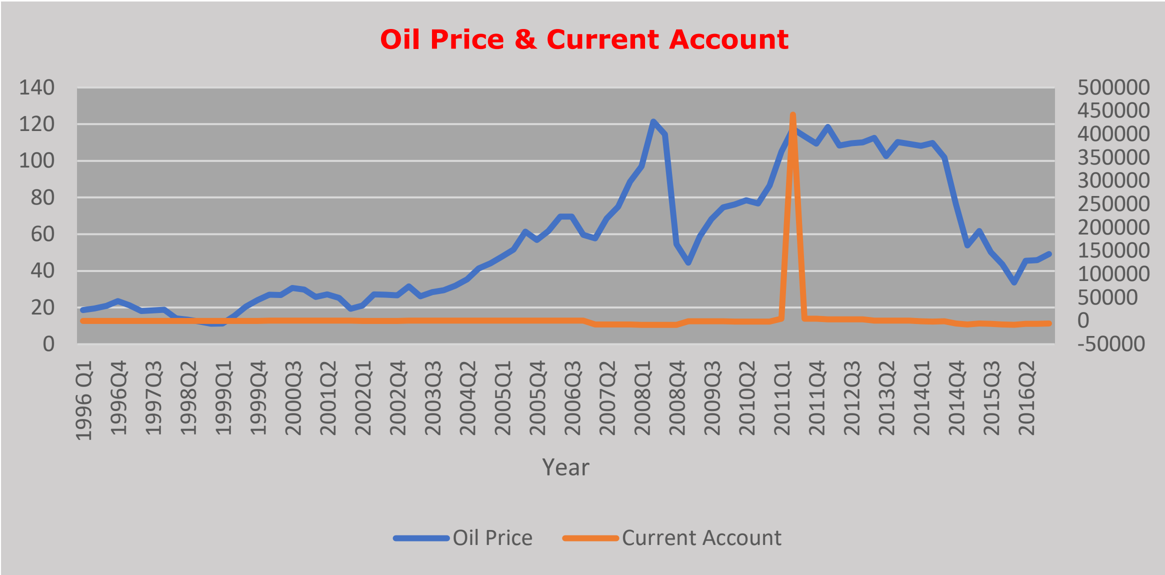
Figure 2.4: The Response of Current Account to Oil Price Fluctuations in Algeria from 1996q_1 to 2016q_4



Sources: Author generated 2021

2.1.3 Egypt and Oil Price Shocks

Egypt is a country located in the north-eastern of African continent, bordered in the south by Sudan, the Mediterranean Sea in north, Libya in the west and the Red Sea in the east. Egypt is considered one of the non-OPEC members that export crude oil and third largest dry natural gas producer in Africa (EIA 2019). Egypt's operation of the Suez Canal and the Suez-Mediterranean (SUMED) pipeline placed her in a position to play a vital role in international energy market by allowing a transit route for crude oil export (EIA 2018). The operation of these crude oil transit routes is significant revenue source for Egyptian government (Zahran 2019). Table 2.4 highlighted more on the response of macroeconomic variables to major oil price events between 1996 to 2016 in Egypt. Figures 2.5 and 2.6 are visual representation of how macroeconomic variables especially GDP and current account responded to oil price fluctuations from 1996q_1 to 2016q_4 in Egypt. From

1996 the current account of Egypt gradually fluctuates upwards as oil price increases until 2008 when the oil price decreases. Also, GDP was on steady growth rate from 1996q_1 to 1996q_4 and fluctuated steadily downwards from 1998 to 1999. However, it increases afterwards as oil price increase causing Egypt to experience improved current account as opined by Aslanoğlu and Deniz (2013). The increase in oil price especially from 2002q_4 to 2008q_3 facilitated increase in remittance inflow in Egypt, hence, increase in current account and GDP growth rate, creating a positive impact on economic activities in Egypt. Although, as oil price increases between 2011q_1 to 2014q_2 the current account of Algeria declined. This could be as a result of the civil unrest in Egypt at this period.

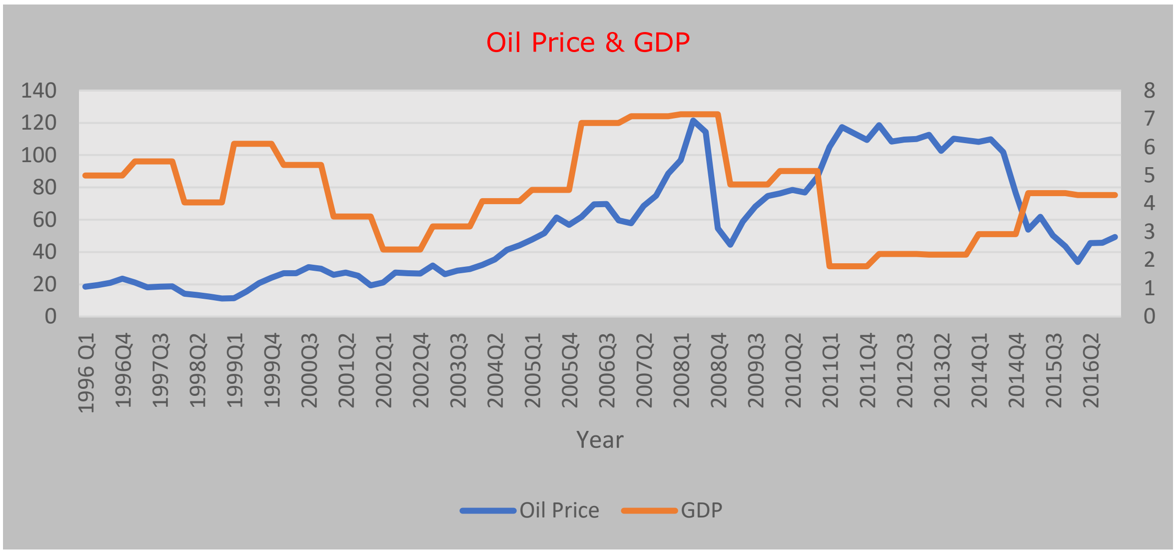
Table 2.3 Related Major Oil Price Shocks & Their Effects on Macroeconomic Variables in Egypt

Time period	Oil Price Fluctuations	Related Events	Changes in Macroeconomic Variables
1996 to 1998	1% increase in oil price	Increase in demand due increased industrial revolution in Asia (Mohaddes and Raissi 2013).	Egypt experienced improved exporting earning, improved current account exceeding 30% of GDP (Choucri et al. 1990; Aslanoğlu and Deniz 2013).
2002 to 2007	1% increase in oil price	Industrial revolution in Asian countries (Morshed and Pitafi's 2008)	The inflow of remittances increased on average by 13.76% due to increase in oil price and this give rise to GDP growth rate (Zahran 2019). Egypt experienced increase in output (Morshed and Pitafi's 2008). Oil import grew from 5.97 billion barrel per month in 2008 to 7.36 barrel per month in 2009 (Mohaddes and Raissi 2013).
2007 to 2009	1% decrease in oil price	Global financial crisis (Zahran 2019).	Oil import dropped from 6.70 barrel per month in 2010 to 3.29 barrel per month in 2011, hence, a reduction in GDP growth rate (Makhlouf and Kasmaoui 2017). This is attributed to revolution in Egypt within that period ((Zahran 2019).
2009 to 2013	1% increase in oil price	Egyptian revolution between 2011 and 2013 (Zahran 2019).	Egypt experienced currency depreciation, inflation, reduction in remittance, foreign reserves, current account balance and economic growth rate (Zahran 2019).

2014 to 2016	30% decrease in oil price	Oil price plunge due to demand and supply dynamics, technological and geopolitical factors, and appreciation of U.S dollars (Baffes et al.2015; Hou et al.2015).	In 2016, the remittance inflow drops from $18.3 in 2014 to $16.6 billion in 2016, representing 4.8% of GDP (Zahran 2019). Loss of export of $1823,700 billion which is 0.14% of GDP and current account deficit increase from 0.55% in 2008 to -3.96% in 2016 (Hou et al. 2015 and Makhlouf and Kasmaoui 2017).

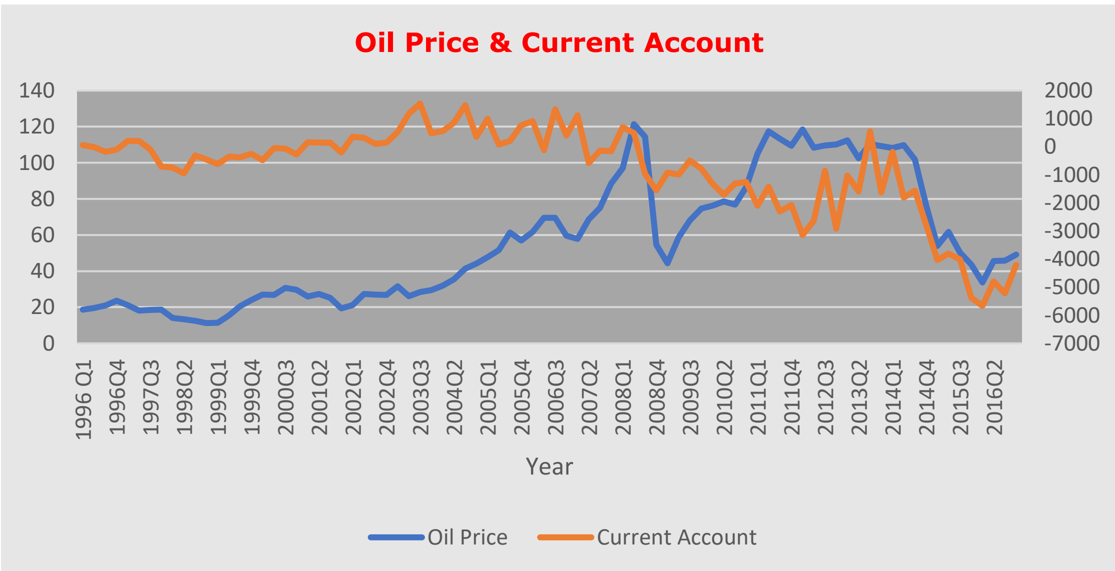
Sources: Author generated 2021.

Figure 2.5: The Response of GDP to Oil Price Fluctuations in Egypt from 1996q_1 to 2016q_4



Sources: Author generated 2021

Figure 2.6: The Response of Current Account to Oil Price Fluctuations in Egypt from 1996q_1 to 2016q_4



Sources: Author generated 2021.

2.2 The Net Oil Importing Countries

The impact of fluctuations in oil price on macroeconomic variables are assumed to be of two dimensions in the economies of net oil importing countries (Ahmed 2031). First, a decrease in oil price is advantageous to net oil importing countries through reduction in import bill which may cause improvement in current account (Grímsson et al.2017; Beckmann et al.2017). Second, an increase in oil price can cause a steep decrease in income and production level particularly for net oil importing countries who are highly oil dependent (Trang et al.2017). This can result to decrease in investment and increase in unemployment rate and ultimately decline GDP growth rate (Brown and Yucel 2002). A recent study by Akinsola and Odhiambo 2020 validated that oil price-macroeconomic relationship is a function of demand and supply factors subject to an asymmetric relationship. This study will examine the asymmetric relationship between oil price and macroeconomic variables effect in the context of net oil importing countries in Africa. Specifically, South Africa and Kenya has been selected because of their involvement in oil trade, and importantly their involvement in crude oil importation and consumption level.

Research on negative and positive effect of fluctuations in oil price on macroeconomic variables in net oil importing countries from the context of asymmetries have grown especially in developed and Asia countries. Few scholars who investigated such relationship in Africa include Akinsola and Odhiambo (2020).

Several recent studies, e.g., Knotek and Zaman (2021) and Liu et al. (2021) examined long run and short run asymmetries associated with fluctuations in oil price and its effect on macroeconomic variables in net oil importing countries[1]. Their empirical result which focused mainly on Europe, US and Asian countries indicate that the short run and the long run asymmetric relationship between oil price and macroeconomic variables varies across countries (see Lin and Bai 2021; Hashmi et al.2021). However, little or no study has been conducted in the context of net oil exporting and net oil importing countries in Africa, as such this study intends to examine the structural breaks of oil price shocks caused variations in macroeconomic variables in the context of net oil exporting and oil importing in Africa. This is to identify the adjustment process of these key macroeconomic variables to oil price shocks that contain information exploitable by policy maker, firms and investors to strategies and reduce the exposure of macroeconomic variables to oil price shocks. This study fills this research gap in this chapter by utilizing extended literature review to examine how the structural breaks caused by the major oil price shocks events created variations of the selected key variables. This is done by using quarterly data of the major shocks in oil price between 1996q_1 to 2016q_1 and demonstrate how changes in oil price influenced macroeconomic variables in the context of selected net importing countries in Africa.

2.2.1 South Africa and Oil Price Shocks

South Africa is a country in the southern part of African continent bordered by Namibia to the northwest, Zimbabwe and Botswana to the north, Swaziland, and Mozambique to the northeast and east Lesotho. South Africa is an oil importing country, whose economy is estimated to be the largest and most developed economy in sub-Saharan Africa. Yet, half of her population is living under poverty

[1] Knotek and Zaman (2021) examined this relationship in US and Liu et al. (2021) focused on China.

(Sibanda et al.2018; Wakeford 2013). South Africa's imports of crude oil and refined products is estimated to be 370,000 barrels per day which is approximately 66% of its annual consumption of petroleum products in 2012 (Wakeford 2013). South Africa has the highest consumption of energy in Africa (EIA 2017). Table 2.4 highlights the response of macroeconomic variables to major oil price shocks events between 1996q_1 to 2016q_4 in South Africa. Figures 2.7 and 2.8 present the trend of how macroeconomic variables, in this case, GDP and current account responded to shocks is oil price within the period under study in South Africa economy. The trend reveals negative trend between oil price and GDP between 2008q_4 and 2009q_4 but also between 2011q_4 to 2014q_4. These represented the global financial crisis period and the period of increase in oil price given a continued increase industrialization. From 1996q_1 to 2008q_4, South Africa's current progressively fluctuates downward. This is due to increase in oil price caused by increase in demand as shown in table 2.4. The fluctuation in oil price at this period indirectly affected the transport and agricultural sectors (Wakeford 2015). For example, fertiliser prices were influenced mainly by prevailing international prices, the freight costs and rand-dollar exchange rate (Wakeford 2015). Hence, they were prone to increasing oil prices both directly through higher transport costs and indirectly through the impact of oil prices on the exchange rate and international prices.

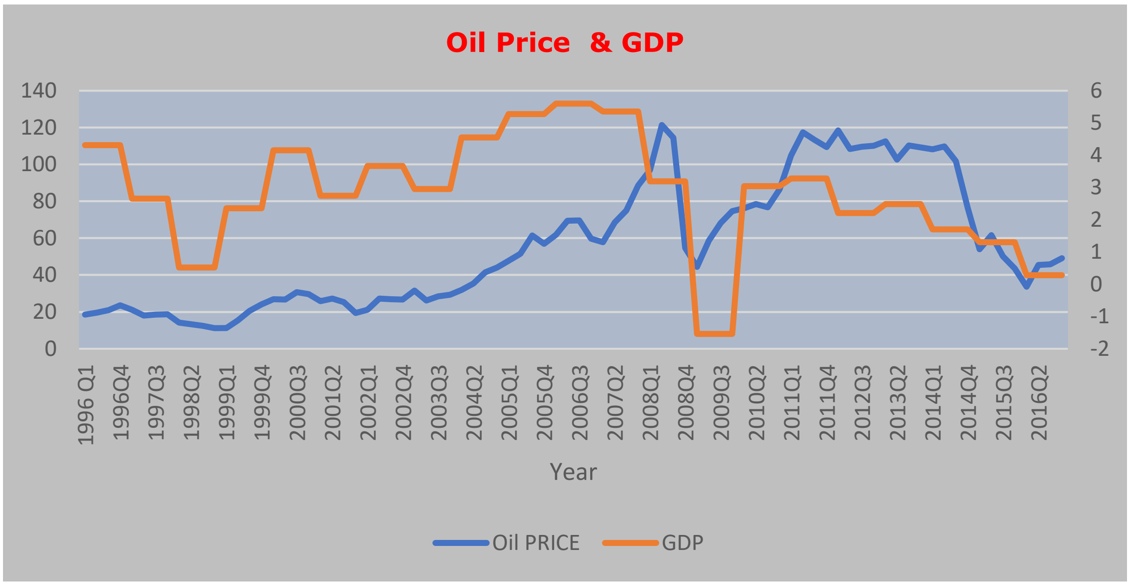
Table 2.4 Related Major Oil Price Shocks Events and their Effect on Macroeconomic Variables in South Africa.

Time period	Oil Price Fluctuations	Related Events	Changes in Macroeconomic Variables
1996 to 1998	1% increase in oil price	Increase in demand due increased change from agro-economy to industrial and manufacturing economy (Wakeford 2013).	Energy provisions increase from 8% 1993 to 13% between 2007 and 2008 (EIA 2017).

2002 to 2007	1% increase in oil price	Industrial revolution in Asian countries (Ajmi et al. 2015).	Same as above. Hence GDP growth rate increased as manufacturing and transport sectors saw improvement (Ajmi et al. 2015).
2007 to 2009	1% decrease in oil price	Global financial crisis (Chitiga et al.2012).	Oil importation dropped from 471,000 barrel per day in 2008 to 402,000 barrel per day in 2009, oil importation of account for about R138billion approximately 6% of GDP in 2008 (Aye et al.2014). Oil importation dropped from R95 billion, 4% of GDP in 2007 to R33 billion, accounting for about 1.4% of GDP in 2009 (Wake ford 2013). Monthly import reserve grew from 3.33% of GDP in 2008 to 5.21% of GDP in 2009 (Hou et al. 2015).
2009 to 2013	1% increase in oil price	Continued increase demand for oil (Wakeford 2013).	Oil importation grew to 450,000 barrel per day in 2010 but dropped to 443,000 barrel per day in 2011, however, importation grew up proportionately in 2012 (Wakeford 2013). Again, oil importation dropped to 420,500 barrel per day in 2013 (Wakeford 2013). Direct use of coal energy declined from 30% to 21% making way for about 30% increase in oil consumption between 2010 to 2013 (Sibanda et al. 2018). Experienced also in South Africa, is deficit of current account by 3.3% of GDP, currency depreciation, fiscal deficit increase from 5% of GDP in 2009 to 9% in 2013, the ratio of external debt to GDP increase from 27% to 48.9% in 2013, inflation stood at 6.7% and unemployment rate stood at 30% of GDP (Ajmi et al. 2015; Chitiga et al.2012)
2014 to 2016	30% decrease in oil price	Oil price plunge due to demand and supply dynamics, appreciation of U.S dollar, technological and geopolitical factors (Baffes et al.2015)	Import value increase by $15billion in 2014, current account deficit reduced from -7.17% of GDP in 2008 to -5.64% of GDP in 2016 and inflation decrease by 2% (Hou et al.2015).

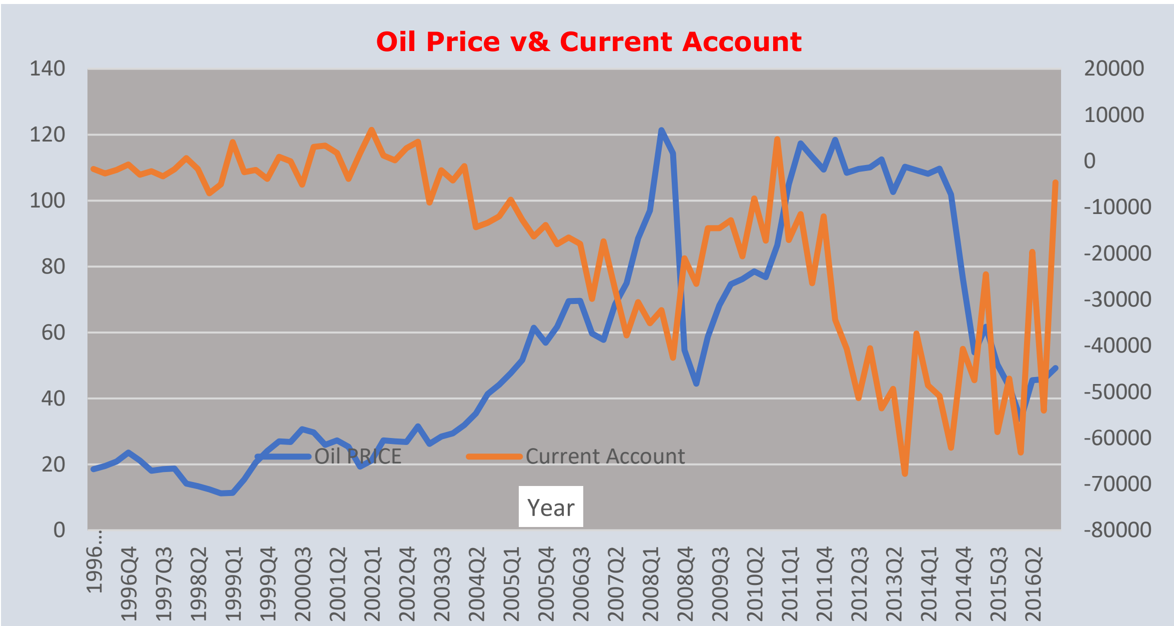
Sources: Author generated 2021

Figure 2.7: The Response of GDP to Oil Price Fluctuations in South Africa from 1996q_1 to 2016q_4



Sources: Author generated 2021

Figure 2.8: The Response of Current Account to Oil Price Fluctuations in South Africa from 1996q_1 to 2016q_4



Sources: Author generated 2021

2.2.2 Kenya and oil Price Shocks

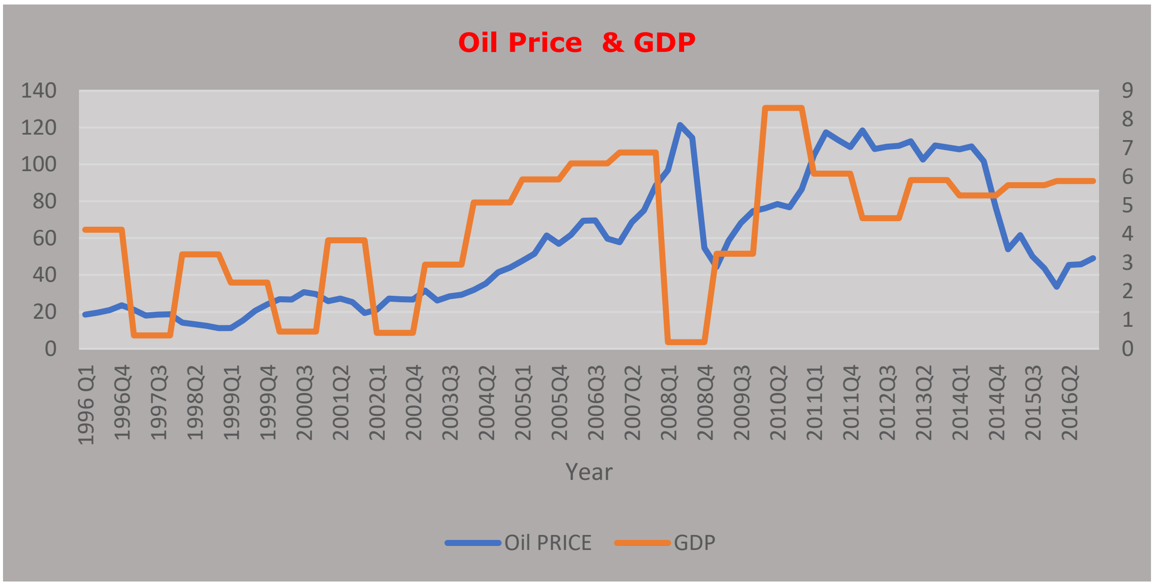
Kenya is a country in East Africa bordered by Somalia to east, Uganda to the west, Ethiopia to the north, Tanzania to the south, South Sudan to the northwest and Indian Ocean to the east. Kenya imports petroleum products and sell part of it to her neighboring countries such as Uganda (Kibunyi et al.2018). Hence, giving Kenya a significant role to play in importation of petroleum in East African countries. Currently, Kenya does not produce crude oil. But a discovery of 600-million-barrel recoverable oil resource was made in the South Lokichar basin of Kenya (EIA 2016). The initial takes off oil production in commercial quantity in Kenya was meant to start 2020 given the discovery of oil in the country (EIA 2016). Owing to the instability of Kenya and unsuccessful negotiation with Uganda on joint export pipeline route, oil production in Kenya had delayed (EIA 2016). COVID-19 also delayed crude oil exploration and production in Kenya. Table 2.5 presents the response of macroeconomic variables to the major oil price shocks events between 1996q_1 to 2016q_4 in Kenya. Figures 2.9 and 2.10 evidenced the visual representation of the response of GDP and current account to fluctuations in oil price in Kenya from 1996q_1 to 2016q_4. This is to further portray how these macroeconomic variables responded to shocks in oil price within the period under study. Current account evidenced downward fluctuation given the steady increase in oil price from 1996q_1 to 2008q_1. However, oil price slightly decreased and went up again from 2008q_4 up till 2014q_1. The increase in oil price impacted on Kenyan's economy through the gas market, cost of living, including foodstuff and pump prices increased (Okach 2021). Hence, the agricultural and transport sector were directly affected as Kenyan's current account continued to dwindle.

Table 2.5 Related Major Oil Price Shocks & Their Effects on Macroeconomic Variables in Kenya

Time period	Oil Price Fluctuations	Related Events	Changes in Macroeconomic Variables
1996 to 1998	1% increase in oil price	Asian crisis and changes in OPEC policies (Hamilton 2013).	Decline in GDP from 4.1% in 1996 to 0.5% in 1997 but regained growth by 3.3% in 1998 (Odhiambo and Nyasha 2019). Budget deficit and increase in external debt due import bill (Dehn 2000).
2002 to 2007	1% increase in oil price	Industrial revolution in Asian economies (Hamilton 2011).	6% increase in GDP growth between 2006 and 2007 (Odhiambo and Nyasha 2019).
2007 to 2009	1% decrease oil price	Global financial crisis and supply disruption in Libya in 2009 (Lopez-Calix and Touqeer 2016).	0.2% decline in GDP in 2008 (World Bank 2018a)
2009 to 2013	1% increase in oil price	Continued increase in industrial revolution (Wanjala 2018).	Due to Kenya involvement in re-exporting crude oil to other parts of east Africa, her GDP growth rate increased by 8.4% causing appreciation of Kenyan shilling by 2.16% in first quarter of 2009 which gradually appreciated to 2.34% over a three-year horizon (Maina 2015).
2014 to 2016	30% decrease in oil price	Oil price plunge due to demand and supply dynamics, technological and geopolitical factors (Baffes et al.2015)	Inflation dropped by 2%, low import bill, 1% increase in household expenditure and reduced investment in energy sector (Hou et al.2015). Economic growth averaged 5.6% in 2014 but was 5.8% in 2016 (World Bank 2018a).

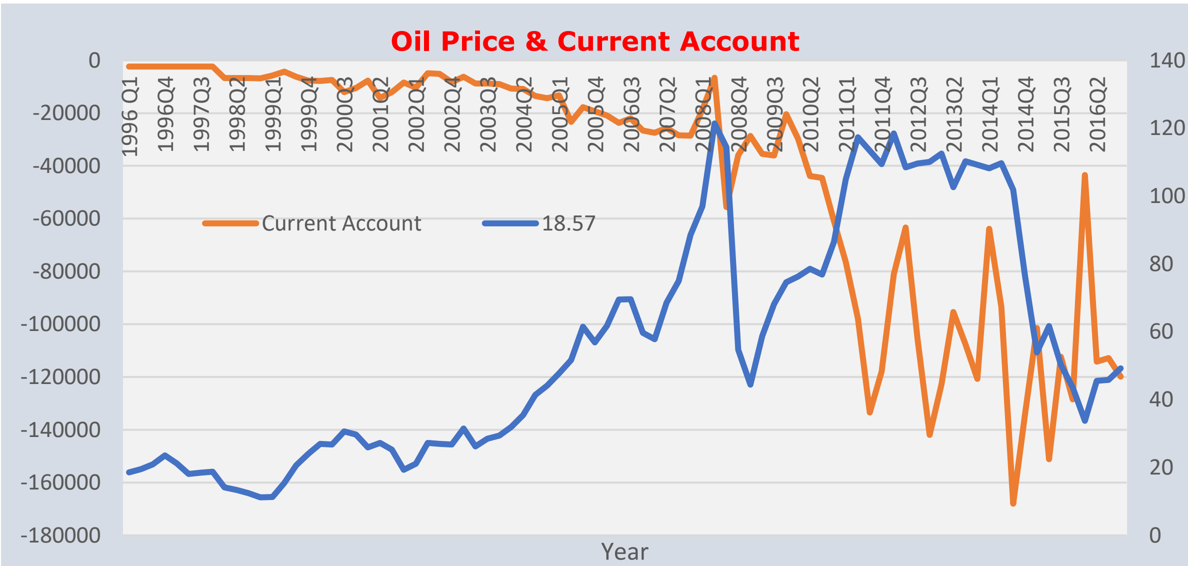
Sources: Author generated 2021

Figure 2.9: The Response of GDP to Oil Price Fluctuations in Kenya from 1996q_1 to 2016q_4



Sources: Author generated 2021

Figure 2.10: The Response of Current Account to Oil Price Fluctuations in Kenya from 1996q_1 to 2016q_4



Sources: Author generated 202

2.3 Shocks in Oil Price Pathway in Net Oil Exporting and Oil Importing Countries in Africa

The combination of global demand and supply dynamics, together with appreciation of U.S dollars, unconventional exploration of crude oil and major geopolitical conflits in oil producing areas have caused fluctuations in oil prices (Baffes et al.,2015). The effect and its magnititude in net oil exporting and importing countries dependes on transmission channel and policy strurcture responses of each economy (Bouchaour and Ali Al-Zeaud 2012 ; Lin and Bai 2021). In this section the exposure of macroeconomic variables to oil price shock on selected African countries is analysed focusing on oil price plunge between 2014 and 2016.The focuse of oil price shock event between 2014 and 2016 in this section is informed by the sharp change in oil price from $140 per barrel in early 2014 to $30 per barrel in 2016. The anaysis is amied to identify the actual effect of how this sharp change in oil price affect macroeconomic variables in the context of net oil exporting and oil importing countries in Africa.

2.4 Pathway Through Actual Effect

This Section discusses the oil price decline between 2014 and 2016 and the effects on selected Africa exporting and importing countries. As background, extended literature review is used to review the actual effect and uncertainties associated with exposure of macroeconomic variables to shocks in oil price.

The actual effect of oil price decline between 2014 and 2016 according to Hou et al. (2015) saw a noticeable 17% drop in export value of sub-Saharan oil exporters. The export of crude oil from sub-Saharan Africa countries to US dropped by 44%, EU dropped by 10% while export to China increased by 4%. At the same time, crude oil import bill of net oil importing countries dropped by 20% from quarter of 2014 to February 2015. Baffes et al. (2015) opined that the actual effect of oil price plunge between 2014 and 2015 on net oil exporters is the reduction on fiscal revenue, contraction of oil sector, deterioration of current account and domestic currency depreciation. Given the effect of the oil price plunge, most of the net oil exporting countries in Africa countries adopted currency adjustment. This significant mechanism created rise in inflation of non-oil trade products (Baffes et al. 2015). For net oil importers, they concluded that oil price plunge between 2014 and 2015 validated rise in corporate and household income in a manner like tax cut, improvement in current account balance by 1.7% of GDP especially in South Africa, reduction in headline inflation by 1.4% point and downward pressure on input costs that validated 1% rise in GDP, especially in South Africa. Table 2.6 summaries the losers and gainers of oil price decline between 2014 and 2016 in Africa countries in the context of net oil exporters and net oil importers.

Table 2.6 Effect of Oil 2014-2016 Decline on Net Oil Exporters and Net Oil Importers

Gainers -Effect of decrease in oil price on oil importers	Losers- Effect of decrease in oil price on oil exporters
The oil price decline between 2014 and 2016 caused direct Improvement in current account of net oil importing countries through reduced import bill of about $15 billion which Kenya and South Africa are major gainers (Hou et al.2015).	The decline in oil price between 2014 and 2016 has a trade effect which feed through current account deterioration and reduction export revenue. For example, oil export from sub-Saharan Africa reduced by $63 billion which Nigeria is among the major losers. Nigeria oil export drop by 14% in the half quarter of 2014 (Hou et al.2015).
The low import bill feed into reduction in production cost and hence decrease in consumer prices. Kenya and South Africa’s inflation dropped by 2% points as a reduction in production cost in half quarter of 2014 (Baffes et al.2015).	Increase prices of goods for consumers. For example, in Nigeria inflation rate increased given depreciation in exchange rate caused by decline in oil price (Baffes et al.2015)
Appreciation of exchange rate, hence, increase in disposable and investment income (Ogede et al.2020).	In with the above, depreciation of exchange rate imported inflation, causing reduction in disposable and investment income (Baffes et al.2015).

Increase in government spending as investment is validated given an increase in disposable income as import bill is reduced (Baffes et al.2015).	Reduced government revenues and possible problem to service external debt (Didia and Ayokunke 2020).
Increased economic growth spillovers from global economic growth impacts (Hou et al.2015).	Effect on capital inflow due to volatility in financial and currency markets.
Rise in corporate and household income in a manner like tax cut (Baffes et al.2015).	Decline private investment especially in oil sectors (Baffes et al.2015)
A possible decline in agricultural prices given that food production tends to be energy intensive. This can be passed through into domestic food prices, benefiting majority of the poor (Baffes et al.2015).	Increased pressure on financial market and fiscal balance causing deteriorating growth prospect (Baffes et al.2015).
The pass through into reducing inflation may easy pressure on central bank, and may provide room for policy accommodation (Baffes et al.2015)	Central banks in net oil exporters try to balance the need to support growth against the need to contain currency and inflation pressures (Baffes et al.2015).
Savings from reduced oil price may help rebuild fiscal space and create opportunity to implement structural reforms (Hou et al.2015).	Structural reforms such as fuel subsides may have adverse distributional effect on poor consumers (Baffes et al.2015).

Sources: Adapted from Hou et al. (2015)

2.4 Summary

About 83% of government revenues of some net oil exporting countries in Africa are from oil (Kretzmann and Nooruddin 2005). Net oil exporting countries under study heavily depend on oil revenues for its national income and it is unlikely that these countries' dependence on oil will change soon. Despite the immense oil wealth, economic volatility, fiscal and monetary disequilibria, inflation, external debt burden, low investment rate and low GDP growth rate are observed in the selected African oil exporting countries.

Net oil importing countries are significantly affected by oil price shocks (Salius and Isah 2017). This assumption is echoed by Kretzmann and Nooruddin (2005) and Hou et al. (2015) by concluding that oil price shocks are highly correlated with significant changes in macroeconomic activities in African net oil importing countries. This study has also reviewed that the selected net oil importing countries in Africa experienced increased interest payments, higher import costs and adverse domestic macroeconomic conditions following oil price shocks using extended literature review.

However, existing policy responses that can help both net oil exporting and net oil importing countries to shield their economies from the shocks of oil price are limited. This study aims to help policy makers to develop not only policy responses such as diversification, infrastructural development, refining of crude oil locally by having a workable refineries and investment on agricultural development but also, pursue policy that will enhance increase in the use of renewable energy especially in net oil importing. Through this there will be job creation, increase in foreign earning, increase in current account, reduction in inflation and dependency on crude oil. This will economic activities and ultimately validate increase in GDP growth rate.

Table 2.7 An Overview of the Literature

Authors	Country	Period	Methodology	Results
Jimenez-Rodriguez and Sanchez (2005)	OECD countries	$1972q_1$ to $2001q_4$	Various assumptions in literature alongside a VAR model	Impact of 10% decline in oil price on output after 1 year (%): UK (0.020, Canada (-0.18), U.S (-0.14). Effect on other countries is statistically insignificant. The effect of 10% rise in oil price on output after 1 year (%): Euro Area (-0.1 to -0.34), U.S (-0.3 TO -0.6).
Cologni and Manera (2008)	G7 countries	$1980q_1$ to $2003q_4$	Structural Cointegrated VAR model	The effect of 1 standard deviation increases in oil prices on inflation after 1 year (%): Japan (0.39), U.S (0.77), Italy (0.42), UK (0.50), Germany (-0.11), Canada (0.41), France (-0.22). The effect of 1 standard deviation rises in oil prices on output after 1 year (%) Germany (0.04), Italy (-0.17), UK (0.08), Japan (0.01), Canada (-0.41), France (-0.22).
Peersman and Robays (2011)	Australia, UK, U.S, Germany, Japan, Canada, Norway, Italy, Spain, France, Switzerland	$1986q_1$ to $2014q_4$	SVAR	Impact of 10% supply-driven long run increase in oil prices on inflation within two years (% point): Japan (0.2), U.S (0.3), Switzerland (0.6), Norway (-0.2), Canada (0.1), Spain (0.1), Germany (0.2), France (0.1), U.K (0.1), Australia (-0.5). Impact of 10% supply-driven long run increase in oil price on output within 2 years (percentage point): Japan (-0.4), France (-0.2), U.S (-0.4), Italy (-0.7), Switzerland (-0.2), Canada (0.2), U.K (-0.1), Spain (0.1), Norway (0.3) and Australia (-0.1). Impact of 10% demand-driven oil prices shock on output caused by economic activity dynamics after one year (%): Switzerland (0.15),

				U.S (0.3), UK (0.2), Australia (0.1), Spain (0.4), Italy (0.4), Germany (0.4), France (0.3), Japan (0.3), Norway (0.2). Impact of 10% demand-driven oil prices shocks on inflation caused economic activity after one year (%): Japan (0.5), U.S (0.6), Switzerland (0.4), Germany (0.3), France (0.4), Italy (0.3), Canada (0.3) UK (0.4), Norway (0.3), Australia (0.3), Spain (0.6)
Lawal and Aweda (2015)	Nigeria	2004 to 2014 Monthly data	ARDDL model	The long run and short run effect of oil price on exchange rate is negative and significant in Nigeria.
Longe, et al. (2018)	Nigeria	1977 to 2015 Annual data	ARDL model	The short run oil price impact on current account balance in Nigeria is positive but insignificant. The long run oil price impact on current account in Nigeria is negative and significant.
Maijamaâ and Musa (2020)	Nigeria	1991 to 2018 Annual data	VECM	Changes in oil price negatively and significantly affected unemployment rate in the long run while the short run effect is statistically insignificant.
Alimi et al. (2020)	Nigeria	2009q_1 and 2018q_1	NARDL	Both increase and decrease in oil price exerts negative effect on inflation in Nigeria in the long run. In the short run increase in oil price exerts positive effect on inflation.
Ogede et al. (2020)	Oil exporting countries	1995 to 2017 Annual data	Pool Mean Group	Oil prices have substantial effect on inflation in net oil exporting countries
Akinsola and Odhiambo (2020)	Oil importing countries	1990 to 2018	NARDL MODEL	Oil price has negative effect on GDP in the long run but insignificant in affecting GDP in the short run.
Lin and Bai (2021)	Oil exporting and oil importing countries		Vector autoregressive model	Economic policy of net oil exporting and oil importing countries responded to oil price shocks differently.

Yildirim and Arifli (2021)	Oil exporting countries	2006 to 2018 Monthly data	VAR model	Negative oil price deteriorates trade balance, cause currency depreciation, increase in inflation and fall in economic activities.
Mahmood and Murshed (2020)	Saudi Arabia		ARDL model	Rise in oil prices have positive effect on income while fall in oil price have adverse effect on income in the long run and short run.

Sources: Author generated 2021

Chapter Three

Literature Review

3.0 Introduction

This chapter reviews the existing literature on the relationship between oil price fluctuations and changes in key macroeconomic variables including GDP growth rate, interest rates, inflation, exchange rate, unemployment rate, food supply, external debt, current accounts, and foreign reserves.

Recent development in this strand of literature focuses on asymmetric effect of fluctuations in oil price on macroeconomic variables (Akinsola and Odhiambo 2020; Salisu and Isah 2017; Fowowe 2014). Beginning with Mork (1989), analysing asymmetric relationship between oil price and macroeconomic variables is significant in that it distinguished the effect of oil price increase from the effect of oil price decrease on macroeconomic variables. Some scholars have found that oil price increase has a greater impact on macroeconomic variables compared to oil price decrease (Huang et al. 2005; Zhang 2008; Cologni and Manera 2009; Kilian and Vigfusson 2017). This study intends to identify if this assumption holds in the context of net oil exporting and net oil importing countries in Africa. As most studies on asymmetries of oil price-macroeconomic relationship are either country-specific (Umar and Abdulhakeem 2010; Elmezouar 2014; Chiwaze and Aye 2018 Oluwaseyi 2018; Kibunyi et al.2018) or on net oil importers (Akinsola and Odhiambo 2020; Ahad and Anwer 2020; Murshed and Tanha 2021) or on net oil exporters (Gbatu et al. 2017 Omolade et al. 2019; 2019; Akram 2020; Adebayo; 2020 Jibril et al. 2020; Yildirim and Arifli 2021). This will enable a comparative analysis of the asymmetric effect of oil price on macroeconomic variables in net oil exporting and oil importing countries in Africa.

However, in developed economies, several authors including Lescaroux and Mignon (2008), Jibril et al. (2020) Lin and Bai (2021) and Su et al. (2021) have analysed asymmetric effect of oil price on macroeconomic variables in the context of net oil exporting and oil importing countries. And varying results have been found in literature with respect to how changes in oil price affect macroeconomic variables in developed and Asian economies. For example, Hamilton (1983,1996), Guo and Kilesen (2005), Rafiq et al. (2009) and Mureithi (2014) found negative relationship between oil price and output growth while Ito (2008), Mohammad et al. (2009), Cunado et al. (2015) and Kibunyi et al. (2018) evidenced positive relationship between oil price and output. On the other hand, scholars including Olomola (2006) and Iwayemi and Fowowe (2010) found that changes in oil price is insignificant in predicting output.

Mork (1989), Jiménez-Rodríguez and Sánchez (2005), Narayan and Narayan (2007), Ayadi (2011), Mahmood and Murshed (2021), Hashmi et al. (2021) and Lin and Bai (2021) found evidence of asymmetric relationship between oil price and macroeconomic variables while Khan et al. (2019) evidence no asymmetry in oil price and macroeconomic variables relationship. Furthermore, some studies found short run effect of oil price on macroeconomic variables (Basnet and Upadhyaya 2015; Gbatu et al. 2017b) while others evidence long run effect of oil price on macroeconomic variables (Zhang 2008; Aziz and Dahalan 2015). With few or no studies researching on net oil exporting and net oil importing countries in Africa. Hence, this study tends to examine how changes in oil price affect GDP alongside other variables including interest rates, inflation, exchange rate, unemployment rate, food supply, external debt, current account, and foreign reserves in the context of net oil exporting and net oil importing countries in Africa. This will enable identifying the asymmetries in the adjustment process to long run equilibrium that may consist significant information utilisable by firms, academia, investors, and policy makers to strategies and reduce the exposure of macroeconomic variables to oil price shocks.

The section of this chapter is divided into ten sections. Section3.1 presents the relationship between oil price and GDP as it relates in literature. 3.2 describes the oil price-interest rate dynamics within the context of related literature. Section 3.3 describes the relationship between oil price and inflation. Section 3.4 deals with oil price-exchange rate dynamics. Section 3.5 narrates oil price- unemployment rate in the context of related literature. Section 3.6 describes fluctuations in oil price and its impact on food supply. Section 3.7 present oil price -external debt relationship in relation to literature review. Section 3.8 identifies and review literature on oil price- current account relationship. Section 3.9 describes the relationship between oil price and foreign reserves with reference to studies in literature.3.10 presents the summary of the finding on the reviewed literature.

3.1 Literature Review on the Relationship Between Oil Price and GDP

The first examination of the relationship between oil prices and economic growth started in 1980s, for example Mork, and Hall (1980) used simulated model and concluded that a change in the price oil had a significant adverse impact on the US economy in the mid-1970s. This inverse relationship between increase in oil price and aggregate economic activities in the US was also found in Hamilton (1983, 1996). Guo and Kliesen (2005) analysed oil price-output nexus in US economy and found a negative effect of oil prices on output and other macroeconomic variables including employment rate and investment. Rafiq et al. (2009) focused on Thailand and confirmed oil price increases negatively affected output and macroeconomic variables such as unemployment rate, interest rate, inflation, trade balance and investment. Ghosh et al. (2009) used structural error correction model to account for changes in the oil price and show the short and long run effect of oil price-macroeconomic relationship in US economy. They concluded that both linear and non-linear effect of oil price predicted on average 0.4% reduction in GDP growth rate in the first, second and third quarters of 2008 and a rise of 1.7% in the fourth quarter of 2008 as the prices of crude oil decline.

Du and Wei (2010) used VAR methodology with linear and non-linear specification model to analyse oil price-macroeconomic relationship in China. They used the linear and non-linear specification because some scholars including Cologni and Manera (2009) are of the view that the linear assumption may hypothetically limits economic analyses which can cause distortion of the relationship, as such, they employed linear and non-linear specification to differentiate the response of macroeconomic variables to changes in oil price. With the linear specification, they found that a 100% rise in oil price forecasted economic growth positively and validated an increase in GDP by 9%, while inflation increased by 2.1%. With non-linear model specification, they concluded that 100% rise in oil price validated negative response of GDP in Chinese economy. Applying Lee et al. (1995) asymmetric model, Du and Wei (2010) found that increase in oil price validated 1% decline in GDP. Whereas with the application of Hamilton (1996) and Mork (1989) asymmetric models, they discovered that changes in oil price caused 10% and 17% decline in GDP respectively in China. These findings show that oil price is significant factor in predicting GDP in Chinese economy. They suggested that policy that will shield GDP from oil price shocks should be pursued.

Besides evidence in the literature that changes in oil prices affect economic growth at different levels (Niaz and José 2013; Melike and Özgür 2015 Dinh 2018).

Literature evidenced long run relationship between oil prices and economic growth. This relationship is estimated using data from the US economy countries, Europe G7 economies and the Euro area. Notwithstanding that the study employed VAR model to examine the unequal cointegration between oil price and GDP Sandrine and Valérie (2008), concluded that there is a long run relationship between oil price and GDP. Another study estimated the impact of oil price shocks on GDP using vector autoregression (VAR) model, impulse response functions and Granger causality test to analyse variance. The findings indicate that oil price shocks significantly have impact on economic growth.

Focusing on low-income country, Gbatu et al. (2017b) investigated the effect of oil price shocks on Liberian economy using ARDL Bounds test. Their result reported an asymmetric relationship between oil price and output growth in the short run. However, no positive impact on GDP growth was found in the short run with decline oil price. Unlike studies in developed countries, Gbatu et al. (2017b) argued that a decrease in oil price do not explain increase in production inputs in developing countries just like in developed countries. The insightful revelation of this study is that where substitution exist, increase in oil price validates increased labour and capital intensity and this can have offsetting effect depending on their contribution to GDP. The study proposed that declining oil price should witness policy measures directed at boosting the service sector.

For cross-country analysis, Lescaroux and Mignon (2008) focused on both net oil exporters and net oil importers using Granger causality test to ascertain the asymmetric relationship between oil price and GDP, CPI, unemployment rate, household consumption and share price. They uncover existence of various relationship between oil price and macroeconomic variables especially a significant short run relationship between oil price and share price in net oil exporting and net oil importing countries. Equally discovered is that oil price does not Granger cause GDP for group of net oil exporting countries, but causality run from oil price to GDP in net oil importing countries. With the results obtained, their recommendation suggested investigating the impact of global demand and global economic growth on oil price and as well examining sectoral stock indices to analyse the current situation.

Focusing on selected OECD countries, Jiménez-Rodríguez, and Sánchez (2005) further explained that the effect of oil price is non-linear on real GDP. In other words, there is a differential effect of increase and decrease in oil price on GDP in OECD countries. Particularly, not only that oil price increase is found to have greater impact on GDP than oil price decline, but also increase in oil price has negative impact on net oil importing countries and positive effect on net oil exporting countries expect UK. They emphasised on the significance of this result is not only the consideration of direction and magnitude of oil price changes but also the context in which the oil price shocks took place. They suggested a policy response that will shield GDP of these economies from shocks from oil price.

In the investigation of oil price- macroeconomic nexus, a few studies focused on the causality issue. The significance of causality effect is not only to shield light on the economic mechanism of the relationship but also show the direction of the relationship. The implication is to ascertain if changes in oil price have direct or indirect influence on macroeconomic variables as many channels have been discovered in literature through which oil price influence macroeconomic variables (Lescaroux and Mignon 2008; Bouchaour and Al-Zeaud 2012; Oluwaseyi 2018). Jiménez-Rodríguez and Sánchez (2012) found that the oil prices did not Granger-cause key macroeconomic variables rather the changes in macroeconomic variables are induced by inflation. This finding supported the views of Hooker

(1999) who argued that oil price does not Granger-cause GDP variation using samples ranging from 1980 to 1998 in US. Focusing on net oil exporting countries in Africa, Iwayemi and Fowowe (2010) found causality running from oil price to GDP. Their result is consistent with the views of Lescaroux and Mignon (2008) who found causality running from oil price to GDP in net oil importing countries.

Although this relationship seems to be getting weaker. Hooker (2002) and Valcarcel and Wohar (2013) confirmed this for US while Blanchard and Gali (2007) confirmed it for industrialized economies. Landerretche et al. (2007) on the other hand, confirmed it for a set of developed and developing economies and Kilian (2008) put forward the same argument for G7 countries. While other studies that focused on the relationship between oil price and macroeconomics in China varies in conclusions. Excluding exports, Wei, and Guo (2016) show that the output and interest rate in China significantly respond to oil price shocks. Zhao et al. (2016) evidenced that China's output is influenced negatively by different types of oil price shocks. Tang et al. (2010) revealed that output and investment are forecasted negatively by oil price. Given the positive relationship between oil price and Chinese exports and its large surplus, Du et al. (2010) show that fluctuations in oil price and China's GDP co-move in the same direction and correlated positively, explaining that, both China's exports and oil price are strongly forecasted by the European Union and US. Furthermore, Faria et al. (2009) show that there have been negligible increases in oil price in China than in other countries.

Few studies examined African economies on the relationship between the changes in oil prices and macroeconomic variables. For example, Akinsola and Odhiambo (2020) used data range from 1990 to 2018 and performed asymmetric analysis between oil price and real GDP, labour force, inflation, and trade openness in net oil importing countries in Africa. The results show that oil price does not have significant short run impact on economic growth but has a negative and significant impact in the long run of the group countries studied. This result implies that the effect of oil price on macroeconomic variables is time varying. They recommend that policymakers should implement efficient energy policies and technological innovation policies to reduce oil price risk.

Salisu and Isah (2017) estimated oil price and macroeconomic relationship in the context of net oil exporting (Indonesia, Nigeria, Kuwait, Qatar, and Saudi Arabia) and net oil importing (Argentina, Australia, France, Germany, Japan South Korea) economies using ARDL model. Their finding established asymmetric response of stock prices to oil price. Although the response is stronger in net oil exporting countries compare to net oil importers. They argued that the separation of the samples into net oil exporting and net oil importing has implication on oil price-stock relationship and recommend extending the research to examine the sectoral response of non-energy stocks to oil price shocks, to verify whether the co-movement between oil price and stock price is not driven by energy-related stocks.

The empirical evidence from cross-sectional examination on oil price-economic growth relationship is mixed (Berument et al. 2010; Mureithi 2014). Several studies take advantage of using panel data such as Salisu and Isah (2017), Akinsola and Odhiambo (2020), Olayungbo (2021) and Lin and Bai 2021). This is to capture within group differences and allow for heterogeneity effect of the countries under study. For example, Lin and Bai (2021) used panel data and concluded that the response of macroeconomic variables to oil price uncertainty varies among net oil exporters and net oil importers. Their finding showed that the economic policy uncertainty of net oil exporters response to oil price shocks is negative and is greater than the economic policy response of that of net oil importers.

Furthermore, with panel data covering the first quarter of 1990 to fourth quarter 2010, Omojolabi and Egwaikhide (2013) examined the impact of oil price on economic performance of five net oil exporting countries in Africa including Nigeria, Algeria, Angola, Egypt, and Libya. The result showed that macroeconomic variables including real GDP, fiscal deficit, gross investment, and money supply responded to shocks in oil price. Although, they suggested that gross investment is the channel through which other variables including GDP respond to oil price shocks. The policy implication drawn from this study is that continued use of fiscal deficit and gross domestic product policy tools in net oil exporters in Africa can speed up economic development even in the presence of oil price shock. A recent study by Gbatu et al. (2017a) focused on Economic Community of West African (ECOWAS) countries and samples of net oil exporting and net oil importing countries with variables of oil price, real GDP, and exchange rate to analyse oil price-macroeconomic relationship using fixed effect model. Their result showed a significant negative effect of oil price on real GDP of full ECOWAS sample and net oil importers. They recommended implementation of diversification and monetary policies to stabilize macroeconomic variables from oil price shocks.

The reviewed studies have identified that changes in oil price have a significant impact on macroeconomic variables. However, given that there is little or no empirical analysis in the context of net oil exporting and net oil importing countries in Africa, this research will build on the existing literature such as Salius and Isah (2017) and Akinsola and Odhiambo (2020) and add to these empirical evidences using various macroeconomic variables including GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current account and foreign reserves to investigate this relationship using ARDL model in the context of net oil exporting and net oil importing countries in Africa and examine the effect of oil price on macroeconomic variables' of these group of countries.

3.2 Literature Review on the Relationship Between Oil Price and Interest Rates

A large amount of literature examines the fluctuations in oil prices in relation to macroeconomic variables (see Cologni and Manera 2008; Jumah and Pastuszyn 2007 and Mattei 2005), however limited studies have analysed the effect of oil price changes on interest rates with most of the work focused on developed economies. For example, Wu and Ni (2011) examined the impact of changes in oil price on interest rate alongside with other variables such as inflation, and money supply with monthly data ranging from 1995 to 2005. The investigation is focused on understanding how macroeconomic variables interact with external shocks with different lag length. The result show that shocks in oil price have effect on interest rate and including inflation and money supply. However, with the different lag chosen for the analysis, it shows that monetary policy is significant in determining the relationship between oil price and macroeconomic variables. The research recommended the application of effective monetary policy to reduce the effect of oil price shocks on interest rate and inflation.

Using data from 1950 to 2005 and US variables adopted as global variables, Frankel (2006) suggested that an increase in real interest rate reduces inventory demand, hence, commodity price including oil price decline. Frankel conclude with monetary implication by recommending central bank of every country to add commodity prices to the list of their variables for monitoring purposes regardless the monetary policy target. Cologni and Manera (2008) argued that the causality may run from oil price shocks to interest rates. They adopted structural cointegrated VAR model focusing on G-7 countries. The empirical analysis shows that interest rate of US, Canada, France, and Italy are significantly affected by unexpected oil price shocks. And this is due to monetary policy response to oil price shocks which relates to contractionary monetary policy response set to fight inflation. Similarly, Steidtmann (2004) found that an increase in oil prices caused a rise in interest rates during the economic recession in the 1970s. Oil prices increase was an inflation pass through, which caused an increase in interest rates as a monetary policy intervention, thus creating economic recession. However, the existing studies fail to show if the interaction between oil price and interest rate is a long run or short run interaction. As differentiating this relationship into long run and short may help policymakers, firms, investors, and household consumers to understand if the relationship is either inflexible or can be adjusted.

Few studies have examined the asymmetric issue between oil prices and interest rates. For example, Ratti and Vespignani (2015) employed global factor-augmented error correction model and found that a rise in oil price validates a significant increase in global interest rate. Furthermore, positive innovation in oil price causes a decline in the trade weighted value of US dollar rate. Their result shows that volatility and uncertainty in oil price are disadvantageous to economic growth with complications for monetary policy. The authors recommended addressing the implication of asymmetries, nonlinearity and uncertainty in future research relating to oil price-macroeconomic relationship. Consistent with this findings, Kilian, and Zhou (2019) used structural vector autoregressive (SVAR) model and forecasted how changes in oil price affect interest rate and exchange rates in US. The result evidenced not only that oil price changes affected US real interest rate, but it also showed that 58% variation in the US exchange rate is driven by global oil price shocks. These results provide direct support for theoretical models of the relationship between oil price, interest rate and exchange rates. The implication bordered on pursuing policy that hedge interest rates and exchange rates from the risks associated with oil price shocks.

The investigation in African economy on the relationship between oil prices and interest rates is limited. Abdulkareem and Abdulhakeem (2016) provided analytical insight on oil price- macroeconomic volatility behaviour in Nigeria using GARCH model and its variants (GARCH-M, EGARCH and TGARCH) with data covering 1986 to 2014. The results show that all the macroeconomic variables considered including interest rate, GDP and exchange rate are volatile to oil price fluctuations. Meaning that volatility arises from oil prices to macroeconomic variables. However, it is not clear if the effect is short run or long run, but the authors advocated support for asymmetry in analysing oil price-macroeconomic relationship in Nigeria. The authors recommended diversification of other sectors of Nigerian economy including agricultural sector and industrial sector to reduce the impact of oil price shocks on macroeconomic variables. This study will differ from previous studies by analysing the asymmetric response of interest rate with respect to changes in oil price in the context of African net oil exporting and net oil importing countries. In addition, this study will analyse both the short run and long run relationship between oil price and interest rate using panel ARDL model.

3.3 Literature Review on the Relationship Between Oil Price and Inflation

The examination of the relationship between oil prices and inflation is important because it is argued in literature that changes in oil price validates inflationary pressure and this can reduce economic growth (Cologni and Manera 2008; Mallik and Chowdhury 2011; Davari and Kamalian 2018; Zakaria et al.2021).

Hooker (2002) provided formal evidence of the asymmetric and nonlinear relationship between oil price and inflation in the US. This was aimed at differentiating the effects of oil price increase and decrease on inflation. Furthermore, it helps in determining the long run and short run effect of oil price on inflation. There was a statistical break in the estimated relationship between oil price and inflation at the end of 1980s. When he allowed the interaction to vary between the period 1962 to 1980 and 1981 to 2000, he found a significant feedback effect of oil price on inflation in the earlier period, but no significant effect in the later period. Implying that monetary policy may have help to create a regime where inflation is less sensitive to oil price in the later periods. Hence, he recommended that policymaker need to make sure that their response to changes in oil price should not replicate that of 1970s.

Trehan (2005) focused on oil price-inflation relationship in US economy and suggested that changes in oil price is statistically significant in forecasting inflation in the 1970s. He argued that after 1970s, not only that monetary response to oil price shocks offset the effects of oil price shocks on inflation but also inflation expectations contributed to why oil price shocks do not have the same impact on inflation after 1970s. The implication is that sometimes, shocks in oil price are assigned too much role in the inflation run-up in the 1970s because scholars tend to ignore the role of monetary policy and inflation expectation at that period. He recommended the inclusion of inflation expectations and monetary policy variables in analysing oil price-inflation nexus. Roeger (2005) investigated the long-term and short-term quantitative effect of changes in oil price on inflation and output in the European region. The results indicate a short run trade-off between output and inflation. A 25% increase in oil price validates 0.2% reduction in output in the first year. Suggesting that macro policy cannot smoothen the adjustment. The author recommends monetary policy that will help cushion inflationary pressure in the economy.

Castillo et al. (2010) estimated oil price -inflation relationship using perturbation method and suggested that increased oil price volatility caused an increase level of average inflation in US economy. Perturbation method is adopted because it has the advantage of making it simple to obtain strong analytical results for the relationship between oil price volatility and inflation. To respond to oil price shocks central bank raises interest rate in response to fluctuations in output, hence, inflation is affected. The implication of their finding is that monetary policy can be used to mitigate the effect of oil price shocks on inflation. Misati et al (2013) used structural vector autoregressive (SVAR) model and analyse oil price-inflation relationship in Kenya. The study found that the role of oil price shocks is significant in predicting inflation in the long run. The study recommends adoption of monetary policy and measures to reduce oil dependence.

Zhao et al. (2016) employed an open-economy dynamic stochastic general equilibrium (DSGE) model to analyse oil price-inflation dynamics in China and the rest of the world. The model is structured in a way to capture oil price shock effect on inflation in four dimensions. These dimensions include oil price supply shocks driven by political events in OPEC countries, other oil price supply shocks apart from OPEC's actions, demand shocks related to industrial commodities, and specific demand related to global crude oil market. Their findings reveal that oil supply shocks driven by political events produce short run impact on China's inflation and output. While the other three dimensions produce long term effects with shocks specific global oil demand contributing the longest run effect. This result is robust as it includes different countries and long run and short run effect. Though it did not indicate if the effect is negative or positive. However, the findings imply that oil price play a key role in determining inflation in China. Hence, they suggested implementation of policy that will enhance reduction inflationary pressure in China.

Cunado and Gracia (2005) estimated the relationship between oil price and macroeconomic variables by investigating the effect of oil price changes on inflation and economic growth rates of six Asian countries from 1975q_1 to 2002q_4. They utilized oil price and various oil CPI specifications to calculate the effect of global oil prices on inflation and economic growth on few Asian economies. They found the oil price forecasted inflation and economic growth. They applied the same model using domestic oil price in place of global oil price. They found that domestic oil price has more predictive power over inflation and economic growth more than global oil price. This explanation is attributed to exchange rate dynamics. The result of this finding is limited to short run. The Granger-causality test revealed that domestic oil price Granger-cause inflation and economic growth in South Korea, Thailand, and Japan only. The significance of oil price appears to be less in Malaysia being an oil importer. The implication is that the effect of oil price on net oil exporting countries differs from net oil importing countries.

With respect to Kenya, Kibunyi et al (2018) used ARDL model covering the 1970 t0 2016 to identify the effect of oil price on some selected macroeconomic variables. Their findings show that not only those fluctuations in oil price have positive effect on inflation but also, the effect is for the long run. Equally identified is a long run positive impact of oil price on GDP growth. The growth in GDP is defined to be a function of Kenyan's ability to import crude and re-export it to other countries including Uganda, Rwanda, and South Sudan. The problem with this finding is that it is country specific and cannot be use for generalization. The economic implication is that trading in crude oil has substantial effect on Kenya's inflation dynamics.

Barsky et al. (2002) documented that a rise in oil prices causes increase in output prices and hence validates increase in inflation. On the other hand, LeBlanc, and Chinn (2004) are of the view that increase in oil prices have negligible influence on inflation in European, US. and Japanese economies while Cunado and De Gracia (2005) focused on Asian countries and documented that the effect of oil prices on economic activities and price level is significant. Zhang and Reed (2008) argued that oil price is key factor for rise in agricultural output during the first decade of 2000. Chou and Tseng (2011) draw the same conclusion for emerging Asian economies in the long run while Chou and Lin (2013) documented same for Taiwan in the short and long-run. Ibrahim and Said (2012) examined the pass-through of oil price into consumer price inflation and evidenced a long cointegration between the oil price and inflation for Malaysia. Supporting the findings, Ibrahim and Chancharoenchai (2014) affirmed long run relation between CPI and oil prices and in Thailand. Though, with more advancement, improvement and investment in energy efficient technologies and a change towards alternative energy sources.

Kiptui (2009) employed conventional Phillips's curve and estimated the pass-through of oil price into inflation in Kenya. The finding shows that correlation between inflation and oil prices declined in the early 90's but strengthened after trade liberalization. The outcome of the analysis indicate that oil price has significant predictive power over inflation. His result equally showed that aggregate demand and changes in exchange rates significantly influenced inflation. The measure of oil price pass-through is shown to be 0.05 in the short run and 0.10 in the long run to inflation, much lesser than exchange rate pass-through which is 0.32 in the short run and 0.64 in the long run. Implying that 1% increase in oil price will cause 0.5% increase in the short run and 1% increase in inflation in the long run. Thus, oil price pass-through is low in both case. The implication is that oil price does not a strong determinant factor in influencing inflation both in the long run and short run.

Michael and David (2004) employed augmented Phillips's curve framework to analyse oil price -inflation nexus in Japan, UK, Germany, US, and France. They concluded a negligible effect of oil price increase on Japan, US, and Europe's inflation. The outcome indicated that 10% increase in oil prices cause about 0.1-0.8 % direct inflationary pressure in US. Inflation significantly responded to oil price changes more than US's inflation.

Cunado and Perezde (2003) estimated oil price-macro economy relationship and linked it to oil price effect on inflation and industrial manufacturing for different European countries for period covering 1960 to1999. The outcome of the research showed asymmetric significant effect of oil price on inflation and production growth rate However, the response of inflation to oil price shocks of the countries studied varied. Implying that the effect of oil price shocks on inflation is country specific. They recommend policy that will shield inflation from oil price shocks.

Khan and Ahmed (2011) focused on Pakistan and with application of SVAR concluded that oil price shock cause increase in inflation. Using cointegration, Ansar and Asghar (2013) support this view by evidencing positive relationship between oil prices and inflation in Pakistan. Chen (2009) estimated oil price-inflation nexus using a state space approach for 19 industrialized countries and conclude a positive relationship. While Alvarez et al. (2011) focused on Spain and Euro zone and applied Dynamic Stochastic General Equilibrium model to reach the same conclusion.

Jiménez-Rodríguez and Sánchez (2009) employed both linear VAR and three nonlinear approaches, including Mork's asymmetric model, Hamilton's net oil model and Lee's scaled model in their investigation on the effects of oil price shocks on the real economy of major industrialized OECD countries. They used quarterly data covering 1970:3 to 2003:4 with variables including the real wage, short-term and long-term interest rate, real effective exchange rate and CPI inflation. The results showed a non-linear effect of oil price on inflation and the real economy. Furthermore, the scholars showed that when the conditional variance of the shocks was controlled, the context of oil price volatility with constant price environments exhibited significant larger impacts compared to those with fluctuating price environment. This shows that price regime is important in determining oil price-inflation relationship.

Though this study used different models that focus on the effect of oil price shocks on macroeconomic performance, thus, appearing to integrate all of them, the period of sampling according to Ghosh (2009) demonstrated declined volatility of oil prices with reducing effects on output and inflation. Thus, this may not give a reflection of the current behaviour of the macroeconomic variables. The scholar moreover did not specify if the countries chosen are net exporters or net importers of oil and hence does not provide clarity in terms of the variations in behaviour of output and inflation of the net oil exporting and net oil importing economies.

There are limited studies on oil price-inflation nexus in African context and the results are mixed (Kibunyi et al.,2018; Oyelami and Omomola,2016). For example, Kibunyi et al (2018) used ARDL model covering the period from 1970 to 2016 in Kenya. They found that fluctuations in oil price have positive effect on inflation and the effect is in the long run. Furthermore, Alimi et al. (2020) adopted nonlinear autoregressive distributed lag (NARDL) model to investigate the relationship between oil and inflation in Nigeria with quarterly data covering $2009q_1$ to $2018q_4$. The result suggest that increase and decrease in oil price influence inflation negatively in the long run. In the short run increase in oil validates positive effect on inflation while decrease in oil price is insignificant in influencing inflation in Nigeria. This implies that increase is oil price is inflationary both in the short run and in the long run. The policy implication is that policy that encourages alternative sources of energy should be sourced to minimize the effect of oil price shocks on domestic price of goods and services.

In contrast, Oyelami and Omomola (2016) found an insignificant effect of oil price on inflation in Nigeria. Given the varying results found in literature concerning oil price-inflation nexus, this study asymmetrical modelled the effect of oil price changes on inflation by adopting panel ARDL model. The adoption of asymmetrical panel ARDL model do not only help to determine positive and negative effect of oil price on inflation, but also provide the short run and long run effect of this relationship in the context of net oil exporting and net oil importing countries in Africa.

3.4 Literature Review on the Relationship Between Oil Price and Exchange Rates

Scholars are of the view that changes in oil price can affect economic activities (Yildirim and Arifli 2021; Sharma et al. 2021). These changes in oil price can dramatically alter macroeconomic condition of countries by triggering exchange rate dynamics (Beckmann et al.2017). And these changes in oil price can either deteriorate or improve trade balance of oil exporters and oil importers through decline or rise in revenues to either net oil exporters or net oil importers (Yildirim and Arifli 2021). Consequently, it may put pressure on country's exchange rate and foreign exchange reserve, and this can eventually force exchange rates to either depreciate or appreciate (Beckmann et al.2020). Hence, this study adds to existing literature by asymmetrically investigating oil price-exchange rates nexus in the context of net oil exporting and net oil importing countries in Africa using panel ARDL model. The estimation of oil price-exchange rates nexus with panel ARDL model is not only to determine the short run and long run effect of this relationship, but also ascertain the positive and negative effect of oil price change on exchange rates.

Cifarelli and Paladino, 2010 showed a negative relationship between oil price and the USD exchange rate using GARCH (1,1)-M model. This finding was endorsed by Fratzscher et al. (2013) who concluded adverse effect of oil price on exchange rate in the US in the early 2000s using VAR model. However, Zebende (2011) and Reboredo et al. (2014) who used wavelet approach had a different view that, negative and weak correlation exist between oil price changes and the US exchange rates. However, the weak correlation was improved after the financial crisis, which aligns with the work documented by Reboredo (2012).

Benhmad (2012) found bidirectional causal relationship between oil price and US real exchange rates. Consistent with this outcome Throop (1993), Zhou (1995), Dibooglu (1996) and Amano and van Norden (1998a, 1998b) also evidenced causality running from oil price to exchange rates. Certainly, Amano et al. (1998a) empirically analysed the relationship between oil price and US dollar real effective exchange rate using cointegration theory and documented that oil price seemed to be the major cause of continued US dollar real exchange rate dynamics. They revealed that oil price is weakly exogenous in the case of Engle et al. (1983) while the real exchange rate is found not to be. Meaning that, the degree at which exchange rate adjusts to the oil price in the long run and not the other way round. In line with the weak exogeneity outcome, causality tests show that while oil price

Granger-cause exchange rate, there is no evidence to support the converse. Similar conclusions were drawn by Hamilton (1983), Burbidge and Harrison (1984) and Mork (1989). Amano and van Norden (1998b) evaluated domestic oil price-exchange rates nexus for US, Germany, and Japan. They clarified why oil price captured exogenous shocks from terms of trade which explained exchange rate in the long run, and why oil price is the key factor of the long run exchange rates dynamics in the countries examined.

The study by Golub (1983) and Krugman (1983) offers theoretical background as to how fluctuations in oil price predict exchange rates and these models are the foundation that support empirical results. They reveal that as oil price increases income is transferred to net oil exporting countries from net oil importing countries and this validates improvement in the current account balance of net oil exporters in their local currency. Hence, appreciation in the value of domestic currency of net oil exporting countries and depreciation in value of domestic currency of net oil importing countries following an oil price increase.

Wang and Wu (2012) evidenced non-linear bidirectional causality and significant unidirectional linear causality running from oil prices to exchange rates before and after the global financial crisis between 2007 and 2009 in China. Their outcome show that regime shifts and volatility spillover contributed to the non-linear causality behaviour of the variables. Focusing on Russia, Bouoiyour et al. (2015) documented causality running from oil price to exchange rate dynamics. Chen et al. (2016) examined the impact of oil price shocks on exchange rates for 16 OECD countries applying monthly data. While separating oil price shocks, they adopted Kilian (2009) approach and evidenced that exchange rates responded substantially different to oil price shocks depending on whether changes in oil prices were driven by demand or supply shocks. They further suggest that the ability of oil price shocks to explain exchange rates changes improves after the global financial crisis between 2007 and 2009. Nusair and Olson (2019) examine the effect of oil price shocks on currencies of Asian countries by employing quantile regression after accounting for asymmetry and structural breaks. Their finding shows that oil price shocks asymmetrically affected exchange rates, and the impact is a function of current market conditions.

Chaudhuri and Daniel (1998) employed cointegration tests and evidenced that the nonstationary characteristic of US exchange rate during post-Bretton Woods period is function of fluctuations in oil price. Chen and Chen (2007) adopted panel cointegration test to estimate the long run association between oil price and exchange rates of G-7 countries. They concluded that oil price seems to be the key driving force of exchange rate variations and that oil price have predictive power over exchange rate. Bénassy-Quéré et al. (2007) and Coudert et al. (2008) offered evidence for long run relation between oil price and exchange rates in real terms. They found causality running from oil price to exchange rate, over the period 1974 to 2004. Coudert et al. (2008) explained that a rise in oil price can validate improvement of US net foreign asset position compared to other countries and this can significantly cause appreciation of US dollar. In other vein, some scholars concluded that variation in the US dollar provide explanation for oil price fluctuations.

Sadorsky (2000) estimated the cointegrated causal relationship between energy futures price of crude oil, unleaded gasoline and heating oil and the US dollar exchange rates. The finding show that exchange rates convey exogenous shocks to energy futures prices. Thus, the movement in commodity prices may be associated with variations in the US dollar. Zhang et al. (2008) employed various econometric techniques and investigated three spillover effects, which are volatility spillover, risk spillover and mean spillover of US dollar exchange rate on oil price. They arrived at different conclusions with each spillover effect. For instance, considering the mean spillover, they suggested that the US dollar depreciation is a function of global crude oil price. Zhang and Wei (2010) adopted causality and cointegration analysis to consider the global oil market and the gold market; they documented that US dollar index seems Granger-cause variations in both gold price and crude oil price.

Thenmozhi and Srinivasan (2016) examine oil price-exchange nexus in 15 major oil importing countries and concluded insignificant relationship between oil price and exchange rates in the short-term but significant in the long-run for some countries. Prasad Bal and Narayan Rath (2015a, 2015b) documented that oil price and exchange rates in both India and China have a bidirectional nonlinear Granger causality relationship. Kisswani et al. (2019) explored the relationship between oil price and exchange rates for the Association of Southeast Asian Nations and conclude the existence of unidirectional and bidirectional Granger causality relationships in oil price - exchange rates nexus of the countries studied. Shahbaz et al. (2014) evidenced significant interaction between oil price and exchange rate in Pakistan. And they concluded that Pakistani exchange rates validates oil prices changes. Furthermore, Aloui et al. (2018) found that exchange rate of Saudi Arabia also has a close relationship with the oil price.

Huang and Guo (2007) focused on Chinese economy and applied vector autoregression model (VAR) to analyse oil price-exchange rate nexus. They concluded that, in the long run oil price validated negligeable appreciation of the CNY exchange rate. Focusing on Gulf Cooperation Council countries, Rasasi (2017) reported linear and nonlinear oil price shocks have different effects on exchange rates. Narayan et al. (2008) applied generalised autoregressive conditional heteroskedasticity model (GARCH) covering the period of 2000 to 2006 and concluded that increase in oil prices cause appreciation of the Fijian dollar. Though, for the oil exporting country such as Nigeria during the period between 2007 to 2010, fluctuations in oil price substantiated depreciation of naira (Muhammad et al. 2012).

Lawal and Aweda (2015) explored the relationship between exchange rate, oil price and inflation rate in Nigeria using ARDL model with monthly data covering 2004 to 2016. They conclude that the short run and long run effect of oil price on exchange rate negative and significant. This implies that oil price significantly accounts for exchange rate dynamics in Nigeria. The implication of this result is that policy aimed at stabilizing variations in exchange movements in Nigeria should be pursued by monetary authority.

Lizardo and Mollick, (2010) employed data covering 1970 to 2008 and evidenced that increase in oil price validated depreciation of the US dollar against the currencies of oil exporting countries including Russia, Canada, and Mexico in the long run. While the currencies of net oil importing countries net oil importers including Japan depreciated relative to US dollars. The findings suggest that significant linkage between oil price and currencies of net oil exporting and oil importing countries. The policy implication of the finding is that oil price does have a role in the information set when modelling US dollar movements through both out-of-sample and in-sample techniques.

Ghosh (2011) evidenced that increase in oil price shocks cause depreciation of Indian domestic currency using GARCH and exponential GARCH (EGARCH) model with data covering from July2 2007 to November 28, 2008. Furthermore, he found that positive and negative oil price shocks have similar effect in terms of magnitude on exchange rate volatility and that oil price shocks have long-lasting effect on exchange rate volatility. This means that there could be portfolio switching by investors from foreign assets to domestic assets as result depreciation of Indian currency. This can cause domestic stock to increase as result of increase in demand. He recommended policy that hedge exchange rates against oil price shocks.

Focusing on South Africa, Fowowe (2014) proved that increase in oil price leads to depreciation of the South Africa Rand against the US dollar using GARCH with daily data covering from January 2, 2003, to January 27, 2012. The finding shows that 105 increase in oil price validates 14% depreciation of the rand. This result is consistent with the theoretical expectations of income shift, that when oil price increases wealth is transferred from net oil importing countries to net oil exporting countries. The policy implications indicate that the use of monetary policy in controlling inflationary pressure from oil price increase can be limited. Again, investors need to pay particular attention on the relationship between oil price and exchange rate when designing portfolios.

Brahmasrene et al. (2014) evidenced significant impact of oil price on exchange rates in the long run and medium term, but insignificant in the short run in US using Granger causality test and variance decomposition impulse response function analysis with monthly data covering from January 1996 to December 2009. The findings shows that oil price play a role in determining exchange rate dynamics in US economy. Hence, information from this finding should be used by policymakers and investors to adjust their policy towards exchange rate and portfolios holdings respectively.

Aloui et al. (2013) showed that increase in oil price has correlation with depreciation of US dollar using copula-GARCH model with data covering 2000 to 2011. The implication is that taken into consideration of the co-movement between oil price and exchange rate by investors will improve the accuracy and precision of the market risk forecast. In another vein, Jammazi et al. (2015) estimated asymmetric relationship between exchange rate and oil price in US with wavelet based nonlinear ARDL model both in the short run and long run. They found that exchange rates negatively exert greater influence on oil price more than positive exchange rates. They suggested denoising exchange rate and crude oil data is effective and necessary before their interaction can be estimated. Jawadi et al. (2016) applied intraday data to indicate that appreciation of the US dollar can lead to decline in oil price. Jain and Biswal (2014) opined that decline in oil prices validated depreciation of the Indian Rupee exchange rate. In addition, Zhang et al. (2008) is of the view that US dollar exchange rates have long run significant influence on global oil market but maintain that the impact is negligible in the short run.

Tiwari et al. (2013) employed wavelet scale Granger causality and saw a different result for India. The causal relationship between variables of oil price and exchange rates varied due to different frequency scales. A similar result was evidenced in the case of Japan by Uddin et al. (2013). The strength of co-movement was evidenced to deviate over the time horizon in their estimation. In like manner, Tiwari et al. (2013) focused on Romania, and evidenced that oil price has a strong significant influence in varying frequencies for the exchange rate.

Few studies focused on the comparative analysis for group of countries. They indicated that two key factors are responsible for the varying results evidenced on oil price-exchange rates nexus in different countries. These two key factors include the exchange rate regime implemented by the country and country's status in international oil trade. Lizardo and Mollick (2010) provided oil price-exchanges rates analysis based on VECM and VAR model. They concluded that an increase in oil price could cause different effect on US dollar exchange rates, which is an appreciation for the oil importers and depreciation against net oil exporters' domestic currencies. Authors including Beckmann et al. (2016) and Živkov et al. (2019) also provide some findings in line to this finding. They suggested that in the face of oil price shocks exchange rates for net oil exporting and net oil importing countries may be affected differently by oil price shocks.

Furthermore, discussions about the role of exchange rate restrictions in the process of oil price affecting exchange rates in Norwegian economy is presented by Akram (2004). He initially argued that the interventions of the Norwegian government gave birth to close association between oil price and exchange rate. Lv et al. (2018) employed data of 17 oil-exporting countries to evidenced that the exchange rate regimes have varying effects of oil price on exchange rates.

Kisswani and Elian (2021) forecasted the symmetric and asymmetric oil price-exchange rate nexus in Canada, China, Japan, Korea, and UK. They utilized non-linear ARDL(NARDL) model with monthly data ranging from 1986:1 to 2020:5. Their findings evidenced a long run and short run asymmetric effect of oil price on Canadian dollar and Chinese renminbi while this effect is symmetric to Japanese yen, UK's pounds, and Korea's won. The implication of this result is that investors and firms need to pay attention on oil price changes while hedging against oil price effect on exchange rates. Given that investment cost and returns can be predicted by exchange rate volatility that is credited oil price changes. They recommended that central banks should design policies that will help them intervene in exchange rate market dynamics.

Baek (2021) applied nonlinear autoregressive distributed lag (NARDL) model to assess if oil price changes asymmetrically influenced exchange rates of net oil exporting OPEC members countries including Nigeria, Algeria, the United Arab

Emirate, Kuwait, Saudi Arabia, and Venezuela. With monthly dataset from 2000:1 to 2017:6, he discovered that changes in oil price have long run and short run asymmetric effect on real exchange rate of OPEC countries with floating exchange rate regime such as Nigeria and Algeria. Whereas the result provided little evidence of long run and short run asymmetric effect of changes in oil price on exchange rate of OPEC countries with fixed exchange rate regime such as Kuwait and Saudi Arabia. The author recommended a policy implication of significant short run influence of oil price to be applied on domestic currencies of these OPEC members regardless of their exchange rate regime.

Furthermore, the author is of the view that OPEC members with floating exchange rate regime should implement expansionary monetary policy aimed at reducing interest rate and depreciating their domestic currencies in the long run which may subsequently improve their trade deficit. OPEC members with fixed exchange rate regime particularly Saudi Arabia, the author recommended change in the exchange peg level to boost export earnings and current account balance in the long run. The author is of the view that policies aimed at diversifying export earnings of OPEC members via long term industrial policies should be encouraged for OPEC members to maintain their current role in oil global market.

Additionally, Baek and Choi (2021) confirmed asymmetric effect of oil price changes on Indonesian rupiah both in the short run and long run with nonlinear ARDL model application. The asymmetric response of Indonesian rupiah to changes in oil price indicate that Indonesia rupiah is more responsive to oil price increase than oil price decline. The implication of this relationship is that changes in oil price triggers exchange rates of Indonesia to experience depreciation or appreciation. With appreciation of the rupiah Indonesia economy experiences current account surplus while depreciation validates current account deficit. Since increase in oil price is beneficial to Indonesia economy via increase in export earning, Baek and Choi (2021) are of the view that Indonesia government should not adopt monetary policies that are expansionary, aimed at intentionally depreciating the domestic currency as a means of economic growth.

Nevertheless, Kisswani (2016a) adopted dynamic conditional correlation (DCC) and generalized autoregressive conditional heteroscedasticity (GARCH) models to conclude that for some countries in Asia such as Japan did not evidence long run relationship between oil price and real exchange rates despite the application of structural breaks in an ARDL model. His argument is that most exchange rate dynamics is a function of monetary policies rather than changes in oil price. In the same manner Volkov and Yuhn (2016) opined that the asymmetric effects of oil price changes on exchange rate dynamics on countries such as Canada, Russia, Brazil, Mexico, and Norway reflect changes in financial markets efficiency rather than the significancy of export earnings from crude oil within the period of study which include 1998 to 2012. Meaning that the exchange rate dynamics is related to expected inflation dynamics, and this cause the countries involved to have less efficient and effective financial and foreign exchange rate markets compared to other countries with stable inflation volatility. And since efficiency of financial and foreign exchange market is key to exchange rate dynamics, they recommended policies that could enhance foreign exchange market.

With Fractal hypothesis Jiang and Gu (2016) provide evidence of asymmetry between oil price and exchange rates. They illustrated the asymmetries in oil price using market structural shocks amid demand and supply shocks. Their results indicate that most of asymmetries in oil price is credited to oil supply shocks. Hence, they recommend that investors identify the structural shocks associated with oil price before predicting the market. Mishra and Debasish (2017) observed positive and negative asymmetries in oil price have similar effects on Indian rupee with daily dataset ranging from June 2003 to March 2016. With Generalised Autoregressive Conditional Heteroskedasticity (EGARCH) models the impact on exchange rate dynamics seemed to be long lasting. The findings of this study aimed at providing policymakers significant understanding in dealing with exchange rate volatility caused by changes in global oil price.

Theoretically, Bloomberg and Harris (1995) evidenced that exchange rates dynamics cause fluctuations in oil prices. They are of the view that since oil is a globally traded homogeneous commodity priced in US dollars, a decline in the value of the US dollar may cause a corresponding reduction in oil price for other countries whose domestic currency is not in US dollar which may bid up the price of oil in the US dollars. Hence, they concluded that US. dollar and oil prices are negatively correlate. This suggest that US dollar movement play a significant role in validating oil price change and swings in investors' sentiments. They recommend policymakers and investors to consider US dollar volatility in the policy formulation and investment decision making.

Jawadi et al. (2016) documented a negative correlation between the US dollar and oil returns, implying that an appreciation in US dollar may validate decrease in oil price. Using a sample period ranging from May 2007 to December 2016, Singh et al. (2018) investigated how linked are exchange rates of major currencies to oil prices shocks. They found that the Euro currency is significantly sensitive to oil price shocks and well as transfers significant risk to other currencies. It implies that oil price market has a significant impact on the total linkage of the crude oil-currency-implied relationship. Hence, policymakers and investors need to formulate policy and make investment decision with understanding that crude oil and currency prices are volatile. Finally, Anjum and Malik (2019) documented a comprehensive overview of the literature on the empirical and theoretical relationship between oil prices and exchange rates. They evidence that the consensus in the literature is that there is bidirectional causality between exchange rates and oil price which implies that there is substantial economic effect using one variable for forecasting the other.

Amano and Norden (1998) used Granger-causality test and error correction (ECM) model to show if there was a stable link between oil price shock and US real effective exchange rate during the post-Bretton Woods. Their findings not only suggest that fluctuations in oil price could be the main cause of continued real exchange dynamics but also suggested that fluctuations in oil price may have significant consequences for future study on exchange performance and should be incorporated into models of real business cycles.

Buetzer et al. (2016) separated net oil exporting countries and net oil importing countries in the sample of 43 economies. Their VAR analyses reported that oil exporting countries tend to experience appreciation pressure mainly from oil demand shocks, but this is offset by foreign exchange reserves accumulation.

However, set against the findings in literature, Buetzer et al. (2016) argued that net oil importing countries experience appreciation of exchange rate as well. The reason they gave is related to the theory that either oil importers peg their exchange rate, or they accumulated foreign reserves in the wake of these shocks. As such, their exchange rate is hedged against shocks in oil price. Hence, the lack of correlation between oil price shocks and exchange rates may be due to intervention measures taken in foreign exchange rate market by oil surplus economies (see Olayungbo 2019). Implying that foreign exchange reserve is a significant shock absorber of the effect of oil price shocks on exchange rate. The recommended that policy aimed at enhancing foreign exchange reserves should be pursued.

Bayat et al. (2015) employed monthly data to investigate the causal dynamics between oil price and exchange rate in Czech Republic, Poland, and Hungary. Their findings on Hungary shows that oil price does not have causal effect on exchange rate with frequency domain analysis. On Czech Republic and Poland economies, the frequency domain analysis reveals a long run effect of oil price on exchange rate. Hence, their results with respect to oil price-exchange rate relationship is country-specific. They recommend that policymakers should pursue a country-specific policy regarding oil price-exchange rate relationship.

Kin and Courage (2014) used Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model with monthly data covering 1994 to 2012 to analyse the impact of oil prices on exchange rate in South Africa. The findings showed a significant inverse relationship between oil price and nominal exchange rate. Meaning that, fluctuations in oil price has predictive power over exchange rate dynamics in South Africa. Al-Ezzee (2011) underline the role of oil price in determining exchange rate dynamics in Bahrain using Vector Error Correction (VECM) model with data covering 1980 to 2005. Increase in oil price is found to depreciate exchange rate in Bahrain in the long run within the period of study. This implies that oil price is a determinant factor of exchange rate dynamics in Bahrain in the long run. Hence, policy aimed at hedging exchange rate against oil price dynamics should be pursued.

Given that the oil price-exchange rate dynamics are inconclusive in the empirical findings, this study adopts panel ARDL model to analyse the asymmetric response of exchange rate to changes in oil price. This is to determine how the asymmetries of negative and positive changes in oil price affect exchange rate in the long run and in the short run, in net oil exporting and oil importing countries in Africa.

3.5 Literature Review on the Relationship Between Oil Price and Unemployment Rate

Regarding the relationship between oil price-unemployment rates nexus, findings from empirical analysis varies from country to country (Zhang and Liu 2020). As such the relationship between oil price and unemployment dynamics spawn great interest in the literature (Nusair 2020; Zhang and Liu 2020; Raifu et al. 2020). Many studies in the literature focused on the channel through which fluctuations in oil price affect unemployment rate (Nusair 2020; Zhang and Liu 2021). Loungani (1986) argued that the main reason for increased unemployment rates in US is the unexpected level of reallocation of work force across sectors due to increases in oil price. Similarly, Hamilton (1983) evidenced a strong correlation between oil prices and unemployment rate in US. Mory (1993) advocates an asymmetric relationship by highlighting that the negative effect of rising oil prices on unemployment rate was greater more than the positive effect of decrease in oil price on unemployment rate in US. Keane and Prasad (1996) documented that the fluctuations in oil prices validates the variations in relative wages and employment rates across different sectors.

Carruth et al. (1998) used a theoretical framework to empirically demonstrate the effect of oil price on unemployment rate in US. The efficiency wage framework used by Carruth et al. (1998) show that without any assumption with respect to labour supply elasticity, changes in the labour market can be credited to demand changes created by changes in input prices. In summarising this theoretical framework, Zhang, and Liu (2021) underline the role of oil price in determining unemployment rate dynamics by exploring if the efficiency wage model is consistent for US and China. Supporting the efficiency wage model, their finding shows that oil price and unemployment rate interact through demand, supply, and inflation channels. For US, the interaction between oil price and unemployment is mainly explained by monetary policy, geopolitical events, shale revolution and financial crisis. Whereas in China oil price-unemployment rate nexus is explained by high oil demand. The significant implication of this study is identifying factors that caused causal link between oil price and unemployment rate and formulate policies that hedge unemployment rate from oil price shocks in US and China.

Maijamaâ and Musa (2020) employed VECM technique to explore the relationship between oil price and unemployment rate in Nigeria with data covering 1991 to 2018. The result showed that oil price is negative and significant in affecting unemployment rate in the long run. While the short run effect of oil price on unemployment rate in Nigeria is insignificant. This means that changes in oil price only account for unemployment rate dynamics in the long run in Nigeria. The policy implication is that policymakers should encourage policy strategized in providing reduction in unemployment rate in the long run due to oil price shocks.

Ordóñez et al. (2019) are of the view that although the effect of declining oil price is weaker compared to increasing oil price in Spain. A decreasing oil price has a positive predictive power over unemployment rates and an increasing oil price forecast unemployment rate negatively. The study highlights the need for designing policy measures aimed at reducing unemployment rate given oil price increase. Cuestas and Ordonez (2018) evidenced that before the financial crisis between 2007 and 2009, positive oil price shocks significantly and negatively affected unemployment rates, while negative oil price shocks kept UK unemployment rate at low levels since the financial crisis.

Cuestas and Gil-Alana (2018) indicated a mixed outcomes for the short run effect, whereas a rising or falling oil price increase or decreases the equilibrium unemployment rates in Eastern and Central Europe. Karlsson et al. (2018) documented evidence that under a time horizon of roughly two years, increase or decrease in oil price reduces or increase unemployment rate in Norway. Karaki (2018) focused on US and revealed that positive oil demand shocks reduce unemployment rate while a negative oil supply shocks validates an increase in unemployment rate in most US.

The findings of Caporale and Gil-Alana (2002), Gil-Alana and Henry (2003) and Gil-Alana (2003) put forward that oil prices and unemployment are slightly cointegrated for Australia, Canada, and UK. Ewing and Thompson (2007) conclude negative interaction between crude oil price and unemployment rates in US. Likewise, Lescaroux and Mignon (2008) proved significant impact of oil prices on unemployment rate in the US. The estimation of Andreopoulos (2009) pointed out the forecasting ability of oil prices on unemployment rate to only exists in recessions. Herrera and Karaki (2015) documented that the effect of oil price shocks on employment in the US exist in manufacturing sector. This occurs mainly through channels of income transfer and reduced potential output. Karlsson et al. (2018) found unemployment rate to negatively responded to oil price shocks in Norway. They argued that the relationship may probably be due to Norway is an oil exporting country. Adopting nonlinear autoregressive distributed lag (NARDL) model, on the contrary to earlier study, Kisswani and Kisswani (2019) evidence a significant impact of negative oil price shocks on unemployment rate rather than positive oil price shocks in the US. In Greece, Papapetrou (2001) concluded negative relationship between oil price shocks and unemployment rate. In like manner, Doğrul and Soytas (2010) confirm significant causality running from oil prices to unemployment rate in Turkey.

Cuestas (2016) opined that in Spain, oil price affects the equilibrium unemployment rate, and compared with a declining oil price an increasing oil price has an adverse and significant effect on the equilibrium unemployment rate. Katircioglu et al. (2015) show that unemployment rate, consumer prices and GDP are forecasted by the oil price in OECD countries. Andreopoulos (2014) employed Markov switching models to revealed that the COP can help predict the UR during recessions. Mitchieka and Gearhart (2019) indicate that oil price affects trade and mining employment in the long run and short run, whereas employment in service industry is not affected. Karaki (2018) indicates that oil price shocks cause job reallocation in the US. Herrera et al. (2017) revealed that jobs were reallocated away from the gas and oil industry to the manufacturing industries, service industry and construction, following a decrease in oil price. Herrera and Karaki (2015) documented those positive oil price shocks cause a rise in job assignment and decline in US manufacturing industry employment.

Raifu et al. (2020) evidenced the asymmetries in oil price- unemployment rate relationship in Nigeria using linear and nonlinear ARDL model with quarterly dataset ranging from $1979q_1$ to $2018q_1$. The application of linear and nonlinear ARDL model help in evidencing the effect of positive and negative oil price shocks on unemployment rate. The result from linear ARDL model showed insignificant relationship between oil price and unemployment rate. Similar result is obtained with short run nonlinear ARDL analysis when oil price dynamics is separated into increase and decrease effect. Whereas in the long run the result show that increase in oil price has adverse effect on unemployment rate in Nigeria while decrease in oil price is insignificant in forecasting unemployment rate in Nigeria.

The implication is that increase in oil price has stronger effect on unemployment rate in Nigeria, hence, the authors recommend the need for government to invest oil revenues in alternative sources of energy with the objective to reduce firm's production cost.

Kocaarslan et al. (2020) investigated the presence of asymmetries in relation to the interaction between oil price, oil price uncertainty, unemployment rate and interest rate in US using nonlinear auto-regressive distributed lag (NARDL) model. The result suggests that an increase in oil price substantiated increase in unemployment rate while decrease in oil price is insignificant in forecasting unemployment rate. The authors found that measure of oil price uncertainty is stronger in predicting unemployment rate more than conditional volatility of crude oil prices. Given the uncertainty associated with oil price, the authors offered significant recommendation to policymakers to construct sound economic policies that can reduce the vulnerability unemployment rate to oil price shocks.

Nusair (2020) focused on Canada and US to analyse oil price-unemployment nexus using nonlinear ARDL (NARDL) model. The result confirmed that only decrease in oil price have a significant short run effect in unemployment rate. Whereas both decrease and increase in oil price have significant positive long effect on unemployment rate. This shows that increase in oil price cause increased unemployment rate while decrease in oil price reduces unemployment rate in Canada. While in the sample of US evidence of asymmetry exist both in the long run and short run with decrease in oil price having a greater impact on unemployment rate more than increase in oil price. The study suggested that oil price is very influential in determining unemployment rate both in Canada and US, hence, government of these countries should seek policies that will reduce dependence on oil by diversifying energy resources into renewable energy power plants.

There are very few literatures on the relationship between oil prices and unemployment in developing countries. Umar and Abdulhakim (2010) explored Nigeria economy with VAR model and forecasted the significant effect of oil price on unemployment rate, money supply and GDP. They found insignificant effect of oil price on price index. The authors concluded that given the volatility of macroeconomic variables to external shocks, the macroeconomic performance is subject to oil price volatility, thus, making it difficult to manage macroeconomic variables. The authors fail to show not only if the effect is positive or negative but also whether the effect of the oil price volatility on macroeconomic variables is in the short run or in the long run. However, the authors recommended that diversification of the economy is necessary to minimize the consequences of external shocks. This study will extend to the most recent oil price movements that occurred during and after the financial crisis between 2007 to 2009 and provide new evidence on oil price unemployment relationship in the context of net oil importing and exporting countries in Africa using panel ARDL model. The adoption of panel ARDL model is to evidence the asymmetries associated with oil price-unemployment rate relationship by separating changes in oil price into positive and negative short run and long run effects.

3.6 Literature Review on the Relationship Between Oil Price and Food Supply

Oil price shocks affects energy intensive farming because prices paid by farmers for oil products or direct energy reflect the domestic oil price markets (Esmaeili and Shokoohi 2011). Furthermore, agricultural producers buy oil indirectly for their agricultural inputs, for example, nitrogen fertilizers, electricity, and fuel costs for field operations, drying and irrigation (Srinivasan 2009). With fertilizer costs, these costs amount to a substantial proportion of the cost incurred in production of many crops (Esmaeili and Shokoohi 2011). Thus, increase in food prices are reflection of global oil price and these stimulated economic research on the relationship between oil price and food price (Musser et al., 2006).

Additionally, changes in food prices are significant for the welfare of both developed and developing countries (see Neftci and Lu 2008; Frankel 2008; Daude et al. 2010). This significance has spawned a considerable academic literature with the focus on food price response to fluctuations in oil price. Seminal empirical work by Al-Maadid et al. (2017) show that oil price significantly forecasted food price especially during financial crisis period between 2007 and 2009. An extensive literature including Roman et al. (2020) and Widarjono et al. (2020) found a close relationship between oil prices and agricultural commodity prices. Ibrahim (2015) employed nonlinear autoregressive distributed lag (NARDL) to model the asymmetries in oil price and food price in Malaysia. He evidenced a long run significant influence of increase in oil price on food price and insignificant effect of decrease in oil price on food price. The absence of insignificant influence of decrease in oil price on food price shows that demand and supply forces is influential in shaping Malaysia's food price. Hence, the author recommends policies that will contain the effect of supply and demand in the food supply chain. And such policies include anti-competition act and profiteering regulation policy to hedge against food price volatility in Malaysia. In contrast, Reboredo (2012) used weekly data ranging from January 1998 to April 2011 to analyse the relationship between oil price and prices of grain and wheat in China. The agricultural prices are expressed in US dollar per ton. The empirical result suggested that oil price spike had no causal effect on changes in agricultural price rather the monetary policy associated with exchange rate dynamics. Implying that spikes in agricultural prices is not directly a function of oil price change but exchange rate dynamics. Hence, policy designed to mitigate risk management and hedging strategies is suggested by the author. This view was supported by Nazlioglu and Soytas (2011) and Lambert and Milijkovic (2010).

Nazlioglu and Soytas (2011) documented that individual agricultural price are react naturally to oil price changes in Turkey. They used monthly data covering from January 1994 to March 2010 with oil price and lira dollar exchange rate in their analysis. The reaction of agricultural price to oil price is attributed to the use of explicit inflation targeting and a balancing policy in the exchange rate. The implication is that monetary policy plays a significant role in determining oil price-agricultural price relationship in Turkey. Hence, the policy implication is that balancing real agricultural price dynamics may require an appropriate policy response.

With global computable general equilibrium model, Gohin and Chantret (2010) examined the long run relationship between global oil price and global food prices with the inclusion of macroeconomic linkages. A positive relationship was found between global oil price and global food price due to the cost-push effect. Meaning that the omission of these macroeconomic linkages has substantial bearing on the relationship between oil price and food price. The policy implication is that the consequences of macroeconomic linkages must be properly considered in determining oil price-food price relationship. Adopting time series prices on fuels and agricultural commodities, Zhang et al. (2010) investigated the long-run co-integration relationship between oil price and agricultural commodity prices. They documented no direct long run relationships between oil price and agricultural commodity prices. Their argument is that competitive markets efficiently respond to price signals. Meaning that agricultural prices is a function of both crop yield and demand and supply response to shift in relative agricultural products. They suggested an agricultural commodity buffer policies designed to blunt price spikes caused by demand and supply.

Furthermore, Chen et al. (2010) estimated the relationship between global oil price and the global grain prices of soybean, wheat, and corn. The empirical outcome indicates that changes in global oil price significantly predicted the variations in each grain price during the period covering from the 3rd week in 2005 to the 20th week in 2008. This implies that price of grain commodities is competing with the resulting demand from biofuels. Given that corn and soybean are used to produce biodiesel or ethanol during the period of increased crude oil price, as orthodox agricultural production systems in developed countries depend hugely on fossil energy (Cruse et al. 2010). This evidenced volatility spillover among oil price, wheat, and corn markets. This could be essentially explained by increased linkage between oil price and corn and wheat markets stimulated by ethanol production. The authors suggested that governments should pursue policy that will consider dropping subsidy that gave rise to increased bio-fuel industries which may have contributed to increase in food price.

Abdel and Arshad (2008) confirmed the existence of long run causality running from petroleum to prices of palm rapeseed, sunflower and soyabean using Engle-Granger two-stage estimation method with monthly data covering from January 1983 to March 2008. This implies that oil price is a factor growing in significance in vegetable oil production as the demand for biodiesel has increased. They suggested incorporating oil price in determining the structural behaviour of vegetable oil. The authors suggested that government should pursue policy that will shield vegetable oil from oil price shocks.

Obadi and Korček (2014) used VECM to analyse the Granger-causality between oil price and food price in Malaysia using monthly data covering from January 1975 to September 2013. The result confirmed the existence of long run and short run relationship between oil price and food price. Causality run from oil price to food price in the long run while the short run causality shows bidirectional causality between the variable of food price and oil price. They suggest that policymakers should account for this relationship in formulating policies relating to oil price and food price in Malaysia.

Adopting time series econometric technique, Gogoi (2014) examined the long run relationship between oil price and global food commodity prices such as rice, wheat, maize, and soybean for the period covering from 1980 to 2011. The outcome of co-integration estimation showed the existence of long run relationship between oil prices and the prices of soybean, wheat, and maize, except for rice prices. His Granger causality test further confirm unidirectional causality with only oil prices Granger causing each of the four food commodity prices. This implies that oil price is a significant factor in determining the food prices. Policymakers should consider policy that will shield food price from oil price shocks.

Using scenario analysis, Tokgoz (2009) evidenced that the effect of oil price on the European Union agricultural sector is rising with the development of the bio-fuels sector This shows the significance of trade policy in reacting to increase oil price and grain prices. They suggested that policy that consider the linkage between oil price and agriculture should be considered to hedge the vulnerability of agricultural products from oil price shocks.

Sujithan et al. (2014) adopted Bayesian multivariate framework to investigate the impact of oil price on the volatility of global prices of coffee, wheat cocoa and sugar with monthly data covering from January 2001 to March 2013. The result from the impulse response reveals that oil price shocks cause increase in the prices of coffee, wheat, cocoa, and sugar within 2 to 3 months, and then followed by a downward peak after 4 months. Furthermore, the result revealed a negative effect on soybeans and sugar while a positive effect is recorded with coffee, corn, wheat, and cocoa prices. This implies that oil price plays a key role in determining the price of food commodities. Policy aimed at minimizing the vulnerability of food prices should be considered.

Alvalos (2013) examined if oil price Granger cause soybean and corn prices employing a VAR model with monthly data covering from January 1986 to April 2006. His result revealed that oil price shocks do not have predictive causality power over corn and soybeans prices in US. However, the result from the VAR model indicates significant negative influence of oil prices on soyabean and corn both in the short run and long run. The implication of the result is that oil price is significant in determining the price of soybean and corn both in the short run and long run. Hence, policy that will minimize the vulnerability of food price to oil price shock should be considered in US.

Arshad and Abdel Hameed (2009) analysed the relationship between oil price and cereal prices in US using monthly data covering from January 1980 to March 2008.Engle–Granger two-stage bivariate co-integration estimation procedures was adopted, and the result revealed unidirectional long-run causality running from oil price to cereal prices. They relate this effect to cost factors which include growing dependency of modern agriculture on seed fertilizer and technology that is highly relied on chemical inputs derived from oil. They equally pointed out that biofuel production is another factor to the oil price-food price nexus.

Gilbert and Morgan (2010) estimated oil price-food nexus with the intention to find out if global oil price affect food prices over time. Employing generalised autoregressive conditional heteroscedasticity (GARCH) model with monthly dataset from 1970 to 2009 also monthly dataset covering 1990 to 2009 for comparison purposes. The result indicated that influence of oil price on food price increased over the most recent years. Equally noted by the scholars is that there is a record of high volatility periods in the recent and the past episode. Thus, there is probability that volatility levels may drop back to historical levels. This is consistent with the findings of Huchet-Bourdon (2011). Although, they stated that some factors could lead to future rise in food price such as increased volatility in oil price and global warming. This means that with rise in these factors, there could be chance of increased food price in the future. Therefore, in formulating policies to hedge food price from oil price shocks, these factors should be considered.

Fondazione (2013) employed DCC-MGARCH models with daily food prices covering 12-year sample from 2000 to 2011 to analysed co-movement between oil price and in food commodities price. His empirical analysis revealed that increased volatility in grains exist during period covering from 2008 to 2009 spike was significant due to shocks transferred from oil price to grains prices, particularly wheat, soybean, and corn prices. However, oil price contributed relatively less at other periods. Implying that the effect of oil price on food price is based on time horizon. The authors were of the view that time horizon should be accounted for in formulating policy on oil price-food nexus.

Al-Maadid et al. (2017) employed bivariate VAR_GARCH (1,1) model with daily data covering 2003:01 to 2006:01 and 2015:06 to examine the relationships and between fluctuations in oil price and food price and the spillover effect in the context of different events in oil price fluctuations. Their result showed a significant relationship between oil price and food with the financial crisis event between 2007 to 2009 having more significant effect on food. This study fails to indicate if the effect is negative or positive and if it a long run or short run effect. However, the study shows the impact was very significant during financial crisis, but an explanation is not provided for why this event is exhibit great significance more than the other events. However, they suggested policymakers should adjust subsidies for energy crops and develop high yield technologies to improve and support agricultural prices.

Ibrahim (2015) estimated the relationship between oil price and food for Malaysia using a nonlinear autoregressive distributed lag (NARDL) model. The asymmetries in the relationship evidenced that increase in oil price significantly affect food price in the long run. While decline in oil price insignificantly affect food price in the long run. The absence of significant relationship between decline in oil price and food price both in the short run and long run is attributed to the role of forces of the market in shaping the behaviour of Malaysia's food price. The analysis is limited as it is country specific. The implication is that oil price is significant in determining food price in Malaysia. The author suggested policy that will contain market power that will cover all suppliers in the food supply chain.

Cabrera and Schulz (2016) used GARCH model to examine price and volatility risk that stem from the relationship between oil price and agricultural commodity prices in Germany. Weekly data covering 20:030:523 to 20:120:424 which amounted to 467 observations is used for the analysis. Their results showed that the prices are positively correlated in a long run equilibrium relationship in a continuous market shock. The result fail to show which of the variables of oil price and food price is significant in predicting the variation. Also, the analysis is country-specific which according to Gómez-Loscos et al. (2012) different results may be obtain using other countries. The implication is that oil price plays a key role in determining food price in Germany in the long run. The authors proposed the strategy of considering the time varying nature of the long run covariance matrix to improve hedging agricultural commodities against oil price shocks.

On the econometric analysis regarding the effects of biofuel and oil price on food prices scholars including Urbanchuk (2007), Imai et al. (2008) and Kind et al. (2009) have estimated the relationship. Urbanchuk (2007) concluded that increasing oil price has double impact on food prices as measured by the Consumer Price Index (CPI) than the price of corn and ethanol production. Kind et al. (2009) also have same correspondingly found. They discovered that the increased use of corn for ethanol accounted for about 10 to 15% rise in food prices between April 2007 to April 2008. However, Baek and Koo (2009) argued that the method of the analysis on the examination of increasing foods prices are based on graphical methods and descriptive statistics and very few studies applied econometric technique in examining factors responsible fast-rising food prices in US Baek and Koo (2009) used ARDL model to estimate the impact of market factors on US food prices. They documented that agricultural commodity prices play a significant role in determining the long run and short run movements of US food prices and found that oil prices and exchange rate are significant factors in predicting US food prices in recent years both in the long run and short run. They further suggest that the linkage between oil price and agricultural commodity food markets is strong due to crop-based biofuel production and Energy Security Act of 2005 and the Energy Independence of Security Act 2007. The authors suggested the review of continuous production of biofuel under the above-mentioned legislations to enable reduction of agricultural commodity and food prices in US.

Trujillo-Barrera et al. (2011) analysed volatility spillovers in the US from oil price to agricultural markets covering the period from 2006 to 2011. They concluded significant spill-overs effect from oil price to ethanol and corn markets. The effect seems to be significantly evidenced in high volatility periods for oil price markets. Equally identified by them is significant volatility spillovers from corn to ethanol markets. From a policy perspective, the report from 2011 G20 Study Group on commodities identified two channels linking oil price and food prices. These channels include the growing energy intensity of food production. Implying that energy is a primary input and a cost component in food production and distribution (Avalos 2014). The next channel is biofuel production, which substantially contributes to the increase demand for specific commodities (Arshad and Abdel Hameed 2009). Hence, policy that account for this relationship should be considered.

With structural VAR model, Wang et al. (2014) examined the effect of changes in oil price on agricultural commodity markets. Data from period covering January 1980 to December 2012 with variables of oil price and agricultural commodities deflated with consumer price index (CPI) of US are used for the analysis. The key findings showed that the agricultural commodity prices responses to changes in oil price is a function of oil demand shocks or supply shocks. The analysis did not reveal if the relationship is a long run or short run and as well if the impact is negative or positive. The implication is that oil price plays a key role in determining changes in food price US. Hence, policymakers should unravel if high agricultural commodity prices are driven by global economic activity or other oil market-specific factor.

Huchet-Bourdon (2011) statistically estimated the historical food commodity price volatility over the last half century using extended range of agricultural commodities such as maize butter, soyabean, oil, beef, rice, sugar, whole milk oil and wheat. He also estimated the relationship between oil price and each of the mentioned agricultural commodities and fertilizer price employing Spearman's correlation coefficient with monthly data. The result show that causal effect exists between oil price and fertilizer price and between oil price and each agricultural commodity price. His finding reveals that there may not be tendency of commodities price volatility increase over the past 50 years for each of the agricultural product price. However, in general, price volatility in the period covering from 2006 to 2010 recorded higher increase than that in the 1990s, however, not higher than that in the 1970s. Implying that oil price is not very significant in determining food commodities price in the future. The author suggested policymakers pursuing policy that will minimize agricultural price volatility by looking at the linkage between oil price and biofuel production and fertilizer prices.

Few studies examined the relationship between oil prices and food price in developing countries. For example, Minot (2011) estimated food price volatility in Africa with the aim of verifying the oil price-food price nexus in Africa. Adopting F-statistics, he estimated the changes in food price volatility using structural breaks of period covering between 1980 to 2006 and 2007 to 2010. His analysis showed that food price volatility in the global market has risen in the past five years, however, relatively low. The result revealed that in a group of 11 African countries, food price shock is high and has not risen in recent years. Implying that oil price is not a determining factor in food price volatility in African countries.

Nwoko et al. (2016) focused on Nigeria economy using Generalized Autoregressive Conditional Heteroskedasticity (GARCH (1, 1)) and VAR models to model long run and short run oil price- food price nexus. They found a significant positive short run relationship between oil price and food price. The study recommended improved market information, trade policies and investment in research and development as an intervention and strategy to hedge food price from oil price volatility. Equally recommended by the study is a policy that will enhance subsidising of refined crude oil price, alternative sources of energy and less dependence on oil for fertilizer production.

Oluwaseyi (2018) applied GARCH (1,1)-TY to model the influence of oil price on aggregate price of food (APF) and urban average price of food (APFR) during the pre-crisis and post-crisis periods in Nigeria. He concluded that both aggregate price of food (APF) and urban average price of food (APFR) responded positively to oil price shocks with urban average price of food (APFR) responding more to il price shocks in the post-crisis periods and full sample period. The study recommended that government should formulate policies that hedge food price from oil price shocks. This study complements these studies by empirically modelling how changes in oil price affect food supply alongside other variables including GDP, interest, inflation, exchange rate, unemployment rate, external debt, current account, and foreign reserves in the context of net oil exporting and importing countries in Africa using panel ARDL model. The adoption of panel ARDL model is to account for the asymmetries associated with oil price by separating changes in oil price into positive and negative long run and short run effects.

3.7 Literature Review on the Relationship Between Oil Price and External Debt

In African countries, the study on the effect of oil price changes on external debt is not as well explored as the evidence found in developed countries. The mismanagement of public funds through corrupt practices and inadequate public investment processes has caused the windfall generated from excess crude oil to be mismanaged with consequences on economic growth (Didia and Ayokunke 2020). Studies, including Chimezie et al. (2020), Al-Tamimi and Jaradat (2019), Senadza et al. (2017) and Udeh et al. (2016) argue that external debts are destructive to economic growth, especially when it has adverse terms of trade effect. Ajayi and Oke (2012) argued that external debt not only cause bad management but also validates exchange rate devaluation, creating cost for debt service obligations, budget deficit, money supply effect and inflation. Studies confirmed that countries that depend mainly on oil export for foreign earnings seem to suffer from remarkably high level of corruption, authoritarian government, poverty, government ineffectiveness and geopolitical instability (Kretzmann and Nooruddin 2005), despite the huge revenues generated from oil.

However, external debt can be useful in stimulating economic growth, particularly when it is carefully used and managed within the corridors of crucial economic activities (see Didia and Ayokunke 2020; Sohn 1987). For example, Didia and Ayokunke (2020) used vector Error Correction (VECM) model with dataset covering 1980 to 2016 to analyse the effect of external debt and domestic debt in Nigeria. They found that domestic debt has a positive feedback effect on economic growth while external debt has a negative feedback effect on economic growth. The implication of the finding is that as price of oil increase, Nigeria spends more money, hence, Nigeria will increase external borrowing with hope to get more revenue from oil price increase. The increase in external borrowing may increase debt overhanging, increase in interest rate and debt servicing causing reduction in current account, foreign reserves and ultimately decline in economic growth. On the other the positive significant relationship between domestic debt and economic growth is a function of the loan and interest paid remained in the country. The authors recommended that Nigerian government should provide policies that will enhance investment of external debt into infrastructures that are of economic yielding value that will enhance the servicing and payment of the loan and interest associated with the loan on time.

Kretzmann and Nooruddin (2005) showed how the first OPEC oil shock of 1973 to 1974 affected global economic growth negatively. They opined that increase in oil prices at the end of 1973 to early 1974 was considered a double-edged sword as countries with enough oil reserves were expected to benefit significantly by the increase in export revenues while countries that do not have oil reserves and net oil importing countries were burdened with unbearably large energy bills and external debt. On the other hand, William (1984) argued that increase in oil prices from 1973 to 1974 caused serious economic harm to net oil importing countries as it is most significant exogenous cause of the debt burden of developing net importing countries and even that of 1979 to 1980s. William (1984) further projected that net oil importing developing countries lost $141 billion in high interest payments, high import costs and low export receipts. All these resulted from 1973 to 1974 oil shocks. Focusing on Latin America, Robert (1985) analysed oil price and external debt cycle. He argued that due to increase in oil price, external revenues of net oil exporters increased causing their foreign reserves to increase. Due to increase in foreign reserves of net oil exporters international banks such as IMF and World Bank had more money on hand to lend to developing countries who are willing to borrow. Another thing that encouraged international banks to lend money specially to developing net oil exporting countries is their potential creditworthiness especially the net oil exporters. These are the common factors that explain the increase in external loans in both net oil importing and net oil exporting countries (see Kretzmann and Nooruddin 2005). In line with this finding, Cline (1984) argued that an increase in oil price validates the increase in Mexico's external debt as Mexico borrowed heavily to develop oil production in 1970s.

Net oil exporting countries who had a windfall from oil price increases did not escape debt crisis as Dutch disease hypothesis set in (Olomola and Adejumo 2006; Abeysnghe (2001). Net oil exporting countries especially African countries directed their revenues to increase the imports of manufactured goods. The rise in oil prices, however, validated the simultaneous increase in the price of manufactured imported goods from the developed countries. Thus, the import bills of manufactured goods for developing countries also increased swiftly (Dizaji 2014), leading to an increase in external debt.

Kretzmann and Nooruddin (2005) examined debt burdens with data covering 1970 to 2000 and found that an increase in oil price caused economic volatility in net oil exporting countries such as Nigeria, Ecuador and Congo-Brezzaville. This validates macroeconomic shocks that undermines government revenues. The explanation for the macroeconomic shock is related to the nature and magnitude of government spending. Government that spends more are likely to incur debts to cover their budget. Furthermore, not only those countries that depend mainly on crude oil for energy need are more likely to be affected by oil price shock but also developing countries that their economy is exposed to the flukes of international trade might be expected to have an increased debt burdens given an increased volatility of income and probably trade deficits (Cline 1984; Didia and Ayokunke 2020). Udeh et al. (2016) used Ordinary Least Square and diagnostic tests to suggest that external debt has long run negative effect on economic development in net oil exporting country such as Nigeria. There are few studies researching oil price and external debt nexus in net oil exporting and net oil importing countries in Africa. As such this study in complementing previous studies, focuses on net oil exporting and net importing countries in Africa to analyse the impact of oil price shocks on external debt alongside other macroeconomic variables such as GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, current account, and foreign reserves using panel ARDL model. Panel ARDL model is adopted in this study to analyse the asymmetries associated with oil price and external debt relationship both in the long run and in the short run. The finding will help policymakers and formulate long run and short run policies that will shield external debt from oil price shocks. Equally, from the finding investors will be able to make short run and long run investment decisions.

3.8 Literature Review on the Relationship Between Oil Price and Current Accounts Balance

Previous studies provide insights on current account dynamics using the Dutch disease hypothesis (see Chen and Rogoff 2003; Cashin et al., 2004). Chen and Rogoff (2003) focused on OECD countries including Australia, New Zealand, and Canada where their main commodities (oil) represent a substantial share of their exports. The results showed that the US. dollar price of New Zealand and Australia commodity (oil) exports are significant and stable in influencing their floating real exchange rate thereby affecting their current account balance. Although, after controlling for commodity (oil) price shocks, the purchasing power parity remind a puzzle in the residual. This result is relevant to developing oil exporting countries given that their capital market is liberalized towards floating exchange rates. The authors are of the view that understanding the responses of exchange rate towards changes in commodity (oil) and towards current account dynamics can provide significant information for diverse range of policy issues including inflation control and the conduct of monetary policy.

Turan et al. (2020) used ARDL model to examine the relationship between oil price and current account balance in Poland, Czechia, and Hungary with quarterly data covering 1996q_1 to 2018q_1 for Hungary, data from 2004q_1 to 2017q_2 for Poland and data from 1995q_1 to 2017q_4 for Czechia. The result show that changes in oil price has significant effect on the current account balance in Poland and Czechia. Equally reported is a causal relationship running from oil price to current account balances in all countries in the sample in the short run. The authors emphasized the significance of incorporating long and short run effect in the analysis. They recommended that policies that will encourage alternative and renewable energy sources, domestic savings and policies that will weaken negative link between oil price and current account balance, especially in Poland.

Longe et al. (2018) analysed oil price-current accounts nexus in Nigeria using ARDL model with annual data covering from 1977 to 2015. The result reviewed that the long run effect of oil price changes on current account negatively and significantly while the short run effect is positive and insignificant. Implying that as oil price changes increases current accounts in the short run, it decreases in the long run. The policy implication is that policymakers should consider the long run and short run effect of oil price on current accounts in Nigeria while formulating policy that will shield current accounts from oil price shocks in Nigeria.

Qurat-ul-Ain and Tufail (2013) used Vector Autoregression (VAR) model to evidence the effect of oil price on current account balance and exchange rate on D-8 countries including Nigeria, Iran, Egypt, Pakistan, Turkey, Bangladesh, Malaysia, Indonesia with annual data covering 1981 to 2011. The result showed that increase in oil price improve the current account balance of all net oil importing countries which is Pakistan, Turkey, and Bangladesh in the short run and deteriorates in the long run expect Bangladesh. This causes depreciation of exchange rate for Pakistan, Indonesia, and Turkey while exchange rate appreciates in Bangladesh in the short run. Whereas all oil exporting countries experience deterioration of current account in response to oil price shock both in the long run and short expect Malaysia whose current account increases in the long run. The recommendations drawn from this study include diversification of export base from oil to non-oil export to reduce their dependency on oil especially the oil exporting countries. Also, it recommended that oil importing countries to develop alternative energy resource to lower its reliance oil resources.

Le and Chang (2013) examined if the variability of trade balances and their oil and non-oil components is correlated with fluctuations in oil price in net oil exporting and net oil importing countries of Asia using Toda and Yamamoto approach. The findings revealed a positive feedback effect from oil price to trade balances of oil and non-oil components in Malaysia. While the result in Singapore showed that trade balances of oil and non-oil components responded negatively to changes in oil price both in the short run and the long run. In Japan, the trade balance of oil component responded negatively to changes in oil price while the trade balance of non-oil component responded positively to fluctuations in oil price but cancelled within 4 months as result of continued increase in oil price. The implication of this finding that trade is a significant channel through which oil price shocks affect macroeconomic variables and hence, should not be ignored by both policy makers and in economic modelling. And in modelling this, it significant to distinguished between net oil exporting from net oil importing countries and the causes of the shocks, whether driven by supply shocks or demand shocks.

Hou et al (2015) conducted a cross country analysis in the context of net oil exporting and net oil importing countries in the sub-Saharan Africa over the period between 2008 and 2015. The result indicates that following 2014 – 2015 oil price decreases, the African oil exporters experienced the reduction in export revenues by $63 billion. Particularly, Nigerian exports fell by 14% in half quarter of 2014 deteriorating the current account that cause government expenditure to drop by 8%. the study showed that Tanzania imports of oil reduced by 20% in the first quarter of 2015 validating an improvement in the current account. Thus, an increase of about 1-2% point in real disposable as income is transferred from net oil exporting to net oil importing countries in form of less import payment. However, the criticism about this study is that it is not empirically analysed.

Gnimassoun et al. (2017) employed time-varying parameter vector autoregressive (TVP-VAR) model with sign restriction to analyse the relationship between oil prices and current account in Canada, a net oil exporting country. Using oil demand and supply shocks framework, the result showed that oil supply shock has a statistically insignificant effect on current account. While oil demand shock is found to have a positive long run significant effect on current account balance. The significant effect of oil demand shock on current account is found to be a function of propensity to spend oil revenue on imports. Implying that spending oil revenues on imports have a significant negative effect on current account balance. Hence, the authors recommended providing policies that will encourage increasing the degree of domestic financial market development and management of foreign exchange reserves.

Existing literature suggests that the fluctuations in oil prices can trigger a current account imbalance both in net oil exporting and net oil importing countries. Besides, the imbalance follows a trend that reflect the cause of the fluctuations in oil price. This shows that the pass-through of fluctuations in oil price to the current account is keyed into supply and demand factors (see Stefanski, 2014; Jibril et al.2020). The pass-through is incomplete without additional adjustment structures to lessen the impact of the oil price shocks on the current account balance (see Kilian et al.2009; Gnimassoun et al.2017). According to Gnimassoun et al. (2017) the adjustment process depends on internal and external factors. For the external factors, the source and strength of fluctuations in oil price are the most significant factors to consider with respect to oil price-current account dynamics given that not all oil price shocks are alike (see Rebucci and Spatafora 2006; Gnimassoun et al. 2017). The internal factor includes the tendency to spend the extra oil revenues on imports, the degree of openness, the ability to regulate exchange rate reserves, the degree of international financial market integration and economic policy (Gnimassoun et al. 2017). And these factors can detect the dynamics of oil price-current account balance nexus.

Some of the reviewed literatures have shown the asymmetries in the effects of changes in oil price that are specific to oil supply and aggregate demand shocks, while recounting the theoretical channels through which oil price dynamics affect current account balance via terms of trade. This study intends to complete the existing literature by adopting panel ARDL model to analyse this relationship in the context of net oil exporting and net oil importing countries in Africa. Panel

ARDL is adopted to separate the dynamics of changes in oil price into positive and negative long run and short run effects using data covering 1996q_1 to 2016q_4.

3.9 Literature Review on The Relationship Between Oil Price and Foreign Reserves

Natural resources including crude oil has been a sources of foreign revenue generation especially for net oil exporting countries, hence, a means through which economic growth is promoted (Van der Ploeg and Venables 2011). However, most net oil exporting economies in Africa have failed to use these resources generated from crude oil to promote economic growth and development and as such, failed to save sufficiently and make investments that yield high returns to support diversification of their economies (Van der Ploeg and Venables 2011; Onigbinde et al.2014).

Numerous studies especially from developed countries of Europe and Asia on oil price-foreign reserves nexus emanating from the cross-country analysis are available in literature (Sachs and Warner 1995; Boschini et al.2007; van der Ploeg and Poelhekke 2009). For example, Sachs and Warner (1995) found that after controlling for initial investments in physical and human capital, income per capita, rule of law and trade openness, oil price dependence (measured by the ratio of crude oil export to GDP) is negative and statistically significant in predicting GDP growth per capita, hence, a reduction in foreign reserves. Re-estimating with institutional quality instead of rule of law established the presence of oil price in predicting foreign reserves. These outcomes indicate that, ceteris paribus, a rise in the ratio of crude oil exports to GDP of 10% point reduces average GDP growth per capita by 0.77% to 1.1% yearly, thus, foreign reserve is depressed. The authors recommended policy aimed at hedging foreign reserves from oil price fluctuations.

Shaibu and Izedonmi (2020) used ARDL model with dataset covering from 1986 to 2018 to show that shocks in oil price is insignificant in predicting foreign reserves dynamics in Nigeria. The authors recommended that policies directed at improving and managing foreign reserves to avoid linkage of resources should be adopted. Furthermore, the authors recommended embracing policies aimed at adopting exchange regime that will enable build the economy and ensure accumulation of more reserves to smoothen out exchange rate volatility.

Olowofeso et al. (2020) analysed the relationship between foreign reserves and oil price, GDP, exchange rate, investment, consumer price index and interest rate using ARDL model with quarterly data covering 2000 to 2018 in Nigeria. They conclude that investment, consumer price index, trade openness, exchange rate and interest rate have positive long run predictive power over foreign reserves. While oil price has short run effect on foreign reserves. The authors suggest that monetary authorities and policymakers should put forward policies that will hedge foreign reserves from volatility of oil price and exchange rate both in the short run and in the long run.

Kaka and Ado (2020) investigated the influence of indirect tax, total debt, direct tax, and oil price on foreign reserves using Ordinary Least Square method with dataset covering 1980 to 2019 in Nigeria. The outcome shows that indirect tax and direct tax have insignificant influence on foreign reserves. Whereas oil price and total debt are significant in influencing foreign reserves. The finding shows that Nigerian government has not utilized the advantage of her taxation to generated revenue. The authors recommended that policy aimed at diversifying Nigeria economy should be created. And such policies include creating small scale and medium industries, development, and extraction of non -oil mineral resources for export to boost her foreign reserves.

From the analysed literature it has been shown that oil demand and supply shocks have separate effect on foreign reserves, however literature has disregarded the possible asymmetries associated with these effects, especially in Africa. However, studies that analysed these asymmetries in oil prices and foreign reserves nexus did not differentiate between oil demand and supply shocks. This study bridges this gap in the literature by analysing the asymmetries associated with the positive and the negative oil price changes and its effect on foreign reserves in terms of demand and supply shocks in long run and short run in the context of net oil exporting and net oil importing countries.

3.10 Summary of the Findings on the Reviewed Literature

This chapter reviewed the literature on the relationship between oil price and macroeconomic variables. The review literature showed mixed findings on the relationship between changes in oil prices and key macroeconomic variables (see Van der Ploeg and Venables 2011; Kaka and Ado 2020;).

Al- Abri (2013) showed no clear demarcation between the short run and long run effects of changes in oil price on macroeconomic variables. Jiménez-Rodríguez and Sánchez (2009) fail to differentiate between the net oil exporters and net oil importers and the data used covered only the earlier period, hence, unable to provide any information on the current effects of oil price shocks on macroeconomic variables. Similarly, Ghosh et al. (2009) analyse the effect of changes in oil price on macroeconomic variables prior to 2008 and it does not cover the long run effects. Some of the other studies including Jiménez-Rodríguez and Sánchez (2012) are estimated within the context of developed countries and thus, same conclusions cannot be drawn for developing countries of Africa. Furthermore, recent studies on African economies are not updated to include most recent oil price shocks e.g., financial crisis between 2007 and 2009 and plunge in oil price between 2014 and 2016 and those that included it such as Kaka and Ado (2020) and Olowofeso et al. (2020) are mainly country specific. Thus, this study will contribute to the existing literature by jointly modelling short run and long run asymmetries between oil price and GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current account, and foreign reserves in the context of net oil exporting and net oil importing countries in Africa. Utilizing panel ARDL model, this study tends to fill this gap.

Chapter Four

Asymmetries in Oil price, Transmission Channel and Related Theories

4.0 Introduction

Previous chapter reviewed the literature on the asymmetric relationship between oil price and key macroeconomic variables. Various transmission channels and theories were identified in previous literature through which asymmetries in oil prices relate with macroeconomic variables (Brown and Yucel 2002; Doğrul and Soytas 2010; Bouchaour and Al-Zeaud 2012; Oluwaseyi 2018; Kocaarslan et al.2020). This chapter review studies in literature to understand the channels and related theories aim at analyzing the asymmetric relationship between oil price and macroeconomic variables in the context of net oil exporting (Nigeria, Algeria, and Egypt) and net oil importing (Kenya, and South Africa) countries in Africa.

This chapter is divided into sections. Section 4.1 provides an insight on the asymmetric relationship between oil price and macroeconomic variables. Section 4.2 describes the channels through which changes in oil price is transmitted into macroeconomic variables and relate them in terms of relevance to the study. Section 4.3 presents four theories deemed suitable for their theoretical underpinning for the study and this include theory of investment under uncertainty, the theory of reallocation effect, the theory of business cycles and the income shift theory. Section 4.4 put forward summary of this chapter.

4.1 The Asymmetries in Oil Price

Various scholars have evidenced the asymmetric relationship between oil price and macroeconomic variables which the related to various channels through which changes in oil price is transmitted into the macroeconomy (see Bouchaour and Al-

Zeaud 2012; Oluwaseyi 2018). Also, evidenced in literature is the related theories of the asymmetric effect of oil price on macroeconomic variables. The asymmetric effect is significant because it is assumed that symmetric assumption of oil price-macroeconomic relationship may hypothetically limit the economic analyses of this study, which may even cause distortion of the relationship (Cologne and Manera 2009). Researchers including Hashmi et al. (2021), Su et al. (2021) and Nusair and Olson (2021) emphasized that changes in oil prices have an asymmetric effect on macroeconomic variables. The asymmetric effect supports decomposing of oil price variable into positive and negative effect (Mork 1989). It evidences the short and long run varying effects of increase and decrease in oil price on macroeconomic variables. (Nusair and Olson 2021). For example, if there is an unexpected increase in oil price, the cost production of many energies intensive firms is expected to increase assuming this firms do not hedge against risk in oil price fluctuations (Nusair and Olson 2021; Kocaarslan et al.2020). Consequently, the marginal profit of this company may fall and hence, altering economic activities either in the short run or in the long run (Dixit and Pindyck (1994). However, the respond of macroeconomic variables to changes in oil price depend on the nature of positive or negative asymmetric effect associated with the changes in oil price (Kocaarslan et al. 2020; Chatziantoniou et al. 2021; Nusair and Olson 2021).

Furthermore, asymmetric effect also determines how changes in oil price influence microeconomic variables in the long run and in the short run (see Salisu and Isah 2017; Akinsola and Odhiambo 2020). Consequently, studies by Huang et al. (2005), Zhang (2008), Cologni and Manera (2009) and Khan et al. (2019), also confirm the significant of studying asymmetries in the oil price- macroeconomic variables relationship. For example, Kilian and Vigfusson (2017) used NARDL model with data covering 1980Q1 to 2014Q2 and estimated the asymmetric effect of oil price and on 13 Asian economies. The result evidence that in the short run economic activity responded asymmetrically to oil price shocks in Bangladesh, Hong Kong, Indonesia, India, and Japan. The long result evidenced no asymmetric effect between oil price changes and economic activity in all the countries. Meaning that oil price changes is only significant in the short run, in determining variations in macroeconomic variables. Hence, policy aimed at hedging macroeconomic variables from oil price shocks should be in the short run.

In analyzing the asymmetries of shocks in oil price, some scholars have found that increase in oil price have a disproportionately larger effect on GDP, interest rate, unemployment rate and inflation than decrease in oil price shocks (Kocaarslan et al.2020; Nusair and Olson 2021). While other studies have found that decrease in oil price have greater effect on macroeconomic variables than increase in oil price (see Yildirim and Arifli 2021). Also, found in literature is that the long run and short run effect of changes in oil price on macroeconomic variables, varies (see Salisu and Isah 2017; Odhiambo and Nyasha 2019; Akinsola and Odhiambo 2020). This may necessitate formulation of short run and long run policies by policymakers. For example, Akinsola and Odhiambo (2020) evidenced that changes in oil price do not have short run asymmetric effect on net oil importing countries while a long run asymmetric effect exists. Hence, they suggested a long run policy that hedge macroeconomic variables from oil price shocks. In contrast, Salisu and Isah (2017) found that oil price shock asymmetrically affects stock prices in net oil exporting and net oil importing countries both in the long run and in the short run. From the reviewed literature, this study may conclude that there is little or no consensus on the asymmetric impact of changes in oil price on macroeconomic variables. While some scholars report a positive relationship (Vu and Nakata 2018; Cunado et al. 2015), others report a negative relationship (Lee et al.2001; Aziz and Dahalan 2015). Furthermore, while Khan et al. (2019) accounted for insignificant asymmetric effect of changes in oil price on macroeconomic variables, others account for nonlinearity on the effect of fluctuations in oil price on macroeconomic variables (Aziz and Dahalan 2015; Zhang 2008). To offer a better understanding for the conflicting results reported in the literature, this study adopts the negative and positive partial sum processes of changes in oil price and investigate if asymmetry exist between oil price and macroeconomic variables. The next sections offer further insight on the asymmetric relationship between oil price and macroeconomic variables by relating it to theories and channels through which oil price affect macroeconomic variables. This will further examine if the long run effects of oil price on macroeconomic variables are different from short run effects across net oil exporting and net oil importing countries in Africa using ARDL model with data covering from 1996q_1 to 2016q_4.

4.2 Channel of Transmission

In this section the transmission channels through which changes in oil price relate with macroeconomic variables are reviewed and discussed. Scholars including Davis and Haltiwanger (2001), Lardic and Mignon (2008) Bouchaour and Al-Zeaud (2012) and Oluwaseyi (2018) have a detail analysis of the channels through which oil price changes affect macroeconomic variables. For in-depth discussions, the section of this chapter is divided into subsections: 4.2.1 describes the supply-side effect channel. Section4.2.2 presents the demand-side effect channel. Section 4.2.3 put forward details of real balance effect and monetary policy channel. 4.2.4 describes the terms of trade channel. Section 4.2.5 put forward the inflation effect channel. The visual understanding of workings of these channels in relation to how changes in oil price is transmitted into macroeconomic variables is presented in table 4.1.

4.2.1 Supply-Side Effect Channel

Supply-side effect is one of the channels through which changes in oil price relate with macroeconomic variables and it is caused by increase in oil prices (Kilian 2009). The marginal cost of production increases following the rise in oil prices, thus, the productivity and GDP growth rate decline and this can consequently cause rise in unemployment rate (Doğrul and Soytas 2010; Ahmed 2013; Kocaarslan et al.2020). With rising production costs, firms may find it difficult to continue production at the existing production level or full capacity (González and Nabiyev 2009), resulting into downsizing and decline in economic growth and eventually increase in unemployment rate (Kocaarslan et al.2020). Within this context it may be difficult and costly to reallocate capital and specialized labor from one industry to another, hence, labor need to wait for better job opportunity (Ahmed 2013; Dogrul and Soytas 2010). This may further contribute negatively to unemployment rate and economic activity and growth at large.

The rise in oil prices could cause supply shocks, and this has propensity to reduce potential output (Kilian 2009). The rising prices of oil signal crude oil scarcity (Gonzalez and Nabiyev 2009). Given that oil is one of the basic inputs in production (Kilian 2014), hence, the scarcity of crude oil may result in the decline of output growth and productivity decline. The slowdown in the growth and productivity can lead to decrease in the growth of wages and increase in the rate of unemployment at which disposable income decline and purchasing power may decrease (Ahmed 2013). However, if consumers perceive the increase in oil prices to be temporary, they have the tendency of smoothing out their consumption through less savings and increased borrowing and this can lead to a rise in the equilibrium real rate of interest (Brown and Yucel 2002). As the growth in output decreases and real rate of interest increases, there may be a fall in the demand for real cash balances and for a certain monetary aggregate growth, the inflation rate rises (Kilian, and Zhou 2019). The rise in oil prices consequently leads to reduction in the GDP growth rate, while boosting the real rate of interest and measured inflation rate (Ratti and Vespignani 2015). Thus, this study will adopt panel ARDL model and examine this phenomenon by separating the variables of oil price into positive and negative effect and asymmetrically analyse oil price-macroeconomic relationship long run and short run effect in the context of net oil exporting and net oil importing countries in Africa.

4.2.2 Demand-Side Effect Channel

The demand-side effect of oil price changes on macroeconomic variables is transmitted through consumption and investment (Kilian, and Zhou 2019). If the increase in oil price is assumed to be short term, or if the assumed temporary effects on output turn out to have continuing effects, consumers may try to smooth out their consumption by borrowing more or save less, consequently shifting total demand and supply curves (Kilian 2014; Kilian, and Zhou 2019). Such a change in demand and supply may reinforce a decline in GDP growth rate as investment reduces.

However, the general view among scholars is that exogenous shocks in oil price are recessionary and inflationary (Hamilton 1996). But this interpretation is against the views of Kilian (2014) who argued that even if an exogenous shock in oil price cause negative shift of total supply curve and increase in price level, it would not be anticipated to generate continued inflation in the absence of real wage rigidities (see Bruno and Sachs 1982). In quantifying the pass-through of shocks in oil price to inflation, Brown and Yucel (2002) argued that with monetary policy response of an interest rate increase, demand for real cash balances declines. With rising interest rate, cost of borrowing increases, hence, investment and consumption rate are reduced and consequently a decline in output growth rate. This study, therefore, will complement on this view by adopting panel ARDL model and asymmetrically investigate oil price-macroeconomic relationship in the context of net oil exporting and net oil importing countries in Africa. This relationship will be analyzed asymmetrically by separating the variable of oil price into positive and negative effect and determine the long run and short run effect of changes in oil price on macroeconomic variables under consideration.

4.2.3 Real Balance Effect and Monetary Policy

The underlying principle of real balance effect with respect to shocks in oil price is through its effect on inflation (see Brown and Yucel 2002). An increase in oil price can stimulate demand for money (Pierce and Enzler 1974). The failure of monetary authorities to meet with the increasing demand for money may cause an increase in interest rate (Brown and Yucel 2002). Given an increase in interest rate, inflation may increase causing economic activities to deteriorate including depreciation of terms of trade, this can have negative effect on exchange rate, hence, increase in the cost of goods and services (Beckmann et al.2017). Thus, this study draws from real balance effect and monetary policy transmission channel and relate it to interest rate dynamics and test its effect on GDP including other variables created by oil price dynamics. For example, it is assumed that increase in oil price increases money demand, causing interest rate to rise in net oil importing countries. Other the hand, it may create reduction in interest rate in net oil exporting causing increase in purchasing power and investment as it is assumed that there is increase in money circulation.

4.2.4 Terms of Trade Channel

Terms of trade transmission channel was first examined by Amano and van Norden (1998a). The study focused on the relationship between oil price and exchange rate, and their finding revealed bidirectional causality. The fundamental principle of this channel is to show the level at which changes in oil price affect exchange rate dynamics (Beckmann et al. 2017; Bénassy-Quéré et al. 2007). When the term of trade increases, for net oil importing countries, it implies depreciation of exchange rates, thus, a reduction in purchasing power, this can have a negative effect on domestic cost-push inflation (Beckmann et al. 2017). It is expected that when the price of oil increases, domestic currencies of countries who depend so much on crude oil in the tradeable sector may depreciate, reflecting an increase in inflation (Sarno 2005 and Kilian and Taylor 2003). For net oil exporting countries, when the term of trade improves, it implies appreciation of exchange rate, hence, an increase in purchasing power. This can create increase in economic activities and consequently increase in GDP growth rate (Buetzer et al. 2016). This study tends to adopt this phenomenon and analyze how changes in oil price is transmitted to exchange rate in the context of net oil exporting and net oil importing countries in Africa. This is done by relating exchange rate dynamics to fluctuations in GDP growth rate given an increase in oil price. This is based on assumption that exchange rate dynamics affect investment rate and consumer purchasing power.

4.2.5 Inflation Effect Channel

Inflation effect is another transmission channel through which oil price-macroeconomic relationship is transmitted into the economy (Tang et al.2009). In an open economy inflationary targeting is used by monetary authorities to direct their monetary policies and set their interest rate policy (Brown and Yucel 2002). When inflation is caused by increase in oil price shocks, a monetary policy tightening can worsen the long-term output by increasing interest rate and reduced investment (Tang et al.2009).

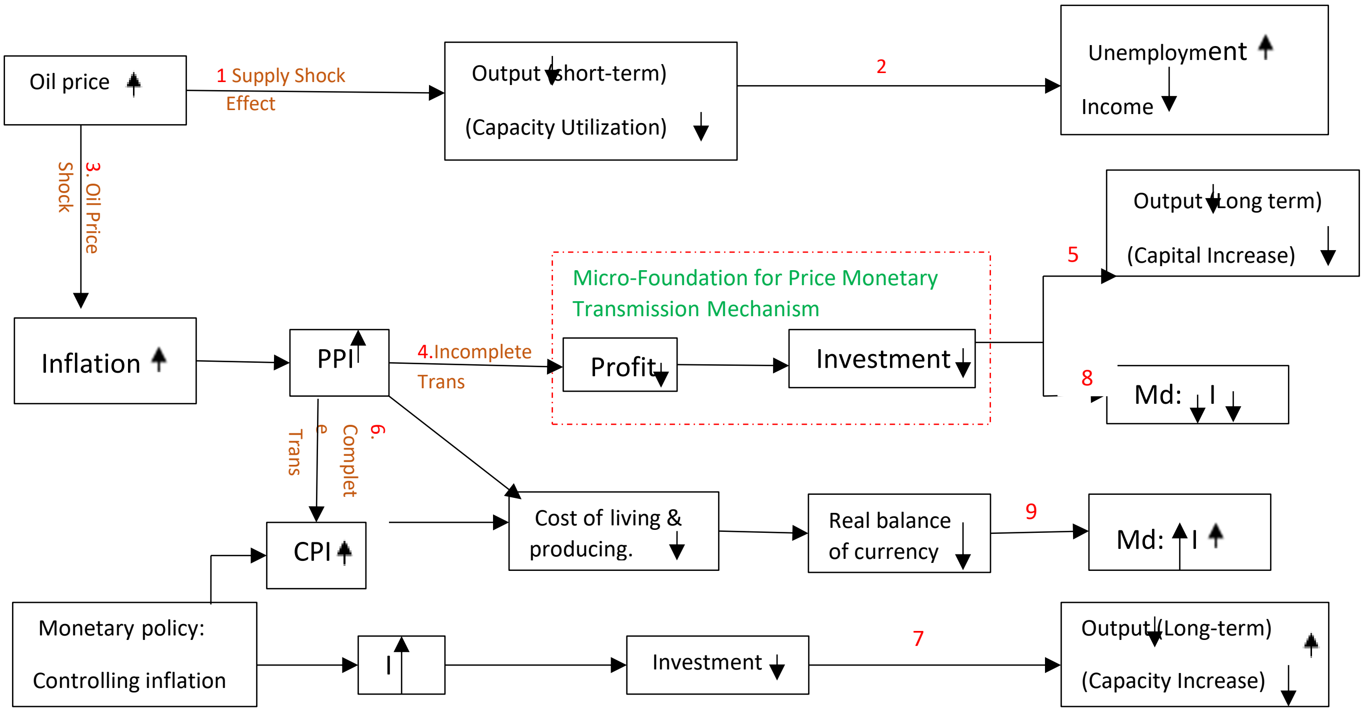
Dinh (2019b) and Jungwook and Ronald (2008) pointed out that oil price is directly relate to the production process and it has a considerable effect on the consumer price index through increased commodity prices that lead to inflation. Consequently, output, employment and inflation are impacted by the risen oil price shock, hence, production cost is caused to increase. The inflationary pressures can validate reduced demand, and this can create output cuts, leading to unemployment rate.

For example, Chen et al. (2020) used structural vector autoregression with stochastic volatility (TVP-SVAR-SV) model with monthly dataset covering 1999 to 2016 and analyze how changes in oil price is transmitted into the macroeconomy through inflation effect in China. They conclude that oil price increase driven by demand-side effect affects Chinese macroeconomy through inflation effect arising especially from import, consumption, and production cost. The authors proposed that policies aimed at alleviating inflation should emphasis on changes in oil demand shocks and a need to stimulate consumption and expand demand is necessary. Furthermore, the authors encouraged risk hedging tools and anti-inflationary policies to reduce the adverse effect of oil price shocks. This study will investigate the relationship between oil prices and inflation in the context of net oil exporting and net oil importing countries in Africa. Inflation is measured by consumer price index. It is expected that oil price dynamics will have effect on purchasing power index (PPI) of consumers through exchange rate dynamics caused by terms of trade effect. The results will have important policy implications because monetary authorities are expected to provide monetary policy that will shield consumer price index from the dynamics of oil price.

The channels through which oil price dynamics is transmitted into macroeconomic economy is illustrated in figure 4.1. When oil price increases, it creates supply shock effect. This is represented by arrow 1. For net oil importing countries output in long-term decrease as capacity and capital unitization declines. This leads to decline in income and increase in unemployment rate as shown by arrow 2. This is consistent not only with the expected theoretical framework of reallocation effect but also support the views of Beaudreau (2005), Ghosh and Kanjilal (2014) and Kocaarslan et al. (2020) who were of the view that increase in oil price caused by supply shocks validates increase in production cost. This can cause reduction in productivity level or reallocation effect, hence, increase in unemployment rate.

When oil price increase, inflation increase especially in net oil importing countries as shown in arrow 3. There will be purchasing power parity dynamics, and this leads to decrease in profit and investment as shown by arrow 4. On one hand, consumer price index fluctuates given monetary policy intervention through interest rate dynamics, cost of living and producing decline and this will give increase in money demand as shown by arrow 9. But with two phase monetary policy intervention to control inflation through interest rate dynamics. On investment side, with monetary policy intervention through interest rate dynamics, investment reduces given an increase interest rate, output in the long-term decline as shown by arrow 7. This is consistent with the views of Ghosh and Kanjilal (2014) who is of the view that increase in oil price validates increase in production, causing prices of goods and services to increase.

Figure 4.1 Transmission Mechanism of Oil Price



Note: PPI is producer price index, CPI is consumer price index, I represent interest rate Md is money demand.

Sources: Adapted from Oluwaseyi 2018

4.3 Related Theories

To understand oil price-macroeconomic relationship in the context of net oil exporting and net oil importing economies in Africa, a few existing theories relevant to this study are reviewed. These include theory of investment under uncertainty (Ferderer 1996; Guidi 2010), the theory of reallocation effect (Davis 1986; Hamilton 1988; Loungani 1992), income transfer theory (Beckmann et al. 2017) and theory of real business cycle (George 1994; Gnonzalez and Nabiyev 2009). These four theories have their specific emphasis and attributes (Alomary and Woollard 2015) which is often used to understand how their dynamics contributed to analyzing the relationship between oil price and macroeconomic variables (Trang et al. 2017). The dynamics and characteristics associated with each theory could be country specific and time varying (Iwayemi and Fowowe 2010; Fowowe 2014).

This section of this chapter is subdivided into sections. Section 4.2.1 describes theory of reallocation effect. Section 4.2.2 presents theory of investment under uncertainty. Section 4.2.3 is where theory of income transfer is discussed. Section 4.2.4 put forward theory of real business cycle. These theories are discussed in detail in the next sections.

4.3.1 Theory of Reallocation

Beaudreau (2005) put forward sector reallocation effect in which the role of oil price changes is explained through changes in production cost. Beaudreau (2005) argued that no production can be done without energy, thus, crude oil is very significant primary production factor. Therefore, when changes in oil price are for long term, it may cause potential impact on the production cost, and this can lead to reduction in production level (Brown and Yucel 2002). As such, firms are forced to change their production structure (Kocaarslan et al.2020) and consequently this may create reallocation of labor and capital across sectors given a shock in oil prices (Doğrul and Soytas 2010), and this can have a great effect on unemployment rate in the long run (Loungani 1986).

Oil price increase has the capability of causing productivity decreases as firms try to cope with the high input cost, as a result, supply reduces, and prices of goods and services increase (Ghosh and Kanjilal 2014). This may result into lower investment decisions or lower demand for goods especially those with long durability (Trang et al.2017). The impact may be more significant on energy sector as resources are being reallocated from efficient energy sector to less efficient energy sector (Kocaarslan et al.2020; Dogrul and Soyatas 2010). All these factors have the capability of affecting macroeconomic variables, hence, slow down economic activities and growth.

For instance, a simple concept is variations in unemployment equilibrium which is a function of changings in demand for labor coming from changings in real input prices for example, price of credit “interest rate” and price of oil (Kocaarslan et al. 2020). Through this, an increase in oil prices cause production cost to increase and profit margins to reduce (Dixit and Pindyck 1994). For economic equilibrium adjustment to take place, labor (wage) price will reduce (Brown and Yucel 2002). Due to the decline in wages, unemployment rates rise as result of the inverse relation between wages and unemployment, purchasing power may reduce given a reduction in disposable income (Trang et al.2017; Kocaarslan et al. 2020). The same mechanism works for increasing interest rates (see Ratti and Vespignani 2015). Thus, this study will consider reallocation effect theory as it provides the matrix needed to analyze the relationship between oil price and macroeconomic variables in the context of net oil exporting and oil importing countries in Africa.

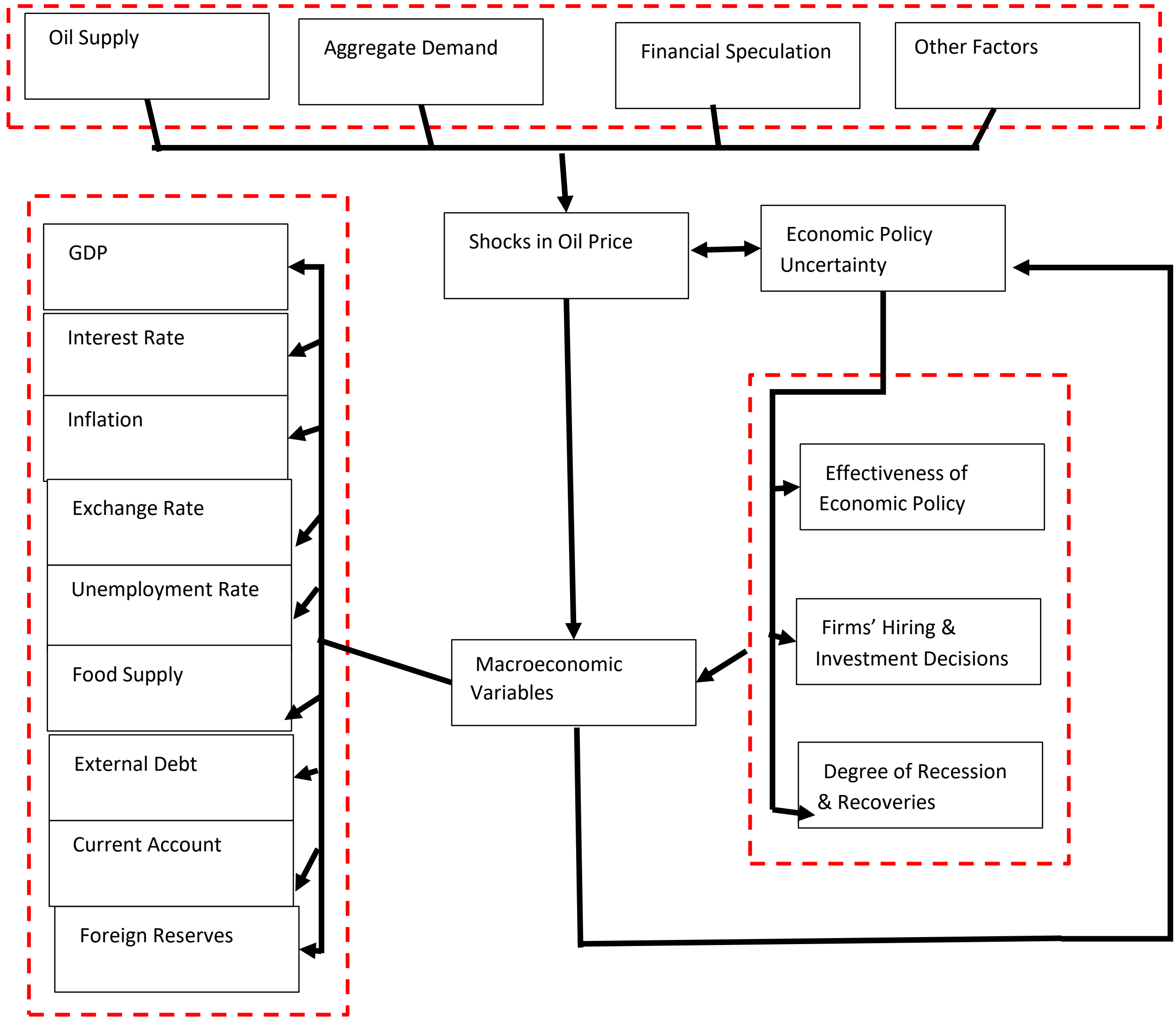
4.3.2 Theory of Investment Under Uncertainty

Previous scholars including Bernanke (1983), Majd and Pindyck (1987) and Ferderer (1996) have suggested that theory of investment uncertainty play a significant role in analysing oil price- macroeconomic relationship. As such, this study draws motivation from this theory to analyse how changes in oil price affect macroeconomic variables in the context of net oil exporting and net oil importing countries in Africa. According to Elder and Serletis (2010 & 2009), under the condition of economic uncertainty, firms and households do not tend to make irreversible investment decisions, and this can bring about investment project postponement until uncertainty disappears (Aloui et al.2016). Given for example, at microlevel investment decisions can significantly influence macroeconomic variables negatively through expenditure switching by consumers (Kilian 2014; Bernanke 1983). Besides decline in purchasing power, uncertainty in oil price can reduce productivity level and this can validate firms to lay-off workers (Trang et al.2017). This may result into increase in unemployment rate which may ultimately reduce GDP growth rate (Kocaarslan et al. 2020; Ahmed 2013).

Furthermore, Guidi (2010) opined that the concern of investors' behaviour in the setting of uncertainty have impact on investment returns because of, for instance the prices of oil may result in the formation of cyclical fluctuations in investments. With this conclusion Aloui et al. (2016) held the view that rise in uncertainty can contribute significantly to validate increase price of oil within a certain period due to hoarding of oil for hedging purposes. Dixit and Pindyck (1994), therefore suggest that uncertainty is very significant when it comes to investment especially economic outcome. Hence, reiterating Guidi (2010) argument on returns, the effect comes into play if for example, the rate at which to borrow increases due to monetary policy that is put in place to control inflation given an increase in oil price. With the perseverance of uncertainty, not only that the tendency of companies to commit their investible resources becomes higher, but also the willingness of buyers to spend on durables that are illiquid may diminished (Brown and Yucel 2002). This gives the suggestion that, for instance the uncertainty concerning the prices of oil has the likelihood of affecting interest rate parity (Chatziantoniou et al.2021). And as such, company's joint decision of where and when to commit resources among the irreversible investments is delayed which may ultimately affect economic growth.

In another manner, the uncertainty regarding future return on investment stimulates optimizing agents to delay investment for the period in which the expected additional information value is greater than the short-term return expected to current investment (Elder and Serletis, 2010). On these claims, one could say that uncertainty about oil prices is essential and significant in influencing total consumption, investment and hence unemployment rate and GDP. With this argument, this study considers this theory suitable to analyse the asymmetric relationship between oil price and macroeconomic variables in the context of net oil exporting and net oil importing countries in Africa. This will enable policymakers and investors formulate effective economic policies and make adequate investment decision. Figure 4.2 provides the framework to show the basic mechanism through which uncertainty in oil price affect macroeconomic variables.

Figure 4.2 Mechanistic Relationship Between Uncertainty in Oil Price and Macroeconomic Variables



Sources: Adopted from Lin and Bai (2021)

Figure 4.2 shows how uncertainty in oil price affect macroeconomic variables. Factors of oil supply, demand, financial speculation, and other factors create uncertainty in global oil market. This can translate into oil price shocks. Hence, economic policies are put in place to absorb the shock. On the government side policies are employed to absorb the shock. These policies affect macroeconomic variables through its application and could be meant to counter recession or recover the economy from shock, On the firm's side, they can adopt hiring, firing and investment decisions to absorb the oil price shocks. This can create varies degree of effect on macroeconomic variables. The oil price shock can affect macroeconomic variables directly as shown in figure 4.2. The degree at which macroeconomic variables is affected is a function of each country's economic environment. This aligns with views of Iwayemi and Fowowe (2010) who pointed out that the effect of oil price shock on macroeconomic variables is country specific.

4.3.3 Income Transfer Theory

The income transfer effect suggests increase (decrease) in purchasing power in net oil exporting (oil net importing) countries given an increase (decrease) in oil prices (Dohner 1981; Brown and Yucel 2002; Beckmann et al. 2017; Udoayang et al.2020.). This gives rise to decline in consumer demand and, hence, decline in GDP growth in net oil importing countries whereas the opposite is the case for net oil exporting countries. As mentioned earlier, the income transfer focuses on changes in purchasing power due to terms of trade dynamics (Dohner 1981; Fried and Schultze 1975; Beckmann et al.2017).

The change in purchasing power can cause decline in consumer demand in net oil importing countries while it will stimulate increase in consumer demand in net oil exporting countries (Ahmed 2013). Thus, consumer demand for goods produced in net oil importing countries will reduce globally while supply of savings increase in the global market (Brown and Yucel 2002). Real interest rate may decrease given an increase in supply of savings in net oil importing countries (Ratti and Vespignani 2015).

It is expected that investments stimulated by decrease in global interest rate will balances off reduction in consumption and cause no change in total demand (Beckmann et al. 2017; Kocaarslan et al. 2020). Kocaarslan et al. (2020) and

Brown and Yucel (2002) suggested that, in a downward sticky price condition, a decline in demand for goods produced in net oil importing countries may further deteriorate GDP growth rate. And if the level did not drop, the decline in consumption may be higher compared to investment increase and this can cause total demand to fall, thus, a further deterioration in economic activities and growth (Dohner 1981). Motivated by the claims of income transfer, this study will consider theory of income transfer suitable for this analysis as it provides the matrix needed some of the objectives outlined in this study.

4.3.4 Theory of Real Business Cycle

Real Business Cycle theory maintains that fluctuations in business cycle to a large extent are functions of real oil price shocks which impact global market dynamics (Brown and Yucel 2002; Su et al. 2021). The advocates of real business cycle are of the view that economic fluctuations and crisis are outcome of external shock, such as shocks in technology (González and Nabiyev 2009). While earlier study revealed that various cyclical events cannot be explained only by model driven by technology shocks (Dixit and Pindyck 1994). This propelled addition of other models of disturbances including natural disasters, oil shocks, environmental and safety policies, periods of bad weather and pandemics such as COVID-19 etc (George 1994; González and Nabiyev 2009; Su et al. 2021). George (1994) went ahead to suggest that real business cycle model can be classified through distinguishing the greatest forces pushing the cycle, which could be in the form of functions of supply shock or demand shock in the economy (Brown and Yucel 2002). Some authors including Baffes et al. (2015) and Prest (2017) ascribe the 2014 to 2015 oil price shocks to be mainly of supply shocks rather than to be more of demand shocks and some other shocks such as technological shocks and appreciation of US as Chen et al. (2015) and Baffes et al. (2015) claimed.

The underlying idea behind real business cycle theory is that if an external shock happened and it directly affects the effectiveness and changes in labour and capital, it may influence firms' and workers decisions, causing variations in their production and consumption patterns and ultimately a negative impact on output (Finn 1982; González and Nabiyev 2009). The implication of this theory is that it supports the idea that shocks in oil can affect economic growth. The effect of business cycles varies in degree and duration; hence, the cycles do not seem to be the same (González and Nabiyev 2009). The level of effect of changes in oil price in the economies being examined in this study vary in duration and magnitude as shown in chapter two of this study and this can be explained by the fluctuations in economic fundamental that will be analysed in the conclusion. Thus, given that this theory has some matrix needed to analyse oil price-macroeconomic relationship in the context of net oil exporting and oil importing countries in Africa, this study draws motivation from it and consider it fit for this analysis.

4.4 Summary

In this chapter, different transmission channels through which shocks in oil price causes changes in macroeconomic variables are identified. The channels identified are supply-side effect (Hosseini et al. 2021; Kocaarslan et al.2020), demand-side effect (Kilian 2014; Liu et al. 2021), real balance effect (Su et al. 2021), terms of trade effect (Beckmann et al.2017; Balli et al. 2021) and inflation effect (Yildirim and Arifli 2021). These channels support the investigation of impact oil price shocks on terms of trade geared towards imbalance in the economy. Furthermore, the channels help to examine the potential decline in output level as average cost of production increases or decrease, consequently leading to GDP growth rate dynamics and the potential effect on consumer purchasing power (Zakaria et al. 2021).

Furthermore, the related theories relevant to this study were discussed and they include theory of investment under uncertainty (Su et al. 2021; Lin and Bai 2021), income transfer theory (Knotek and Zaman 2021), reallocation effect (Lee and Cho 2021) and real business cycle (Usman and Balcilar 2021; Backus et al. 2021). For example, these theories explain the asymmetries in oil price macroeconomic relationship (Nusair and Olson, 2021; Liu et al.2021), examine changes in production structure (Maghyereh and Abdoh 2021) which can cause labor and capital reallocation and hence, unemployment rate dynamics (Kocaarslan et al.2020) and disequilibrium in money market (Jin and Xiong 2021; Lin and Bai 2021), which creates inflation dynamics as interest rates increases or decreases (Brown and Yucel 2002). This study tends to adopt panel ARDL model and examine the positive and negative asymmetric relationship between changes in oil price and macroeconomic variables in net oil exporting and importing countries in Africa in the long run and short run. The results found will be related to the discussed theories and channels to further investigate if the response of macroeconomic variables to changes in oil price varies or the same in net oil exporting and importing countries.

CHAPTER FIVE:
RESEARCH METHODOLOGY

5.0 Introduction

In chapter 3, literature was reviewed, and gaps that exist in literature were identified concerning how asymmetric oil price affect macroeconomic variables. In identifying these gaps, hypotheses needed to analyse this relationship are developed in chapter 6. Thus, this chapter, in addition, presents the research methodology employed to achieve the research aim. Developing research problems and translating them into suitable research strategies, approaches, designs, and data collection and analysis methods do not independently happen. Scholars such as Saunders et al. (2018) view that it requires a researcher comprehending the various paradigms and their impact on research design and the method employed. An adopted philosophical underpinning determines the choice of instruments employed to examine the phenomenon being researched, affecting the researcher's worldview and formulated hypotheses (Saunders et al., 2018). A study's rationale is shaped by a researcher's philosophical position and the purpose of the investigation (Havercamp and Young 2007). The purpose of this research study is to examine how asymmetric oil price relate to macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. In doing so, this study intends to find out if the asymmetric changes in oil price affect macroeconomic variables in the same way in net oil exporting and oil importing countries in Africa.

This chapter is designed to expound the research paradigm by utilizing positivism that anchors on realism from ontological domain, and it also took the objectivism stance from the domain of epistemology. The axiology of data used is unbiased and value free. This involves hypothesis testing as data is quantitatively analyzed using panel ARDL model. This is followed by a discussion on research design, sample size, and data collection and analysis come next in the following chapter.

5.1 Methodology and Methods

Sobh and Perry (2006) defined methodology to mean the specific procedure or technique a researcher employed in research work to select, process, identify and analyse the reality of a relationship or topic. The methodology allows the researcher to critically examine the reality and validity of the relationship between or among variables. Hence, the understanding of the ontological and the epistemological perspective of a researcher determines the type of research method(s) a researcher adopts (Creswell, 2014). Likewise, the understanding of the components of research philosophy (ontology and epistemology) enhances the researcher's orientation in giving proper interpretation and as well aid the researcher to adequately critique and apply research findings to justify or improve practice (Allison and Pomeroy, 2000). This brought to bearing the following questions:

- What is the ontological, epistemological stand of this study?
- What is the underpinning philosophical ideology behind this research work?

The answers to these questions inform the methodological approach employed in carrying out this research. Section 5.1.3.1 gave a summary insight of the research method adopted in this research.

5.1.1 An Overview of Empirical Methodology

Two methods of analysis are employed in this study, and they include descriptive and econometric methods. In the descriptive method, the mean, the median, the maximum, the minimum and the standard deviation are used to meaningfully present the properties of data adopted. Regression analysis is used to summarize the visual relationship between changes in oil price and macroeconomic variables both in individual country levels and group countries levels. This provides the basis for more extensive quantitative empirical analysis using the panel ARDL model with secondary data covering from $1996q_1$ to $2016q_4$. The justification and advantages of using panel ARDL model is well detailed in chapter 6 section 6.3 and section 6.9.1 respectively.

Empirically, various methods are suitable to examine how macroeconomic variables respond to changes in oil price in the context of net oil-exporting and net oil-importing countries in Africa. Nonetheless, this study employed a quantitative method with a panel ARDL model as a methodological tool. The panel ARDL model is adopted to test the hypothesis derived which was informed by chapters three and four. The findings are related to theories and channels through which asymmetric changes in oil price relate affect macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. Some other models such VAR, SVAR, PVAR etc. are capable of accounting for this type of analysis. Although, the adoption of the panel ARDL model is based on the outlined characteristics in chapter 1, section 1.5, and chapter 6, sections 6.9.1.

5.2 Research Design

Previous sections of this chapter examine the research approaches, and the deductive positivism approach was established as the most appropriate for this study. The research design is discussed in this section, and it consists of a comprehensive plan for data collection for empirical analysis (Bhattacherjee 2012). Thus, this study will explain how the formulated hypotheses are intended to be answered using the identified research strategy (Bryman and Bell 2015).

The deductive positivism approach adopted is used to quantitatively analyse panel data of net oil-exporting and oil importing countries in Africa. Time series data of macroeconomic variables employed were collected from the Data Streams of International Monetary Fund (IMF) and Thomson Routers while Brent crude oil price was from DataStream of Energy Information Administration (EIA). EViews software package was used to analyse the data quantitively using panel ARDL model, alongside other empirical methods such as Granger-causality test and Wald test, is used to analyse predictability of the asymmetries in quantitative terms how changes in oil price affect macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. The justification for using the panel ARDL model is well detailed in sections 6.9.1 in chapter 6. The justification for using Granger -causality and Wald test is detailed in sections 6.10 and 6.11 respectively, in chapter 6.

5.3 Data Collection Technique and Sample Size

This section explained the sample size, data collection methods, and statistical techniques employed in the empirical analysis. The countries are divided into net oil-exporting economies and net oil-exporting economies.

5.3.1 Sample Size

The sample size of this study was drawn from net oil-exporting (Nigeria, Algeria, and Egypt) and net oil-importing (South Africa and Kenya) countries in Africa with data cover 1996q_1 to 2016q_4. The justification for choosing these countries is informed by their level of oil export and oil import in Africa. A detailed overview of selected countries is provided in Chapter 2 sections 2.1 and 2.2. Dividing the countries into net oil-exporting countries and net oil-importing countries enables this study to conduct a comparative analysis of the impact of oil price-macroeconomic relationship on economic activities and growth. This is done to determine if changes in oil price have the same asymmetric effect on macroeconomic variable in net oil-exporting and net oil-importing countries in Africa.

5.3.2 Description of Data and Data Collection Method

The data used for this research is secondary data. The macroeconomic data for the analysis is collected from the DataStream of the International Monetary Fund (IMF) and Thompson Routers, while the data for the oil price is collected from the DataStream of Energy Information Administration (EIA). The data employed are quarterly data from 1996q_1 to 2016q_4 to quantitatively examine the aim of the study. 1996q_1 represents the starting quarterly data, while 2016q_4 represents the ending quarterly data making 406 observations for net oil-exporting and net oil-importing economies.

The period covered in this study captures different shocks in oil prices, including the oil price boom period of 1996 –1998 associated with OPEC policies, the 2002-2007 oil price increase related to the industrial revolution in Asia, the 2007-2009 oil price decline associated with the global financial crisis, the 2009-2013 oil price rise connected with the continued increase in the industrial revolution and the 2014 -2016 oil price decline associated increase in unconventional oil production and appreciation of U.S dollar. The effects of oil price shocks have been analysed through theoretical and empirical literature. For example, Lee et al. (2001), Jin

(2008), and Zhao et al. (2016) found a negative effect of oil price increase on GDP, while Du and Wei (2010) found that an increase in oil price positively affect GDP. Jibril et al. and Lin and Bai (2021) found the asymmetric effect of oil price on GDP. On the other hand, Khan et al. (2019) found an insignificant asymmetric effect of oil price on GDP in the Philippines, Thailand, and Singapore.

Nevertheless, this study recognizes existing literature on the relationship between oil price and macroeconomic variables, including country-specific level asymmetries (Kocaarslan et al.2020), net oil-exporting asymmetries (Salisu and Isah 2017), and net oil-importing asymmetries (Akinsola and Odhiambo 2020). However, there seems to be a lack of research in the context of net oil-exporting and net oil-importing in Africa. Hence, this study differs from the studies mentioned by focusing not only analysing the asymmetric effect of oil price on macroeconomic variables net oil-exporting but also analysed the asymmetric effect of oil price on macroeconomic variables net oil-importing countries in Africa. This will enable this study to draw a comparative analysis and determine how oil price asymmetrically affect macroeconomic variables in each group of net oil exporting and oil importing countries in Africa for policy formulation and investment decision making.

This study employs quarterly quantitative data to measure changes in oil prices, GDP, interest rate, inflation, exchange rates, unemployment rate, food supply, external debt, current account, and foreign reserves covering the period $1996q_1$ to $2016q_4$.

5.3.3 Justification for Variables Selection

The justification for choosing these variables is informed by reviewed literature and their critical roles in economic development and growth which form the basis for the formulated hypotheses in this study. The variability of these variables measures the trajectory of economic development and growth of any economy. They are vital sources through which policymakers determine the trajectory of economic growth or decline of any economy. The variables are transformed into log form because many economic variables usually have an underlying growth rate that can or cannot be constant over time; for example, GDP or inflation tend to either grow or decline annually, quarterly, or monthly basis (Dimitrious and Hall 2011).

However, in this analysis, the variables are assumed to grow quarterly, and notably, also, most macroeconomic variables follow a trend pattern and are not stationary, often as the mean continues to increase. The continuous growth of the variables' mean can prevent the data from being stationary despite the differentiations conducted (Dimitrious and Hall 2011). Thus, the variables used in this study are transformed into logarithm form using EViews software. This helped in measuring the percentage effect of the variable for policy formulation. Table 5.1 presents the variables and the justification for using them in this study.

Table 5.1 Variables and Justification

VARIABLES	DESCRIPTION	JUSTIFICATION FOR USE
OIL PRICE (OP)	Oil price is the brent crude oil sold in U.S dollar per barrel.	The choice of Brent crude oil is because it is widely considered as a global crude oil benchmark, but more importantly, it is mainly exported crude oil in the African region.
GDP	GDP is the gross domestic product, is the monetary value of finished goods and services. It is the addition of total consumption, investment, government spending, and net exports. GDP= C + I + G +NX. (Manera 2009).	GDP measures a country's total income and output for a given period. It represents all the goods and services produced over a specific period within an economy. It allows policymakers, economists, and investors to analyse the

		impact of macroeconomic variables on the economy (Gbatu et al., 2017a).
INTEREST RATE (INR)	Interest rate is the 3-month Treasury bill rates deflated by the consumer price index (Wu and Ni 2011).	Interest rate influences how likely firms, investors, government, and individual consumers can borrow either for investment or consumption purposes (Steidtmann 2004).
INFLATION (INF)	Inflation is deflated into the consumer price index. It is the percentage change in consumer goods and services quarterly (Roeger 2005).	Inflation is used because it measures each country's average level of prices based on the cost of a given typical basket of consumer goods and services quarterly (Misati et al., 2013).
EXCHANGE RATE (EX)	The exchange rate is multiplied by the consumer price index of the U.S. and divide with the consumer price index of each country (Jiang and Gu 2016).	The exchange rate is used to determine the value of each country's domestic currency against the U.S. dollar. It also links the domestic and foreign markets for various goods, services, and financial assets. Exchange rate fluctuation tends to affect domestic prices directly (Buetzer et al., 2016).
UNEMPLOYMENT RATE (UNE)	The unemployment rate represents the percentage of the workforce that is not engaged (Loungani 1986)	The unemployment rate is one of the indicators of economic growth. It fluctuates with economic conditions (Raifu et al. 2020).
FOOD SUPPLY (FS)	The domestic food supply index of each country is deflated in U.S. dollar as percentage of GDP (Maadid et al. 2017).	Food supply is used because it an essential component of the economy. Every economy considers food as a strategic part of economic development (Daude et al., 2010).
EXTERNAL DEBT (EXD)	External debt represents all the debt owed to non-residents deflated in the U.S dollar as percentage of GDP (Didia and Ayokunke 2020).	External debt has a direct economic effect on an economy. An increase in external debt can reduce economic growth through increase debt overhanging, debt services, and long-term interest rates (Al-Tamimi and Jaradat 2019).

CURRENT ACCOUNT (CA)	Current represents all transactions in the balance of payment of each country covering export and import of goods and services, income payments, and current transfer between and among to GDP ratio (Qurat-ul-Ain and Tufail 2013)	The current account is used for this analysis because it measures trade activities, direct investment, and the contribution of assets held by individuals, firms, or the government (Rebucci and Spatafora 2006).
FOREIGN RESERVES (FR)	Foreign reserves represent the measure of financial assets held in the form of the U.S dollar as percentage of GDP in each country's central bank (Olayungbo 2019).	Foreign reserve is used because it includes banknotes, deposits, treasury bills, bonds, and other securities that serve as a buffer and a backup in case of unexpected devaluation of domestic currency or economy becoming insolvent (van der Ploeg and Poelhekke 2009).

Sources: Author generated 2021

5.3.4 An Overview of Data Analysis Techniques

To achieve the aims and objectives of the research, descriptive and empirical analyses were employed. The mean, median, minimum, and standard deviations are the statistical and analytical techniques employed in presenting descriptive statistics. Regression analysis is employed to examine the influence of oil prices on selected macroeconomic variables. Unit root test was carried out to determine the stationarity of the variables. Panel unit root tests of Hadri (2000), Levin et al. (2002), Im et al. (2003), and Fisher-ADF and Fisher PP tests were used to determine the stationarity of the variables. These test techniques determined the stationarity of the variables. Determined within the empirical analysis is also the co-integration relationship. Kao (1999) and Johansen's approach (1988), which uses two statistical tests of Max-Eigenvalue and Trace stat, are used to examine the co-integration relationship between and among the variables. Also, within the empirical analysis, the asymmetric relationship is estimated by decomposing oil price component into positive and negative effects. This is done with the use of the panel ARDL model. Here, the short run, and the long run positive and negative effects of oil price on macroeconomic variables was analysed. Furthermore, the panel ARDL model is used to test the validity of the formulated hypothesis. Granger-causality and Wald test form part of the empirical analysis as they were used for a robust check on the findings from the panel ARDL model.

5.4 An Overview of Econometric Analysis

This section presents the model used for econometric analysis. Oil is one of the significant factors of production. Thus, a change in oil price can cause production costs to change (Kilian 2014), which may ultimately affect variations in macroeconomic variables. This study empirically examines how fluctuations in oil price affect macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. This study draws an inference from few studies, including Akinsola and Odhiambo (2020), Salisu and Isah (2017), Behmiri and Manso (2013), and Lescaroux and Mignon (2008). For example, Akinsola and Odhiambo (2020) studied the asymmetric effect of oil price on the economic growth of low-income oil-importing countries of Ethiopia, Gambia, Mali, Mozambique, Senegal, Tanzania, and Uganda. Their finding reveals that fluctuations in the oil price are insignificant in affecting economic growth in the short run for countries studied. While the long run relationship between oil price and macroeconomic variables is significant.

Furthermore, the short-run country coefficients indicate that oil price has a significant but mixed effect on economic growth. Lescaroux and Mignon (2008) examined the link between oil price and macroeconomic variables in the context of net oil-exporting and oil-importing countries. They found a long-run Granger causality running from oil price to other macroeconomic variables. Equally found is a short-run causal link between oil price and stock price. This study, therefore, examines the effect of fluctuations in oil price on macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa, conditioned on some variables including GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current account, and foreign reserves using panel ARDL model.

Focusing on net oil-exporting and net oil-importing countries in Africa, this study not only differs from the studies mentioned above by using extend literature review covering the different oil price shock event and data from 1996q_1 to 2016q_4 to analyse how asymmetric oil price affect macroeconomic variables but also this study used scattered diagram to construct a relationship analysis (see figure 5.2 to 5.65) to determine how much influence fluctuations in oil price have on the variables in net oil exporting countries but also in net oil importing countries in Africa.

5.4.1 An Overview Panel ARDL Model

As previously mentioned, this study employed a panel ARDL econometric model in Akinsola and Odhiambo (2020), drawn from the shine et al. (2014) nonlinear ARDL model. A representation of the dynamic heterogeneous panel data model suitable for estimating large T panels. The justifications for using the panel ARDL model is that it simultaneously accounts for the asymmetries and the long-run and short-run effects of fluctuations in oil price on macroeconomic variables. However, it is worth noting that this study deals with large T dynamic panels. As such, the dynamic heterogeneous panel data model is considered suitable for this study to allow the Pesaran (2007) CD test to capture heterogeneity in the macroeconomic variable index. Also, the Pool Mean Group (PMG) estimator is used to capture the heterogeneity as it pools and averages the coefficients, unlike the

Mean Group (MG) estimator that estimates N time-series regression and averages the coefficients (Blackburne and Frank 2007). The PMG estimator computes the individual variables' response to fluctuations in oil price in the asymmetric scenarios of both long-run and short-run categories of the group of net oil-exporting and net oil-importing countries. The advantage of using panel ARDL over other estimation model is well detailed in chapter 6 section 6.9.1.

The steps before using panel ARDL model estimation process is detailed as follows: The first step is to determine the stationarity of the variables using the unit root test. The second step is optimal lag length selection. The third step is an estimation of the co-integration relationship among the variables. Furthermore, the fourth step is data estimation using the panel ARDL model, where the asymmetric relationship is determined.

5.4.2 An Overview of Panel Unit Root Test

This study considers five different types of panel unit root tests to check the stationarity level of an individual variable. They include Hadri (2000), Levin et al. (2002), Im et al. (2003), and Fisher-ADF and Fisher PP. The Fisher ADP and Fisher PP are non-parametric unit-root tests (Maddala and Wu, 1999). The assumptions of the individual panel unit root techniques are explained in table 5.2.

Table 5.2 Characteristics, Null Hypothesis and Assumption of Individual Unit Roots Test Techniques

Test Technique	Assumption	Null Hypothesis	Key Features (Advantage/Weakness)
Hadri (2000)	Common unit root: such that σ_i and $\propto$ are alike across all cross-sections. The components representation in the test is such that an individual time series assume the sum of a random walk, deterministic trend, and white noise disturbance term. It is assumed to belong to the class of test proposed by King and Hilier (1985) where variance-covariance matrix of error term in linear regression model is tested.	Null: panel data has no unit root (stationary). Alt: panel data has unit root (non-stationary).	It does not only show that the asymptotic statistics are normally distributed but also useful in pure panel dataset context and easy to apply (Hadri 2000) It enables formulation of stationarity test. .
Levin, Lin, and Chu (2002)	Common unit root process, such that σ_i and $\propto$ are alike across all cross-sections. It allows both time series and cross-sectional dimensions to increase independently.	The null hypothesis is H_0: $\alpha = 0$ which has unit root, and the alternative hypothesis has no unit root and is represented as H_1: $\alpha < 0$.	It adopts bias correction factors to achieve its result (Narayan et al 2008). Its weakness is that the hypothesis assumes common unit root across individual group. And this assumption is seen to be restrictive on the dynamics of the series under the alternative hypothesis. The restrictive characteristics is attributed to the fact that test statistic is computed in a pooled fashion (Hlouskova and Wagner 2006). .

Im, Pesaran and Shin (2003)	The standardized demeaned *t*-bar statistics is assumed to congregate to standard normal in the limit. With the alternative hypothesis in IPS (2003) test, some series may be identified by a unit root while others may assume stationarity. Assume individual unit root process.	It uses a null of unit root which assume individual unit root process that allows heterogeneity in the value of the autoregressive coefficient (non-stationary) Alt: panel data has no unit root (stationary)	Im et al. (2003) take care of Levi et al. (2002) limitation by not assuming α is less restrictive i.e., not assuming all cross-sectional dimensions (countries) to be identical or converge with the same velocity towards equilibrium value under alternative hypothesis (Aziz 2009). It has more higher regressing influence than Levin et al. (2002) test (Hlouskova and Wagner 2006).
Fisher Type-Test (ADF & PP) Maddala and WU (1999) and Chino (2001).	It assumes individual unit root process as IPS, but they are not based on restrictive assumption of common unit root across the individual groups in the sample or that the coefficient of the autoregression is the same across countries (Lescaroux and Mignon 2008).	Null: Panel data has unit root Alt: panel data has no unit root (stationary)	It is non-parametric, and the individual p-value from unit root tests are combined. It has the advantage of not only being used regardless whether the null is stationary or of one integrational order but also, it does not show superior performance with respect to variations of cross-sectional *N* dimensions (Hlouskova and Wagner 2006).

Source: Autor generated 2020

5.4.3 An Overview of Panel Cointegration Test

Panel co-integration tests proposed by Kao (1999) and Johansen approach (1988), which uses two statistical tests of Max-Eigenvalue and Trace stat, are employed in this study. Johansen's (1988) test approach is known to provide testing for cointegration in multiple equation co-integration systems. On the other hand, Kao's (1999) co-integrating test approach allows for the single-equation framework. Table 5.3 presents the difference between Kao (1999) and the Johansen-type panel co-integration test.

Table 5.3 Types of Cointegration Techniques

Cointegration Technique	Assumptions	Advantages
Kao (1999) Test	The null hypothesis of Kao (1999) test shows no cointegration (i.e., the residuals are nonstationary) while the alternative hypothesis shows cointegrating relationship among the variables (i.e., the residuals are stationary	It identifies homogeneous coefficients on the first stage regressors and cross-section individual intercepts (Suleman (2013).
Johansen-type Panel Test	The individual cross-sections tests are combined to obtain test statistic for the entire panel.	The test results are based on p-value of trace test and maximum eigenvalue test.

Sources: Author generated 2020

5.10 Conclusion

In this chapter, the researcher was able to discuss the overview on data collection and analytical techniques. The technique showcased descriptive statistics and scattered diagram of regression analysis showcasing relationship between oil price and key macroeconomic variables under consideration. Duly considered is the justification that prompted the variables used for this analysis. Equally discussed is the overview of unit root test, the overview of co-integration test, and the overview of panel ARDL estimation to capture the short-run and long-run co-integration between and among the variables.

However, EViews, a Computer-Assisted Quantitative Data Analysis software, was used to analyse the quantitative data obtained from International Monetary Fund (IMF) DataStream, Thompson Router DataStream, and Energy Information Administration (EIA) DataStream. Descriptive and panel estimation was considered an appropriate statistical technique to describe the data and analyse the short-run and long-run relationship among the variables. The optimal lag length selection was determined including co-integration test analysis of the variables.

Chapter Six

Empirical Analysis

6.0 Introduction

Presented in this chapter are the hypotheses that were informed by chapters 3 and 4 of this study. These hypotheses are then tested by employing econometric techniques. The empirical investigation is to understand the dynamic nature of the **asymmetric effect of oil price on macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa.**

Panel ARDL is used to allow for an asymmetric response of macroeconomic variables to fluctuations in oil price. Macroeconomic variables are expected to respond asymmetrically to positive and negative oil price shocks in the same way (Lin and Bai 2021). Hence, the asymmetry in oil price-macroeconomic relationship is captured by the respecified panel ARDL model that includes error correction term. The panel ARDL model is expressed as follows:

$$\Delta Y_t = \beta_0 + \underbrace{\sum_{i=1}^{p} \lambda_i \Delta Y_{t-1} + \sum_{i=0}^{q} \delta_i \Delta X_{t-1}}_{\text{ARDL Short-run dynamics}} + \underbrace{\varphi_1 Y_{t-1} + \varphi_2 X_{t-1}}_{\text{ARDL Long-run dynamics}} + \varepsilon_t \text{ .... } (6.1)$$

Equation 3 can be rewritten as:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{p-1} \lambda_i \Delta Y_{t-1} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-1} + \varphi ECT_{t-1} + \varepsilon_t \text{ .... } (6.2)$$

Replaces the following long run ARDL component.

$$\left.\begin{array}{l} \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varphi_3 X_{t-1} + \varphi_4 X_{t-1} + \varphi_5 X_{t-1} + \\ \varphi_6 X_{t-1} + \varphi_7 X_{t-1} + \varphi_8 X_{t-1} + \varphi_9 X_{t-1} + \varphi_{10} X_{t-1} \end{array}\right\}$$

Where:

Δ is the first difference operator. φ is the group -specific speed of adjustment coefficient (expected that $\varphi_t < 0$). ECT is the error correction term; $\varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varphi_3 X_{t-1} + \varphi_4 X_{t-1} \ldots\ldots\ldots \varphi_5 X_{t-1}$ is the vector of long run relationship that replaces ECT in equation 4; $\sum_{i=1}^{p-1} \lambda_i \Delta Y_{t-1} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-1}$ is the short run parameters.

It is evident that in equation 6.2 there is no decomposition of oil price into positive and negative changes, hence, the equation represents the assumptions of symmetric effect of changes in oil price on macroeconomic variables. However, equation 6.1 will not be used for this analysis. The reason for not using equation 6.1 symmetric analysis is well detailed in chapter 4 section 4.1. Therefore, to account for the asymmetries in oil price-macroeconomic relationship, equation 6.1 is expressed as shown in the work of Shin et al. (2014) and Salisu and Isah (2017) to account for the positive and negative asymmetries in oil price-macroeconomic relationship.

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{p-1} \lambda_i \Delta Y_{i1}^{+}{}_{t-1} + \Delta Y_{i2}^{-}{}_{t-1} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-1} + (\varphi_1 Y_{i1}^{+}{}_{t-1} + \varphi_2 Y_{i2}^{-}{}_{t-1}) + \varphi_3 X_{t-1} + \varphi_4 X_{t-1} + \varphi_5 X_{t-1} + \varphi_6 X_{t-1} + \varphi_7 X_{t-1} + \varphi_8 X_{t-1} + \varphi_9 X_{t-1} + \varphi_{10} X_{t-1} + \varphi_{11} X_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (6.3)$$

Where Y_{i1}^{+} and Y_{i2}^{-} respectively represent the positive and negative oil price shocks. The error correction version of equation 3 represents $(\varphi_1 Y_{i1}^{+}{}_{t-1} + \varphi_2 Y_{i2}^{-}{}_{t-1}) + \varphi_3 X_{t-1} + \varphi_4 X_{t-1} + \varphi_5 X_{t-1} + \varphi_6 X_{t-1} + \varphi_7 X_{t-1} + \varphi_8 X_{t-1} + \varphi_9 X_{t-1} + \varphi_{10} X_{t-1} + \varphi_{11} X_{t-1}$. while ε_t is the noise.

The long run equilibrium associated in the asymmetric panel ARDL is captured by the error correction term (*ECT*). While φ the associated parameter of *ECT* and is the speed of adjustment that measures how long it takes oil price and macroeconomic variables to reach long run equilibrium in the presence of any shock.

This chapter is organised as follows. Section 6.1 present the descriptive analysis of the data which describes the properties of the variables. Put forward in section 6.2 is the regression analysis that presented how oil price influence macroeconomic variables using scattered diagram. In section 6.3, the correlation matrix is presented by considering the correlation between main variables for further empirical analysis. While section 6.4 detailed the unit root test Section 6.5 presents the cointegration test analysis. Section 6.6 presents and discusses the hypotheses linked to the reviewed literature and theoretical framework discussed in chapters 3 and 4. The results obtained from the econometric analysis are discussed in section 6.7. Section 6.8 presents the long-run and short-run Granger Causality test. The chapter summary is presented in section 6.9.

6.1 Descriptive Data Analysis

Given that variables are assumed to have time-series properties, this study followed the standard procedures to consider both the group and the individual statistical characteristics of the series, starting with descriptive statistics to summarize the information meaningfully and provide insight into the individual and group macroeconomic variables selected for this study.

For example, the mean statistic in tables 6.1 to 6.2 indicates that average foreign reserves are relatively higher in net oil-exporting and net oil-importing countries as it appears to be higher than other variables on average. More so, the mean statistical summary for GDP is relatively the lowest in both net oil-exporting and net oil-importing countries, with respective mean values of 1.39 and 1.03. Equally revealed is the statistical quarterly mean log value of global oil price, which is 3.8.

Also, the highest maximum log value among the variables in net oil-exporting countries is foreign reserves with a log value of 13.86, while the maximum log value in net oil-importing countries is external debt valued with a log value of 11.89. GDP has the lowest minimum log value of -1.47 in net oil-importing countries, while the interest rate has the lowest minimum log value of -2.21 in net oil-exporting countries.

It is evident from table 6.1 that the current account has the highest standard deviation log value of 1.92, followed by the exchange rate in net oil-exporting countries. While in net oil-importing countries, external debt has the highest standard deviation log value of 2.35, followed by the current account with a standard deviation with a log value of 2.21. This shows that these variables appear to be more volatile than other variables in the category group of countries, respectively.

Table 6.1 Descriptive Statistics of Net Oil Exporting Variables in Logarithm Form

	LOP	LGDP	LINR	LINF	LEX	LUNE	LFS	LEXD	LCA	LFR
Mean	3.809	1.391	1.750	1.825	3.611	2.199	4.592	8.601	5.525	9.625
Median	3.880	1.411	1.971	1.988	4.299	2.300	4.592	8.505	5.870	9.740
Maximum	4.799	3.519	3.230	3.793	5.721	3.384	4.621	11.117	12.999	13.864
Minimum	2.415	-0.755	-2.207	-1.218	1.222	1.040	4.555	5.059	0.360	6.964
Std. Dev.	0.684	0.577	1.182	0.876	1.419	0.662	0.014	1.551	1.918	1.022
Observations	252	252	252	252	252	252	252	252	252	252

Sources: Author generated 2021

Table 6.2 Descriptive Statistics of Net Oil Importing Variables in Logarithm Form

	LOP	LGDP	LINR	LINF	LEX	LUNE	LFS	LEXD	LCA	LFR
Mean	3.809	1.028	1.864	1.785	3.186	2.722	4.571	8.414	6.634	8.230
Median	3.880	1.194	1.750	1.798	3.372	2.629	4.568	8.055	7.655	8.337
Maximum	4.799	2.128	3.049	3.373	4.643	3.378	4.627	11.885	9.084	10.584
Minimum	2.415	-1.470	0.798	-0.827	1.328	2.219	4.503	5.488	0.806	5.897
Std. Dev.	0.685	0.881	0.616	0.609	1.180	0.474	0.032	2.347	2.211	1.041
Observations	168	168	168	168	168	168	168	168	168	168

Sources: Author generated 2021

6.2 Analysing the Influence of Oil Price on Macroeconomic Variables Using Scattered Diagram

To visualize any possible relationship between oil price and the variables under consideration, the oil price is plotted against each of the selected variable's indexes at group and individual country levels (see figures 6.1 to 6.64 in the appendix). In each figure, the vertical axis plots the measure of the selected variables of every individual and group country-category, while the horizontal axis plots a measure of oil price.

On the individual and group country level, the evidence of a potential positive relationship between oil price and some of the variables is obvious across both net oil-exporting and net oil-importing countries. However, some variables related negatively with changes in oil price. For example, figures 6.1, 6.28 and 6.38 show a positive relationship between oil price and GDP in Nigeria, Kenya, and South Africa, with respective linear functions of Y = 0.3985x – 0.0063, Y = 0.4742x – 0.6949 and Y = 0.1936x – 0.2351 and coefficients of determination adjusted R^2 = 0.1045, R2 = 0.104 and R^2 = 0.0378. Fluctuations in oil price influence Nigeria's GDP with R^2 = 0.1045, followed by Kenya and South Africa. The positive response of GDP to oil price shows that as oil price increases, the GDP growth rate of Nigeria increases given an increase in economic activities. Oil price positively related with GDP in Kenya and South Africa despite that they are net oil-importing. This is consistent with Kibunyi et al. (2018), who attributed the positive relation, especially in Kenya, to the fact that Kenya imports oil and reexports it to other countries, including Uganda, South Sudan, and Rwanda.

Oil price negatively influenced GDP in Algeria and Egypt with linear functions of Y = -0.1133x + 1.6312 and Y = -0.1501x + 1.9807 and coefficients of adjusted R^2 = 0.0319 and R^2 = 0.0677, respectively (see figures 6.10 and 6.19). Oil price is evidenced to have a more negative influence on Egypt's GDP. The negative influence of oil price on GDP in Algeria and Egypt, even though they are oil exporters, could be attributed to Dutch Disease syndrome, as Kretzmann and Nooruddin (2005) explained.

On the group level, fluctuations in oil price evidenced positive relation with GDP in both net oil-exporting and net oil-importing countries with linear functions of Y = 0.0452x + 1.2185 and Y = 0.3314x + 0.2338 and coefficient of determination adjusted R^2 = 0.0029 and R^2 = 0.0663, respectively (see figures 6.56 and 6.47). Fluctuations in the oil price have a more positive influence on GDP in net oil-importing countries. This result is not only set against the views of Trang et al. (2017), Fowowe (2014), and Ahmed (2013) but also the theories of reallocation effect and income transfer, that the impact of fluctuations in oil on net exporting and net oil-importing countries varies and that fluctuations in oil price have inverse relationship with GDP in net oil-importing countries (see Lin and Bai 2021; Zhao et al.2021).

Virtually all categories of both groups of countries at individual and group level evidence a negative relationship between oil price and interest rate. On the individual country level, Egypt has the highest coefficient of determination adjusted R^2 value of 0.4954, followed by Kenya with an adjusted R^2 value of 0.2457, Algeria with an adjusted R^2 value of 0.1116, and Nigeria that has the lowest R^2 value of 0.0006 (see figures 6.2,6.11,6.20,6.29 and 6.38). This is consistent with the views of Shangle and Solaymani (2020) for Malaysia.

While on the group level, net oil importers' interest rate is influenced more by oil price with a linear function of Y = -0.5062x + 3.7915 and coefficient of determination adjusted R^2 value of 0.3162. Furthermore, the linear function and coefficient of determination adjusted R^2 value of net oil-exporting countries are Y = -0.617x + 4.0994 and 0.1274, respectively (see figures. 6.48 and 6.57). This result is consistent with the views of Ahmed et al. (2019), Nazlioglu et al. (2019), and Omolade et al. (2019) that the oil price-interest rate relationship is a function of the economic structure of countries and their oil dependence.

The influence of fluctuations in oil price on inflation varies within the individual country level but not on a group country level. The oil price has the greatest positive influence on Algerian inflation with an adjusted R^2 value of 90107, followed by Egypt with an adjusted R^2 value of 0.4213 and Kenya having the lowest positive adjusted R^2 of 0. 281. Nigeria and South Africa's inflation is negatively influenced by fluctuations in oil price, with Nigeria having the highest negative impact with an adjusted R^2 of 0.0008 and South Africa with adjusted R^2 = 0.0004 (see figures 6.3, 6.12,6.21,6.30 and 6.39).

On group country levels, fluctuations in oil price related positively with inflations in both net oil-exporting and net oil-importing countries. However, the influence of oil price on inflation is higher in net oil-importing countries with a coefficient adjusted R^2 value of 0.0756 while the adjusted R^2 value of net oil exporters is 0.0208 (see figures 6.49 and 6.58). This is consistent with the views of Zakaria et al. (2021), who concluded a positive relationship between oil price and inflation in South Africa.

The influence of fluctuations in oil price on the exchange rate is the same for individual and group country level. On the individual country level, the oil price has the greatest positive influence on the Egyptian exchange rate with an adjusted R^2 value of 0.434, followed by Nigeria with an adjusted R^2 value of 0.4315 and Kenya with an adjusted R^2 value of 0.2529. While in Algeria, the exchange rate is the least on the individual country level with an adjusted R^2 value of 0.1113, followed by South Africa with an adjusted R^2 value of 0.1574 (see figures 6.4,6.13,6.22,6.31 and 6.40).

The exchange rate of net oil-exporting countries co-moved more positively to fluctuations in oil price with an adjusted R2 value of 0.0109 than net oil-importing countries with an adjusted R^2 value of 0.0007 (see figures 6.50 and 6.59). This indicates that fluctuations in oil price have a more positive influence on net oil-exporting countries' exchange rates. The positive co-movement between oil price and exchange rate of these group of countries could be attributed to foreign exchange rate market intervention to uphold the dynamics of the domestic currency. This result is against the views of Beckmann et al. (2017) that the effect of oil price on the exchange rate is not the same for net oil-exporting and net oil-importing countries.

There is evidence of varying relationship between oil price and unemployment rate on individual country level. Oil prices positively influence unemployment rate in

Nigeria, Egypt, and South Africa. This result is consistent with the views of Nusair (2020) and Cuestas and Gil-Alana (2018) that oil price and unemployment move in the same direction in the long run. In contrast, Algerian and Kenyan unemployment rates are negatively influenced. This result is consistent with the views of Kocaarshan et al. (2020), who concluded that uncertainty in oil price shocks has a negative effect on the unemployment rate. The Nigerian unemployment rate has the highest positive effect with an R^2 value of 0.3609, followed by Egypt with an R^2 value of 0.1802 and South Africa with an R^2 value of 0.004. The Algerian unemployment rate has the greatest negative influence from oil price with an R^2 value of 0.8033, followed by Kenya with an R^2 value of 0.771 (see figures 6.5,6.14,6.23,6.32 and 6.41).

On a group country category, oil price influence on unemployment in both net oil-exporting and net oil-importing countries is positive.Net oil-exporting countries' unemployment is influenced more with an R^2 value of 0.02505 to net oil-importing countries whose R^2 value is 0.0004 (see figures 6.51 and 6.60). This result is against Van Wijnbergen's (1985) views that co-movement between oil prices and unemployment varies across counties.

There is evidence of positive relationship between oil price and food supply in group and individual country levels. On the individual country level, the oil price has more influence on food supply in Kenya with an R^2 value of 0.9556, followed by South Africa with an R^2 value of 0.9101 and Nigeria with an R^2 value of 0.8725. Algerian food supply is the least positively influenced by oil price with an R2 value of 0.5352, followed by Egypt with an R^2 value of 0.6685 (see figures 6.6,6.15,6.24,6.33 and 6.42). This consistent with views of Baumeister and Kilian (2014) for U.S.

On group country level, oil price positively related with food supply, with net oil-exporting countries experienced the highest relationship with an R^2 value of 0.4693 compared to net oil-importing countries whose R^2 value is 0.0044 (see figures 6.52 and 6.61). This result is consistent with Oluwaseyi's (2018) views that oil price positively influenced average urban food price in Nigeria and supports Nwoko et al. (2016) that oil prices in oil price relate positively with food price in Nigeria.

Another pronounced positive association is found between oil price and external debt at individual and group country levels. The relationship between the variables is more pronounced in net oil-exporting countries with an R^2 value of 0.1217, while net oil-importing countries have an R^2 value of 0.0801(see figures 6.53 and 6.62). This evidence is consistent with Kretzmann and Nooruddin (2005) that oil price increase cause external debt of both net oil-exporting and net oil-importing countries to rise.

On the individual country level of co-movement between oil price and external debt, South Africa has the greatest influence with an R^2 value of 0.7569, followed by Algeria with an R^2 value of 0.6423 and Nigeria R^2 value of 0.528 (see figures 6.7,6.16 and 6.43). The least influenced is Egypt, with an R^2 value of 0.2525, followed by Kenya with an R2 value of 0.3338 (see figures 6.25 and 6.34).

Furthermore, evidence showed positive relationship between oil price and current account at individual and group levels. The influence of oil price on the current account is most substantial in net oil-exporting countries with an R^2 value of 0.1487 compared to net oil-importing countries with an R^2 value of 0.1196 (see figures 6.54 and 6.63). This finding is against the views of Balli et al. (2021), who used Russia and China to conclude that shocks in oil price affect the current account balance of net oil-exporting and net oil-importing countries differently. Supporting this view, Qurat-ul-Ain and Tufail (2013) found that shocks in oil price improve only the current account for oil-importing countries in the short run but deteriorate it in the oil-exporting countries. Net oil exporting countries experience deterioration of current account both in the short run and long run.

While on the individual country level, Egypt's current account related with oil price more than other countries' current account with an R^2 value of 0.3574, followed by South Africa with an R^2 value of 0.2572 and Nigeria with an R^2 value of 0.1737 (see figures 6.8, 6.26 and 6.44). The least is Algeria, with an R^2 value of 0.0275, followed by Kenya with an R^2 value of 0.0968 (6.17 and 6.35). This result is consistent with the views of Schubert (2014), who opined that, with continuous increase in oil price, government expenditure gradually falls over time, causing improvement in the current account.

The oil price has the most substantial positive influence on foreign reserves of net oil-exporting countries with an R^2 value of 0.4154 compared to net oil-importing countries whose R^2 value is 0.139 (see figures 6.55 and 6.64). On the individual country level, oil price influenced the foreign reserves of Algeria more with an R^2 value of 0.7146, followed by Kenya with an R^2 value of 0.6869 and Nigeria with an R^2 value of 0.588 (see 6.9, 6.18 and 6.36). The least influenced is South Africa, with an R^2 value of 0.0052, followed by Egypt with an R^2 value of 0.0318 (6.27 and 6.46). This result is against the views of Tiwari et al. (2014) that shocks at oil prices have negative predictive power over foreign reserves in India.

6.3 Panel Unit Root Test Result

The relevant variables are subjected to a panel unit root test to determine the stationarity of data considering the heterogeneity of panel data with large T time dimensions and cross-sectional N dimensions. The results of the panel unit root tests are shown in table 6.3**.**

This study found that only a series of GDP and inflation are stationary at level and are integrated of order zero I (0) in both net oil-exporting and net oil-importing countries. The series of interest rate, current account, and foreign reserves are stationary at level and are integrated of order zero I (0) in net oil-exporting economies. While the series of oil price, exchange rate, unemployment rate, food supply, and external debt are stationary at 1st difference, hence, integrated of order one I (1) in both net oil-exporting and net oil-importing economies. The interest rate, current account, and foreign reserves are stationary at 1st difference and integrated of order one I (1) in net oil-importing economies. Given that the variables are either integrated of order zero I (0) or integrated of order one I (1) in both groups of net oil-exporting and net oil-importing countries has reaffirmed the appropriateness of the choice of panel ARDL model as a preferred analytical framework in the context of this study.

Conclusively, the stationarity results from the five different test methods suggest a possible long-run correlational relationship among the variables. This study estimated a co-integration test using panel co-integration tests of Kao (1999) and Johansen's (1988) to reaffirm this relationship. However, before carrying out the co-integration test, the underlying optimal lag length of the panel ARDL model is determined. In the next section, the optimal lag length selection is presented**.**

Table 6.3 Unit Root Test Result for Group of Net Oil Exporting and Net Oil Importing Countries

Variables	Levin et al.				Im et al.				ADF				PP				Hadri			
	Levels		1ST difference		Levels		1st difference		Levels		1st difference		Levels		1ST difference		Levels		1st difference	
	Inter	Inter &Trend	Inter	Inter & trend	Inter	Inter & Trend	inter	Inter & trend	Inter	Inter & Trend	Inter	Inter & Trend	Inter	Inter & Trend	Inter	Inter & Trend	Inter	Inter & Trend	Inter	Inter & Trend
Net Oil Exporting Countries																				
LOP	0.489	2.755	7.109*	7.104*	0.158	1.676	6.853*	6.155*	3.409	0.917	56.16*	44.435*	3.595	0.572	94.623*	88.298**	8.467	5.249	0.188*	0.250*
LGDP	0.237	0.639	2.408*	1.556*	3.312*	2.251*	7.007*	6.251*	23.732*	15.88*	57.849*	45.329*	21.65*	14.035*	95.899*	132.77*	0.609**	3.469	1.504*	1.451*
LINR	0.380	0.801	3.780	5.883	3.322	2.469*	6.971*	6.263*	22.975	15.923*	57.457*	45.447*	20.453	13.714*	96.525*	132.17*	3.288	2.293	1.306*	1.248*
LINF	7.207*	7.231*	7.207*	7.231*	8.783*	8.346*	8.785*	8.346*	76.74*	65.742*	76.745*	65.742*	92.871*	92.667*	92.871*	92.667*	2.202	1.595*	0.644*	0.549*
LEX	4.109	4.268	2.233	3.332	4.403	3.449	3.487*	2.629*	0.261	0.304	32.189*	25.182*	0.304	0.826	62.491*	97.605*	10.865	2.909	1.617*	3.997
LUNF	0.501	1.405	2.369*	1.572	0.846	0.160	7.739*	7.263*	6.119	8.0669	65.847*	55.163*	5.785	7.484	91.739*	139.30*	10.129	5.294	0.968*	1.048*
LFS	0.756	0.232	7.327*	7.166*	0.599	0.461	8.163*	7.615*	5.979	2.964	70.371*	69.091*	4.087	1.296	93.059*	98.046*	4.421	3.060	0.090*	3.420
LEXD	3.521	3.418	2.094	3.461	2.014	0.075	5.925*	5.576*	4.900	12.336	47.136*	39.537*	4.797	10.277	97.120*	134.72*	9.862	3.103	1.165*	1.261*
LCA	1.070	0.563	6.911*	7.648*	2.373	2.026*	8.854*	8.389*	16.55*	15.578*	77.626*	66.314*	16.752*	14.579*	81.040*	146.38*	2.098	3.236	0.879*	0.456*
LFR	0.966	0.366	0.258	1.473	1.227	0.899	7.791*	7.276*	9.139	8.347	60.797*	54.233*	14.321	25.800*	82.492*	94.708*	10.659	5.729	0.269*	0.864*
Net Oil Importing Countries																				
LOP	0.399	2.250	5.804*	5.800*	0.129	1.369	5.595*	5.026*	2.273	0.611	37.440*	29.623*	2.396	0.381	63.085*	58.866*	6.913	4.286	0.154*	0.204*

LGDP	1.309	1.533	2.642*	2.105*	1.547	1.612	5.806*	5.311*	11.54*	13.747*	39.326*	31.832**	10.467*	9.748	63.481*	89.860*	1.0567	1.163*	1.057*	1.163*
LINR	0.558	0.313	4.975	7.100	1.843*	2.889*	5.771*	5.211*	10.039*	15.094*	39.013*	31.047*	9.062*	11.567*	63.671*	89.181*	5.172	2.205	0.881*	0.328*
LINF	0.589	0.089	5.671	5.591*	2.447*	1.741*	6.755*	6.246*	13.55*	9.174	46.433*	39.351*	11.433*	7.319	56.709*	56.152*	1.064*	2.286	1.143*	0.814*
LEX	0.003	0.420	2.972	2.533*	0.338	0.167	5.663*	5.032*	1.860	2.314	38.167*	30.144*	2.258	3.133	61.709*	78.809*	6.368	2.032	0.562	1.305*
LUNE	0.276	0.453	6.550*	6.492*	0.433	0.223	8.719*	8.466*	7.182	4.312	62.291	56.322*	7.147	5.754	41.676	107.22*	1.878	2.045	0.018*	2.208
LFS	0.402	1.524	8.135*	6.102*	0.018	1.311	6.888*	6.539*	2.610	0.661	48.912*	41.645*	2.855	1.115	66.957*	68.180*	6.373	3.550	0.073*	1.230*
LEXD	1.523	1.577	1.361	0.735	2.514	0.841	4.883*	4.484*	0.524	1.814	31.217*	25.739*	0.467	1.867	62.886*	92.025*	8.561	4.646	0.393*	0.078*
LCA	0.371	0.443	1.231	3.231*	3.515*	1.224	2.557	3.480*	29.676*	20.647*	21.236	21.929*	30.126*	36.274*	35.569*	54.084*	2.098	7.157	5.956	3.264
LFR	0.016	0.848	1.554	3.238	1.405	2.517*	8.193*	7.807*	14.811*	14.303*	58.330*	51.2253*	31.256*	36.727*	36.841*	101.777	8.061	0.333	0.073*	1.230*

Note: Figures in the parenthesis are probability values. ** denotes rejection of null of non- stationarity at 5%. percent level of significance. OP is oil price, INR is interest rate, INF is inflation, EX is exchange rate, UNE is unemployment rate, FS is food supply, EXD is external debt, CA is current account and FR is foreign reserves. LLC= Levin, Lin & Chu (2002), IPS= Im, Pesaran & Shin (2003), ADF-Fisher Chi-square-Fisher Chi-square. The maximum number of lags are selected based on Akaike Information Criterion (AIC). The null hypothesis is the series contain a unit root.

Sources: Author generated 2021.

6.4 Optimal Lag Selection

The optimum lag length is determined by employing lag length selection tests. This is to ascertain the lag structure that is the best fit for both net oil-exporting and net oil-importing economies panel estimation model. The lag length of 1 is selected based on the Akaike information criterion (AIC) for net oil-exporting and net oil-importing countries. The Akaike information criterion has the lowest value compared to other criteria, as shown in table 6.4. Thus, the lag length of 1 is used for both net oil-exporting and net oil-importing countries in estimating the panel ARDL model.

Table 6.4 Lag Selection for Both Net Oil Exporting and Net Oil Importing Countries

Net Oil Exporting Economies						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1777.490	NA	1.39e-06	14.89575	15.04078	14.95419
1	791.7704	4903.005	1.610015*	-5.681420*	-4.086127*	-5.038634*
2	856.3717	117.8973	2.180015	-5.386431	-2.340871	-4.159293
3	941.7430	148.6884*	2.480015	-5.264525	-0.768700	-3.453036
4	1007.455	108.9721	3.370015	-4.978790	0.967302	-2.582949
Net Oil Importing Economies						
0	-712.1530	NA	3.940009	9.026912	9.219110	9.104957
1	1041.638	3266.435	4.160018*	-11.64547*	9.531289*	-10.78698*
2	1134.295	160.9922	4.610018	-11.55369	-7.517522	-9.914741
3	1220.379	138.8103	5.680018	-11.37974	-5.421588	-8.960339
4	1309.364	132.3658*	6.980018	-11.24205	-3.361922	-8.042206

Note: *is the lag order selected by the criterion, LR= sequential modified LR test statistic @ 5% level, FPE= Final prediction error, AIC=Akaike Information Criterion, SC=Schwarz Information Criterion & HQ=Hannan- Quinn Information Criterion.

Sources: Author generated 2020.

In the next section, the panel co-integration test result is presented which confirms the evidence of a long-run co-integration relationship among the variables. As stated in section 5.9.4, co-integration tests of Kao (1999) and Johansen's (1988) are used.

6.5 Result of Panel Cointegration Test

Table 6.5 Kao Residual Cointegration Test

Null Hypothesis: No Cointegration	ADF t-Statistic	Prob.
Net oil Exporting Economies	-4.367	0.0000
Net Oil Importing Economies	-4.738	0.0000

Sources: Author generated 2020

In table 6.5, the Kao (1999) test revealed a co-integration relationship among the variables. Tables 6.6 and 6.7 suggest co-integrating vectors in the system with the Johansen (1988) test approach. The co-integration relationship of the variables is estimated based on the Trace and Max-Eigenvalue statistics in both panel 1 and panel 2 for both net oil-exporting and net oil-importing countries. The results of both Kao (1999) and Johansen's (19888) co-integration panel test indicate the existence of a long-run relationship between and among the variables. Given the presence of not only a co-integration relationship among the variables but also the fact that the variables are integrated of order zero I (0) and order one I (1), this study employs a panel ARDL model.

Table 6.6 Cointegrating Test for Trace and Max-Eigen Statistics for Net Oil Exporting Countries

Panel 1: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	**Fisher Stat.* (From trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	47.49	0.0000**	22.61	0.0009**
At most 1	26.17	0.0002**	10.84	0.0933
At most 2	15.75	0.0152**	6.179	0.4035
At most 3	9.789	0.1338	3.888	0.6919
At most 4	6.357	0.3844	2.143	0.9061
At most 5	4.859	0.5621	2.230	0.8974
At most 6	3.762	0.7089	1.650	0.9489
At most 7	3.712	0.7156	2.103	0.9100
At most 8	4.096	0.6637	2.561	0.8616
At most 9	10.82	0.0942	10.82	0.0942

Panel 2: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	**Trace Test Statistics**	**Prob.****	**Max-Eign Test Statistics**	**Prob.****
None	323.6814	0.0000**	81.5767	0.0006**
At most 1	242.1046	0.0000**	61.0034	0.0273**
At most 2	181.1012	0.0019**	51.3767	0.0629
At most 3	129.7245	0.0274**	38.4368	0.2666
At most 4	91.2877	0.0975	28.8801	0.4997
At most 5	62.4076	0.1690	23.0292	0.5282
At most 6	39.3784	0.2455	16.6543	0.6097
At most 7	22.7241	0.2599	12.5314	0.4962
At most 8	10.1927	0.2662	7.2438	0.4607
At most 9	2.9489	0.0859	2.9489	0.0859

*Note: *** Represents no cointegration, ** Mackinnon-Haug-Michelis (199) p-values, Variables observed are Oil price, GDP, interest rate, Inflation, Exchange rate, Unemployment rate, Food supply, External debt, current account, and foreign reserves.*

Sources: Author generated 2020

Table 6.7 Cointegration Test for Trace and Max-Eigen Statistics for Net Oil Importing Countries

Panel 1: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	**Fisher Stat.***		**Fisher Stat.***	
No. of CE(s)	**(From trace test)**	**Prob.**	**(From max-eigen test)**	**Prob.**
None	51.52	0.0000**	33.63	0.0000**
At most 1	23.30	0.0001**	7.040	0.1338
At most 2	15.59	0.0036**	4.752	0.3137
At most 3	10.85	0.0284**	5.312	0.2568
At most 4	6.517	0.1637	1.757	0.7804
At most 5	5.304	0.2575	2.273	0.6856
At most 6	3.996	0.4066	1.303	0.8608
At most 7	4.298	0.3672	2.440	0.6555
At most 8	4.168	0.3838	3.683	0.4506
At most 9	5.436	0.2454	5.436	0.2454
Panel 2: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	**Trace Test**		**Max-Eigne Test**	
No. of CE(s)	**Statistics**	**Prob.****	**Statistics**	**Prob.****
None	293.4926	0.0000**	85.2756	0.0002**
At most 1	208.2170	0.0129**	44.9191	0.5325
At most 2	163.2979	0.0306**	38.1517	0.6110
At most 3	125.1462	0.0534	34.6046	0.4853
At most 4	90.5416	0.1082	27.9091	0.5683
At most 5	62.6325	0.1636	23.0079	0.5299
At most 6	39.6246	0.2362	15.4409	0.7126
At most 7	24.1837	0.1928	13.7189	0.3886
At most 8	10.4648	0.2467	8.8150	0.3019
At most 9	1.6498	0.1990	1.6498	0.1990

*Note: *** Represents no cointegration, ** Mackinnon-Haug-Michelis (199) p-values, Variables observed are Oil price, GDP, interest rate, Inflation, Exchange rate, Unemployment rate, Food supply, External debt, current account, and foreign reserves.*

Sources: Author generated 2021.

6.6 Correlation Analysis Between the Key Variables

Presented in this section is the correlation matrix of main variables. The variables used for the correlation analysis include oil price, GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current account, and foreign reserves. The variables are selected based on existing literature (see Lescaroux and Mignon 2008; Iwayemi and Fowowe 2010; Akinsola and Odhiambo 2020). The justification of the variables was provided in section 5.3.3 of table 5.1 in chapter 5.

Table 6.8 Correlation Matrix of the Estimated Variables in Net Oil Exporting Countries

			Correlation							
Variables	**LOP**	**LGDP**	**LINR**	**LINF**	**LEX**	**LUNE**	**LFS**	**LEXD**	**LCA**	**LFR**
LOP	1.000									
LGDP	0.054	1.000								
	(0.038)		-							
LNR	-0.357	0.142	1.000							
	(0.000)	(0.024)		-						
LINF	0.144	0.177	-0.081	1.000						
	(0.022)	(0.005)	(0.201)		-					
LEX	0.1042	0.028	0.423	0.057	1.000					
	(0.049)	(0.663)	(0.000)	(0.370)		-				
LUNE	0.004	-0.200	-0.184	-0.401	-0.185	1.000				
	(0.947)	(0.014)	(0.003)	(0.000)	(0.003)		-			
LFS	0.685	-0.0528	-0.123	0.288	0.483	-0.192	1.000			
	(0.000)	(0.404)	(0.051)	(0.000)	(0.000)	(0.002)		-		
LEXD	0.349	0.221	-0.370	0.196	-0.716	-0.083	-0.142	1.000		
	(0.000)	(0.004)	(0.000)	(0.002)	0.000	(0.190)	(0.025)		-	
LCA	0.3790	0.0167	-0.209	0.109	0.095	0.081	0.281	0.108	1.000	

	(0.000)	(0.792)	(0.001)	(0.083)	(0.132)	(0.200)	(0.000)	(0.088)		
LFR	0.644	0.227	-0.037	0.163	0.028	-0.333	0.336	0.477	0.136	1.000
	(0.000)	(0.003)	(0.560)	(0.010)	(0.661)	(0.000)	(0.000)	(0.000)	(0.031)	

Note LOP is log of oil price; LGDP is log of GDP; LINR is log of interest rate, LINF is log of inflation; LEX, is log of exchange rate; LUNE is log of unemployment rate; LFS is log of food supply; LEXD is log of external debt; LCA is log of current account; LFR is log of foreign reserves. Figures in parentheses is the probability value.
Sources: Author generated 2021.

Table 6.9 Correlation Matrix of the Estimated Variables in Net Oil Importing Countries

Correlation										
VARIABLES	**LOP**	**LGDP**	**LINR**	**LINF**	**LEX**	**LUNE**	**LFS**	**LEXD**	**LCA**	**LFR**
LOP	**1.000**									

LGDP	**-0.258**	**1.000**								
	(0.007)	-----								
LINR	**-0.563**	**-0.131**	**1.000**							
	(0.000)	**(0.090)**	-----							
LINF	**-0.275**	**-0.021**	**0.255**	**1.000**						
	(0.003)	**(0.004)**	**(0.001)**	-----						
LEX	**-0.084**	**0.071**	**-0.369**	**-0.169**	**1.000**					
	(0.021)	**(0.034)**	**(0.000)**	**(0.028)**	-----					
LUNE	**-0.809**	**-0.137**	**0.465**	**0.191**	**-0.957**	**1.000**				
	(0.004)	**(0.006)**	**(0.000)**	**(0.013)**	**(0.000)**	-----				
LFS	**0.909**	**0.259**	**-0.582**	**0.287**	**-0.193**	**-0.221**	**1.000**			
	(0.000)	**(0.001)**	**(0.000)**	**(0.000)**	**(0.012)**	**(0.004)**	-----			
LEXD	**0.283**	**-0.072**	**-0.605**	**-0.159**	**-0.852**	**0.919**	**0.432**	**1.000**		
	(0.002)	**(0.355)**	**(0.000)**	**(0.040)**	**(0.000)**	**(0.000)**	**(0.000)**	-----		
LCA	**0.369**	**0.090**	**-0.534**	**-0.115**	**0.440**	**-0.520**	**0.445**	**-0.510**	**1.000**	
	(0.000)	**(0.045)**	**(0.000)**	**(0.139)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	-----	
LFR	**0.373**	**0.135**	**-0.425**	**-0.021**	**0.479**	**-0.529**	**0.546**	**-0.602**	**0.290**	**1.000**

	(0.000)	(0.001)	(0.000)	(0.788)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	-----

Note LOP is log of oil price; LGDP is log of GDP; LINR is log of interest rate, LINF is log of inflation; LEX is log of exchange rate; LUNE is log of unemployment rate; LFS is log of food supply; LEXD is log of external debt; LCA is log of current account; LFR, is log of foreign reserves. Figures in parentheses is the probability value.

Sources: Author generated 2021.

To capture the degree of correlation between oil price and variables under consideration, the correlation matrix is produced alongside the probability value and the results are shown in tables 6.1 and 6.2 for both groups of net oil-exporting and oil-importing countries, respectively.

From tables 6.8 the results show that oil price positively and significantly correlated with GDP in net oil exporting countries with coefficient value of 0.054. While in table 6.9 the result indicates that, in net oil importing countries the correlation is significant, negative but weak with coefficient value of 0.25. This shows that the influence of oil price on GDP is stronger in net oil exporters than net oil importers. The negative correlation found in net oil importers is consistent with the views of Hamilton (1983) for US between 1948 and 1972.

Negative correlation exists between oil price and interest rate in both net oil exporting and net oil importing with individual coefficient values of 0.37 and 0.56. However, the negative influence of oil price on interest rates is more pronounced in net oil importing countries compared to net oil exporting countries. Consistent with this result is evidence of correlation found between oil price and interest rate in India, Japan, and Vietnam by Urom et al. (2021).

A significant positive but weak correlation exist between oil price and inflation in net oil exporting countries with coefficient value of 0.14, while oil price and inflation correlation in net oil importing countries is significant, weak but negative with coefficient value of 0.28 This result is consistent with Su et al. (2020) who identified correlation between oil price and inflation in Venezuela.

Oil price correlated positively and significantly with exchange rate with coefficient value of 0.104 in net oil exporting countries but negative and significant in net oil importing countries with coefficient value of 0.84. The correlation analysis between oil price and exchange rate shows that exchange rates appreciate in net oil exporting countries while it depreciates in net oil importing countries. This supports expectation of income transfer theoretical framework and transmission mechanism of terms of trade discussed in chapter 4 section 4.3.3. This result is consistent with the views of Wang et al. 's (2020) who evidenced the existence of correlation between oil price and real exchange rate in China.

Oil price insignificantly correlated with unemployment rates in net oil exporting countries, while the correlation is strong and negative in net oil importing countries with coefficient value of 0.81. The result of correlation between oil price and unemployment rate in net oil importing countries is consistent with the expectation of theoretical framework of reallocation effect discussed in chapter 4 section 4.3.1, But the finding in net oil exporting countries is against Cheratian et al.'s (2019) evidence for Kuwait, United Arab Emirate and Syria.

Oil price drive very strong significant positive correlation with food supply in both net oil exporting and net oil importing countries with individual coefficient values of 0.69 and 0.91. However, oil price seems to be more significantly correlated with food supply in net oil importing countries more than in net oil exporting countries. The explanation of the strong correlation between oil price and food supply can be linked to the expectation of real business cycle theory (see chapter 4 section 4.3.4

for more detailed discussions). Furthermore, the result is consistent with evidence of Zingbagba et al. (2020) in São Paulo.

Oil price correlated significantly and positively with external debt in both net oil exporting and net oil importing countries with individual coefficient values of 0.35 and 0.28. The correlation between oil price and external debt is higher in net oil exporting countries more than in net oil importing countries. This could be due to oil exporters leveraging oil wealth to gain access to international capital and the dramatic increased spending with hope of continued higher oil earnings (Kretzmann and Nooruddin 2005; Onigbinde et al.2014).

Also, the correlation between oil price and current account is higher in net oil exporting countries with coefficient value of 0.38 compared to net oil importing countries whose coefficient value is 0.36. This finding is line with the evidence of Allegret et al. (2014) that oil price correlate more with current accounts of countries that have poor developed financial system.

Finally, there is significant positive correlation between oil price and foreign reserves in both net oil exporting and net oil importing countries. However, the correlation between oil price and foreign reserves is greater in net oil exporting countries with coefficient value of 0.64 compared to net oil importing countries whose coefficient value is 0.37. This shows that net oil exporting countries have more understanding of the opportunity cost and benefits of holding foreign reserves compared to oil importers (Oyeniran and Alamu 2020). This result is consistent with the evidence of Khan et al. (2021) that significant positive correlation exists between oil price and foreign reserves in Saudi Arabi.

6.7 Panel ARDL Model

The empirical examination of the relationship between oil price and macroeconomic variables in this study has three objectives. First, to determine the short-run and the long-run dynamic relationship among the variables employed. Second, to use the panel ARDL model to evaluate the validity of the hypotheses developed in chapter 6, which captures the asymmetric effect of oil price on the key macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. Third, to evaluate if the response of macroeconomic variables to the asymmetries in oil price is the same in the chosen net oil-exporting and net oil-importing countries in Africa.

In the previous sections, discussions on fundamental testing techniques, including unit root test, optimal lag length selection co-integration test, were discussed in detail. It was found that the variables are integrated of order zero I (0) and order one I (1), indicating that the variables are stationary at levels and 1st difference. A co-integration relationship between and among the variables was equally identified through the Kao (1999) and Johansen (19888) co-integration panel test. This evidence a long-run relationship between and among the variables, Therefore, to account for short-run disequilibrium, which is viewed as an adjustment process to long-run equilibrium, the adjustment process is captured using the Error Correction term (*ECT*). The re-parametrized panel ARDL (p q, q……q) equation is written as:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{p-1} \lambda_i \Delta Y_{t-1} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-1} + \varphi ECT_{t-1} + \varepsilon_t \;\ldots\ldots\ldots\ldots\ldots\ldots\; (6.4)$$

Replaces *ECT* the long run ARDL component.

$$\left.\begin{array}{l} \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varphi_3 X_{t-1} + \varphi_4 X_{t-1} + \varphi_5 X_{t-1} + \\ \varphi_6 X_{t-1} + \varphi_7 X_{t-1} + \varphi_8 X_{t-1} + \varphi_9 X_{t-1} + \varphi_{10} X_{t-1} \end{array}\right\}$$

Where:

φ is the group -specific speed of adjustment coefficient (expected that $\varphi_t < 0$).ECT is the error correction term which has to be negative and statistically significant. ECT shows the adjustment speed to long run equilibrium following a short run shock.; $\varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varphi_3 X_{t-1} + \varphi_4 X_{t-1}$.........$\varphi_5 X_{t-1}$ is the vector of long run relationship that replaces ECT in equation 1. $\sum_{i=1}^{p-1} \lambda_i \Delta Y_{t-1} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-1}$ are the short run parameters. β_1 to β_n are the coefficients of the explanatory variables (independent variables). ε_t is the noise.

The error correction term (*ECT*) captures the long-run equilibrium relationship in the panel ARDL model. The associated φ of the error correction term is the speed of adjustment that measures how long it takes the system to go back to long-run equilibrium in each shock (Salisu and Isah 2017). The variations in the dependent variables are estimated as a function of imbalance in the long-run relationship. The change in the explanatory variables captures all the short-run associations between and among the variables (Pao and Tsai 2010). The panel ARDL model in the ten variables case is specified as follows:

$$\Delta LOP_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \Delta LOP_{t-1} + \sum_{i=0}^{q_1} \delta_i \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \Delta LINR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \Delta LINF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \Delta LEX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \Delta LFS_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \Delta LFR_{t-1} + \varphi_1 LOP_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_{6L} LUNE_{t-1} + \varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10L} LFR_{t-1} + \varepsilon_t \text{.........}$$

$$\Delta LGDP_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LOP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta \mathrm{L}INR_{t-1} +$$

$$\sum_{i=0}^{q_3} \delta_{3i} \, \Delta \mathrm{L}INF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta \mathrm{LE}X_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta \mathrm{L}FS_{t-1}$$

$$+ \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LGDP_{t-1} +$$

$$\varphi_2 LOP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} +$$

$$\varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots$$

$$\Delta LINR_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta \mathrm{L}INR_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LOP_{t-1} +$$

$$\sum_{i=0}^{q_3} \delta_{3i} \, \Delta LINF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta LEX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta \mathrm{L}FS_{t-1}$$

$$+ \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LINR_{t-1} +$$

$$\varphi_2 LGDP_{t-1} + \varphi_3 LOP_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} +$$

$$\varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots..$$

$$\Delta LINF_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta \mathrm{L}INF_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta \mathrm{L}INR_{t-1} +$$

$$\sum_{i=0}^{q_3} \delta_{3i} \, \Delta LOP_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta \mathrm{LE}X_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta \mathrm{LUNE}_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta LFS_{t-1}$$

$$+ \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta \mathrm{L}EXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LINF_{t-1} +$$

$$\varphi_2 LGDP_{t-1} + \varphi_{3L} INR_{t-1} + \varphi_4 LOP_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} +$$

$$\varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots.$$

$$\Delta LEX_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta LEX_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LINR_{t-1} +$$

$$\sum_{i=0}^{q_3} \delta_{3i} \, \Delta \mathrm{L}INF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta \mathrm{L}OP_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta \mathrm{L}UNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta FS_{t-1}$$

$$+ \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta \mathrm{LCA}_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LEX_{t-1} +$$

$$\varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LOP_{t-1} + \varphi_6 LUNE_{t-1} +$$

$$\varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots$$

$$\Delta LUNE_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LINR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \, \Delta LINF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta LEX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LOP_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta LFS_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LUNE_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LOP_{t-1} + \varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots$$

$$\Delta LFS_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta \mathrm{L}FS_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta \mathrm{L}INR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \, \Delta \mathrm{L}INF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta LEX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta LOP_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LFS_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} + \varphi_7 LOP_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots.$$

$$\Delta LEXD_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta \mathrm{L}EXD_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LINR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \, \Delta LINF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta \mathrm{L}EX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta LFS_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta \mathrm{L}OP_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LFR_{t-1} + \varphi_1 LEXD_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} + \varphi_7 LFS_{t-1} + \varphi_8 LOP_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots$$

$$\Delta LCA_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta \mathrm{L}CA_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta \mathrm{L}GDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LINR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \, \Delta \mathrm{L}INF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta \mathrm{L}EX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta \mathrm{L}FS_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LOP_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta \mathrm{L}FR_{t-1} + \varphi_{1L} CA_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} + \varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LOP_{t-1} + \varphi_{10} LFR_{t-1} + \varepsilon_t \ldots\ldots.$$

$$\Delta LFR_t = \beta_0 + \sum_{i=1}^{p} \lambda_i \, \Delta LFR_{t-1} + \sum_{i=0}^{q_1} \delta_i \, \Delta LGDP_{t-1} + \sum_{i=0}^{2} \delta_{2i} \, \Delta LINR_{t-1} + \sum_{i=0}^{q_3} \delta_{3i} \, \Delta LINF_{t-1} + \sum_{i=0}^{q_4} \delta_{4i} \, \Delta LEX_{t-1} + \sum_{i=0}^{q_{5i}} \delta_{5i} \, \Delta LUNE_{t-1} + \sum_{i=0}^{q_{61}} \delta_{6i} \, \Delta LFS_{t-1} + \sum_{i=0}^{q_{7i}} \delta_{7i} \, \Delta LEXD_{t-1} + \sum_{i=0}^{q_{8i}} \delta_{8i} \, \Delta LCA_{t-1} + \sum_{i=0}^{q_{91}} \delta_{9i} \, \Delta LOP_{t-1} + \varphi_1 LFR_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LINR_{t-1} + \varphi_4 LINF_{t-1} + \varphi_5 LEX_{t-1} + \varphi_6 LUNE_{t-1} + \varphi_7 LFS_{t-1} + \varphi_8 LEXD_{t-1} + \varphi_9 LCA_{t-1} + \varphi_{10} LOP_{t-1} + \varepsilon_t \ldots..$$

In addition to the advantages of the panel ARDL model mentioned in this section 5.9.1 of this chapter, the panel ARDL model is significant not only that the estimation from the technique is unbiased in revealing the long-run correlation between and among the variables but also unlike other methods, it adopts a single reduced form equation instead of a system equation (Pesaran and Shin 1999). The panel ARDL model is suitable for any sample size, unlike other approaches, which are sensitive to small sample size and the estimates of t-statistics are also valid even in the presence of endogenous explanatory variables (Akinsola and Odhiambo 2020).

6.8 Hypotheses Development

This section presents the hypotheses development to analysing the relationship between oil price movements and macroeconomic activities.

6.8.1 Presentation of Hypothesis 1

The fluctuations in oil prices create uncertainty (Elder and Serletis 2010; Kocaaslan 2019.) and has a reallocation effect (Brown and Yucel 2002; Gonzalez and Nabiyev 2009; Dogrul and Soytas 2010) on the production structure of firms, and this may create a change in the production cost (Lescaroux and Mignon 2008; Odhiambo 2010; Ahmed 2013). With an increase in production cost due to rising oil price, the productivity level is affected. This can lead to a decrease in the growth rate of wages, which may have an ultimate effect on unemployment rate at which the real money held by households and firms may decrease (Nzimande and Msomi 2016). If the real money held by households and firms decreases the purchasing power is affected, GDP growth rate may be affected, leading to an aggregate contraction of economic activities and growth rate (Gonzalez and Nabiyev 2009).

However, some studies in the literature argued that monetary policy play a key role in GDP growth rate dynamics more than changes in oil price (Bernanke et al.1997; Tang and Xiong 2012; Chatziantoniou et al.2021). For example, Bernanke et al. (1997) found that the post-war GDP growth rate reduction in the U.S. is a function of monetary policy tightening rather than oil price-macroeconomic relationship. This evidence is consistent with the view of Tatom (1988), who argued that monetary authority behaviour was a possible explanation of GDP growth rate dynamics.

Mixed empirical and different theoretical explanations on oil price- macroeconomic variables relationship provide room for further analysis. This study tends to investigate the hypothesis based on reviewed literature and to add to the existing empirical evidence. The essence of this study investigating oil price-GDP relationship in the context of net oil exporting and importing countries, is to obtain information about the size and how the economies of these countries performed after oil price shocks. This will help policymakers and investors to make inform decisions given that GDP is an indicator of the general health of an economy. The following hypothesis will be tested to verify the effect of changes in oil price on GDP growth rate in the context of net oil-exporting and net oil-importing countries in Africa.

H_1: Changes in oil price have no significant effect on GDP growth rate in net oil-exporting and importing countries in Africa.

H_1 : Changes in oil price have a significant effect on GDP growth rate in net oil exporting and importing countries in Africa.

6.8.2 Presentation of Hypothesis 2

Existing literature suggests that an increase in oil price substantiates an increase in money demand and vice versa (Brown and Yucel 2002). When monetary authorities fail to meet the growing demand for money, interest rates may increase, validating economic contraction through a rise in inflation and high cost of borrowing (Ahmed 2013). Tang et al. (2009) believed that given a fluctuation in oil price, the interest rate disparity ratio could cause countries with the high-interest rate to experience depreciation of domestic currencies, and countries with low-interest rates experience appreciation in domestic currencies.

The impact of oil price on economic activities through interest rate has been well documented in the literature (Urom et al. 2021; Śmiech et al. 2021). Studies including Hoover and Perez (1994) and Lee et al. (2001) found that oil price Granger-cause interest rate. Hoover and Perez (1994) found that increase in oil price has a significant impact on interest rate. Lee et al. (2001) found that an increase in oil price induces an increase in the call money rate, which strengthens the Japanese economy's contractionary effect. This is consistent with the view of Kim et al. (2015) that shocks in oil price is a significant source of interest rate volatility in China. Contrarily to this view, Friedmann, and Schwartz (1965) believed that fluctuations in short-term interest rates in the United States are a function of monetary policy instead of oil price shocks.

Given the inconsistent findings on oil price-interest rate nexus, this study presents the following hypothesis.

H_0: Changes in oil price do not have a significant effect on interest rate in net oil-exporting and importing countries in Africa.

H_1: Changes in oil price have a significant effect on interest rate in net oil exporting and importing countries in Africa.

6.8.3 Presentation of Hypothesis 3

Inflation effect is identified in the literature as one of the channels through which oil price-macroeconomic relationships affect economic activities and growth (Tang et al. 2009). In an open economy, it is observed that monetary authorities use inflation to direct monetary policies and set interest rates (Brown and Yucel 2002). The use of inflation threshold by monetary authorities is to avoid overheating the economy through deflation or high inflation (Tang et al.2009).

Given an increase in oil prices, it is expected that the demand for money will increase in net oil importing countries (Brown and Yucel 2002). Furthermore, to adjust to the new equilibrium of money demand, interest rate will change, affecting the prices of goods and services and even borrowing (Ahmed 2013). When the prices of goods and services are affected, the purchasing power of household and firms are affected. This may have an aggregate impact on economic activities and growth.

Using time series analysis, Jumah and Pastuszy (2007) found that an increase in oil prices has a negative effect on inflation in Ghana. This is consistent with Trang et al. (2017), that increase in oil price significantly and negatively affect oil price in Vietnam. In contrast, Miguel et al. (2009) believed that fluctuations in oil price have little or no effect on inflation in the 1980s. Rather variations in inflation is a function of monetary policy. Supporting this view, Reicher, and Utlaut (2010) opined that monetary policy is the primary factor determining inflation variations.

This study intends to throw more light in understanding how fluctuations in oil price affect inflation in the context of net oil-exporting and net oil-importing countries in Africa. This investigation is significant given that inflation affects all aspect of the economy such as business, consumer spending, unemployment rates, investments and government programs including interest rates and tax policies. Hence, if shocks in oil price affect inflation all these economic indicators will be affected given that inflation can reduce their economic values. Thus, examining oil price-inflation nexus will provide information for policymakers and investors to make inform decisions. Therefore, the following hypothesis is put forward:

H_0: Changes in oil price do not have significant effect on inflation in net oil exporting and importing countries in Arica.

H_1: Changes in oil price have a significant effect on inflation in net oil exporting and importing countries in Arica.

6.8.4 Presentation of Hypothesis 4

The theory of income transfer suggests that when oil price increases, wealth is transferred from net oil-importing countries to net oil-exporting countries through terms of trade dynamics (Beckmann et al. 2017, Ahmed 2013 and Brown and Yucel 2002). When there is terms trade dynamics, exchange rate is affected (Balli et al. 2021). An increase in terms of trade given an increase in oil price, cause exchange rate of net oil importing countries to depreciate, while exchange rate of net oil exporting countries will appreciate (Beckmann et al.2017).

Several studies have argued that the relationship between oil price and exchange rate is asymmetric. For example, Rautava (2004) forecasted both long run and short run asymmetric relationship between oil price and exchange rate in Russia. Chen and Chen (2007) used panel data covering 1972 to 2005 and found asymmetric long run relationship between oil price and exchange rate in G7 countries. This is consistent with the views of Volkov and Yuhn (2016) whose predicted significant asymmetric relationship between oil price and exchange rate in Russia. Lizardo and Molick (2010) forecasted negative long run relationship between oil price and exchange rate of Canada, Mexico, and Russia. While Brazil and Mexico. Basher et al. (2012) concluded that oil price and exchange rate exhibit positive long run relationship in emerging markets.

Beckmann et al. (2017) opined that oil price is a valuable predictor of exchange rate variation in the short run. Chaudhuri and Daniel (1998) evidenced a long-run equilibrium relationship between oil price and the U.S. exchange rate following the 1979 oil price increase. They found that the deterioration of the domestic real exchange rate as oil price declines in the U.K., Japan, and German. In contrast to the above views, Bayat et al. (2015) used frequency domain analysis and evidenced that oil price does not have a causal effect on the exchange rate in Hungary.

This study will test oil price-exchange rate relationship in the context of net oil-exporting and net oil-importing countries in Africa. The significance of this empirical analysis is to show that changes in oil price is a significant in determining exchange rate dynamics. This will provide information for policymakers to make informed decisions on the type of monetary and fiscal policies to adopt to shield domestic currency from oil price shocks. The following hypothesis will be tested.

H_0: Changes in oil price do not have a significant effect on exchange rate in

net oil-exporting and importing countries in Arica.

H_1: Changes in oil price have a significant effect on exchange rate in

net oil-exporting and importing countries in Arica.

6.8.5 Presentation of Hypothesis 5

The literature suggests that a rise in oil prices will increase the cost of production in net oil-importing countries due to reallocation effect and structural adjustment cost (Ahmed 2013, Brown Yucel 2002). Reallocation effect and structural adjustment cost affect unemployment rate through production cost. A prolonged increase in oil price can potentially impact productivity level through production cost. (Loungani 1986). Firms may be forced to change their production structure (Doğrul and Soytas 2010) and consequently labour may be reallocated across sectors given an increase in oil price (Kocaarslan et al.2020), and this can affect unemployment rate significantly. There is a likelihood of an increase in investment uncertainty and reduction in productivity level (Kocaarslan et al.2020; Baffes et al.2015). Given a reduction in When the productivity declines, production structure may change, which will lead to increase in unemployment rate as workers are being laid off (Kocaarslan et al.2020; Dogrul and Soytas 2010).

With all other things are held constant, increased uncertainty associated with changes in oil prices may prompt firms to postpone investment decisions (Bernanke, 1983). Furthermore, increase in uncertainty can cause investment to drop (Kilian 2014), given that cash flow for an irreversible investment project is a function of changes in oil price (Carruth et al.1998).

Dogrul and Soytas (2010) used Toda–Yamamoto procedure to show that changes in oil price have predictive power over the unemployment rate in Turkey. In their analysis, Carruth et al. (1998) opined those changes in the equilibrium of unemployment rate are attributed to demand changes triggered by the fluctuations in oil price. Papapetrou (2001) confirmed an immediate and negative effect of oil price shocks on unemployment in Greece using monthly data from 1989m1 to 1996m6. Andreopoulos (2009) used quarterly data from the period 1953q2 to 2007q2 to examine causality between oil price and unemployment rate. His findings reveal that oil prices help forecast unemployment in a recession. In contrast, Cuestas (2016) found that oil price has no effect on the unemployment rate, but oil price affects the equilibrium unemployment rate in Spain.

The following hypothesis is developed to test the effects of oil price changes on unemployment rate in the context of net oil exporting and importing countries in Africa.

H_0: Oil price changes do not have a significant effect on unemployment rate in net exporting and importing countries in Africa.

H_1: Oil price changes have a significant effect on unemployment rate in net exporting and importing countries in Africa.

6.8.6 Presentation of Hypothesis 6

Business cycle theory suggests that changes in oil price affect macroeconomic variables through market dynamics (Pönkä and Zheng 2019; Gonzalez and Nabiyev 2009). The principle of the real business cycle is that if an external shock from oil price fluctuations occurs, indirectly cause changes on food supply through its effect on consumer price index (Sharma and Shrivastava 2021). This may directly affect wages given an increase in inflation (Sarwar et al. 2020). If food constitute a significant part of consumer consumption basket, cost of production may increase, affecting firms' decisions and workers, which may result in changes in their production and consumption patterns (Timilsina et al. 2011). This may eventually affect output and commodity prices, including food supply (Nwoko et al. 2015, Byrne et al. 2012, Gonzalez and Nabiyev 2009, and Finn 1982). Nwoko et al. (2015) forecasted that changes in oil price have positive predictive power over food supply in Nigeria. They identified a long-run relationship between oil price and variations in food supply. The finding suggests that changes in global oil price dictate the behaviour of food price in Nigeria. Hence, market forces of demand and supply shocks of oil price can be used to determine the price of food in Nigeria.

Using the Bayesian multivariate framework, Sujithan et al. (2014) assessed the effect of oil price on food price volatility. Their findings show that shocks in oil price led to an increase in food prices. Timilsina et al. (2011) concluded an inverse relationship between increase in oil price and food supply in Russia, United States, South Africa, Malaysia, India, and Brazil. Sarwar et al. (2020) used NRADL model and forecasted asymmetric significant positive relationship between increase in oil price and food price in Pakistan.

Therefore, the following hypothesis is developed to support the relationship between fluctuations in oil price and food supply. Given that food supply contributes to economic growth, understanding oil price-food supply relationship will help policymaker provide policy that will shield food supply from oil price shocks.

H_0: Oil price changes do not have a significant effect on food supply in net oil exporting and importing countries in Africa.

H_0: Oil price changes significantly affect food supply in net oil-exporting and oil importing countries in Africa.

6.8.7 Presentation of Hypothesis 7

With the fluctuation in oil prices, for example, increase in oil prices is expected to facilitate increased accumulation of revenue in net oil exporting countries, hence reduction in external debt (Kretzmann and Nooruddin 2005). While it is expected that increase in oil price will create increase in external debt, given a decline in income held (Cline 1984). The mismanagement of public funds through corrupt practices and inadequate public investment processes has caused the windfall generated from excess crude oil to be mismanaged with consequences on economic growth (Didia and Ayokunke 2020).

In their empirical investigation, Kretzmann and Nooruddin (2005) used Generalized Method of Moment (GMM) with data covering 1970 to 2000 and found that an increase in crude oil price led to an increase in external debt in both net oil-exporting and net importing economies. Consistent with the above view, Onigbinde et al. (2014) used extended literature reviews and conclude that despite the increased accumulation of revenue from oil price increase, there is an increase spike in Nigeria’s external debt. The implication of this finding suggests that the windfall from increase in oil price is not well utilized for investment and economic growth. Hence, policymakers should provide policies that encourage increase in investment and reduction in external debt accumulation. In contrast to the above views, Jin and Xiong (2021) used New Keynesian model with data from $2003q_1$ to $2016q_4$ to show that external debt is a function of monetary policy instead of changes in oil price in Russia.

With the varying results reviewed in literature, it is important to examine the impact of fluctuations in oil price on external debt dynamics in the context of net oil exporting and net oil importing countries in Africa. This will help provide information that will enable policymakers how to utilize the windfall from oil revenue and shield the economy from external debt shocks. The following hypothesis is developed:

H_0: Changes in oil price do not have a significant effect on external debt in net oil-exporting and importing countries in Africa.

H_1: Changes in oil price have a significant effect on external debt in net oil exporting and importing countries in Africa.

6.8.8 Presentation of Hypothesis 8

The theory of income shift suggests that changes in oil price validates terms of trade dynamics. Countries with high dependence on crude oil will experience exchange rates dynamics from income transfer arising from changes in terms of trade (Brown and Yucel 2002; Su et al. 2021). The transfer of wealth may reflect imbalances in current account (deficits or surplus), due to exchange rates dynamics (Beckmann et al.2017), given changes in oil price (Gnimassoun et al. 2017). The adjustment in exchange rate dynamics can validate increased shift in current account and reallocation of portfolios (Beckmann et al. 2017; Qurat-ul-Ain and Tufail 2013), given that domestic currencies of high crude oil dependence countries will either appreciate or depreciate (Qurat-ul-Ain and Tufail 2013). The degree of impact of oil price fluctuations on current accounts depends on whether an economy is an oil exporter or an oil importer (Gnimassoun et al. 2017; Fowowe 2014; Buetzer et al.2012).

With panel smooth transition regression models and data covering 1980 to 2000 Allegret et al. (2014) concluded non-linear effect of oil price on current account in net oil exporting countries. The result of non-linear effect of oil price on current account is found to be crucially a function of the degree of financial development of the countries examined. Suggesting that the allocation of financial development of the accumulated oil price revenues and ability of these countries to formulate policies that will shield the economy from price shock is very significant.

Beak and Choi (2018) used NARDL model to conclude that increase in oil price yield current accounts surplus in Indonesian. Consistent with this result, Turan et al. (2020) used ARDL model and predicted significant relationship between oil price and current accounts in Poland and Czechia. In Addition, Gnimassoun et al. (2017) used TVP-VAR model with time restriction and found that oil supply shock is insignificant in predicting current account, while oil demand shock positively and significantly forecasted current accounts in Canada.

Qurat-ul-Ain and Tufail (2013) used Vector Autoregression (VAR) model and evidenced significant deteriorating asymmetric long run and short run effect of oil price on current accounts in net oil exporting countries. While in net oil importing increase in oil price asymmetrically improves current accounts dynamics in the short run.

Given the divergent view and empirical explanations contingent on oil price - current account relationship gives room for further investigation; this study will test the following hypothesis:

H_0: Changes in oil price do not have a significant effect on current account in net oil-exporting and importing countries in Africa.

H_1: Changes in oil price have a significant effect on current account in net oil exporting and importing countries in Africa.

6.8.9 Presentation of Hypothesis 9

This section presents the hypothesis informed by the theory of income transfer and terms and trade channel, which reflect how the relationship between oil price and foreign reserves affect economic activities and growth. Just as explained in chapter 4, section 4.5.8, when income is transferred from net oil-importing to net oil-exporting in the form of import payment, it reflects surpluses in net oil-exporting countries and deficit in net oil-importing countries (Ahmed 2013). The foreign reserves of net oil-exporting countries increase while that of net oil-importing countries decreases (Beckmann et al. 2017). However, the magnitude of oil price fluctuations on foreign reserves, according to scholars such as Buetzer et al. (2012) and Gnimassoun et al. (2017), depend on the share of oil dependence the country.

Likewise, terms of trade channel can cause a relative change in export-to-import ratio dynamics (Beckmann et al.2017), as such domestic currencies of these countries will either depreciate or appreciate. The adjustment in exchange rate may amplify portfolio reallocation and increase in foreign reserves (Beckmann et al. 2017). However, the impact of oil price fluctuations on foreign reserve is relative to country's share of oil dependency (Gnimassoun et al. 2017)

Olayungbo (2019) used a frequency domain causality approach to evidence that oil price strongly causes foreign reserves in the short run in Nigeria. Gnimassoun et al. (2017) and Bénassy-Quéré et al. (2007) revealed that as income is transferred from net oil-importing to net oil-exporting countries through import payment, the export ratio of net oil-exporting countries increases, and this may reflect an appreciation of domestic currency and increase in foreign while that of net oil-importing countries decreases. It is also expected that as the foreign reserves of net oil-exporting countries increase, they may reinvest their surplus in foreign assets (Buetzer et al.2016 and Coudert et al.2008 and Bénassy-Quéré et al. 2007). The accumulated foreign reserve is expected to act as a buffer or stabilizer given any economic crisis (Lee 2016). In contrast, Jin and Xiong (2021) opined that policy switching accounts for fluctuations in foreign reserves in Russia.

Given the varying theoretical and empirical explanations on oil price- foreign reserves nexus, this study intends to show how fluctuations in oil price affect macroeconomic variables through oil price-foreign reserves dynamics with the following hypothesis.

H_0: Changings in oil price do have a significant effect on foreign reserves in net oil exporting and importing countries in Africa.

H_1 : Changes in oil price have a significant effect on foreign reserves in net oil exporting and importing countries in Africa.

6.8.10 Presentation of Hypothesis 10

This section presents a hypothesis informed by how fluctuations in oil prices affect macroeconomic variables in the short run and the long run through demand and supply channels. In a classic supply-side effect where an increase(decrease) in oil price is associated with various factors including reduced (increase) availability of basic input to production in net oil-importing economies (González and Nabiyev 2009), transfer of income from net oil-importing (exporting) to net oil-exporting (importing) countries (Beckmann et al. 2017) and monetary policy and real balance effect (Jin and Xiong 2021; Brown and Yucel 2002).

For example, in a classical, supply-side effect, the marginal cost of production increases due to a rise in oil price. Thus, the cost of production increases (Ahmed 2013). Increased production costs make it difficult for the firms to continue production at existing or total production capacity (Kocaarslan et al.2020). Therefore, production level reduces, and potential workers are laid off, and this may lead to an increase in unemployment rate and a potential increase in inflation, consequently a decline in economic activities and growth in the long run (Brown and Yucel 2002).

Several studies on the asymmetric relationship between oil price and macroeconomic variables have been examined in the literature, and the findings are mixed (see Qin et al. 2016; Malikov 2016; Bastianin et al. 2014; Atil et al. 2014; Venditti 2013; Hooker 2002). For example, Ordonez et al. (2019) found that an increase in oil price validates unemployment rate negatively, while the decline in oil price has a positive feedback effect on the unemployment rate in Spain. Caporale and Gil-Alana (2002) advocated for a long-run swing of oil prices on unemployment rate in Canada. In contrast, Keane, and Prasad (1996) found a short-run relationship between oil price and unemployment rate in the U.S.

Considering the long-run impact of oil price-macroeconomic relationship on economic activities, not only that Dogrul and Soytas (2010) found a long-run relationship between oil price and unemployment rate in the emerging market. Furthermore, scholars including Hooker (2002), Carruth et al. (1998), and Rasche and Tatom (1977b, 1981) found a long-term cointegrating relationship between oil price, unemployment, and real interest rate.

Baek and Choi (2021) concluded that fluctuations in oil prices have asymmetric effects on the rupiah exchange rate in Indonesia both in the long run and short run. In contrast, Basnet and Upadhyaya (2015) opined that oil price has little impact on Indonesia's rupiah exchange rate. Chen and Chen (2007) explored a sample of G7 countries and conclude that oil price has long-run predictive power over exchange rate. Reboredo (2012) in identifying oil price-exchange rate nexus, concludes that oil price is insignificant in affecting exchange rate in E.U. countries.

Batu et al.(2017b) focused on low-income countries and found that the oil price - GDP relationship is limited to the short run. Cunado and Perez-de Gracia (2003), in their analysis of oil price-GDP relationship in 14 European countries, revealed that oil price predicted GDP in the short run of countries examined except the United Kingdom and Ireland, where a long run relationship exists between oil price and GDP. In a study carried out by Lescaroux and Mignon (2008), they found a long-run relationship between oil price and GDP in twelve countries but a long-run relationship between oil price and unemployment rate and share price in non-OPEC countries. Cunado and Perez-de Gracia (2013) and Rafiq and Salim (2011) examined the impact of oil price-macroeconomic relationship on economic activities and growth and found a short-run relationship.

Oyelami and Olomola (2016), in their study on oil price-macroeconomic relation in Nigeria and her trading partners, found that oil price supply shocks have a direct effect on GDP and exchange rate but no immediate effect on short term interest rate and inflation in Nigeria but immediate effect on the short-term interest rate and inflation of the developed countries of U.S., E.U., China, and Japan. On the other hand, Baffes et al. (2015), through income shift theory, noted that when income is transferred from net oil-exporting to oil-importing countries given a decrease in oil price, shocks in oil price cause a net positive effect on global economic activities over the medium term.

The divergent explanation contingent on how fluctuations in oil price affect macroeconomic variables in the long run and short run gives room for further examination of this relationship in the context of net oil-exporting and net oil-importing countries in Africa. Therefore, the following hypothesis is formulated.

H_0: Changes in oil price do not have the same short-run and long-run effect on macroeconomic variables in net oil-exporting and net oil-importing countries in Africa.

H_1: Changes in oil price have the same short-run and long-run effect on macroeconomic variables in net oil-exporting and importing countries in Africa.

6.8.11 Presentation of Hypothesis 11

Scholars including Gnimassoun et al. (2017) and Iwayemi and Fowowe (2010) believed that the impact of oil price-macroeconomic relationship on economic activities and growth is country-specific. Implying oil price-macroeconomic relationship is a function of country's share in oil. Thus, there are some emphases on literature that have analysed how fluctuations in oil price affect macroeconomic variables of countries of net oil-exporting and net oil-importing (see Gbatu et al.2017a; Salisu and Isah 2017; Rafiq et al. 2016).

Jibril et al. (2020) studied the asymmetric impacts of oil price fluctuations on the trade balance of 75 oil-importing and 25 oil-exporting countries. They concluded that the effect is a function of the source of the shock. In support of this view, Lin and Bai (2021) argued that economic policy uncertainty indices for net oil exporters and net oil importers respond differently to oil price shock. They found that shocks in oil price have more effect on the economic policy of net oil-exporting countries than net oil-importing countries.

Hou et al. (2015) estimated the direct effect, indirect effect, and actual impact of oil price supply shock on the economies of net oil-exporting and net oil-importing countries in Africa. Their findings showed that the oil price decline of 2014 and 2015 resulted in a 30% drop in crude oil exports of net oil-exporting countries including Nigeria, Angola, Equatorial Guinea, Congo, Gabon, and Sudan, which amounted to a loss of $63 billion. While a reduced import of oil worth $15 billion was experienced in countries including South Africa, Tanzania, Kenya, and Ethiopia. Inflation dropped by 2% in Tanzania, South Africa, and Kenya, while Nigeria and Angola experienced a 2% increase in inflation. Equally noted was a drop in current account, devolution of naira, and an 8% cut in government spending in Nigeria while Tanzania and South Africa had increased current account.

Batu et al. (2017a) divided ECOWAS countries into a group of net oil-exporting and net oil-importing countries and examined the asymmetric effects of oil price shocks on economic activities and growth. The result showed a linear and asymmetric impact of oil price on real GDP and exchange rate of net oil-exporting and net oil-importing ECOWAS countries. Salisu and Isah (2017) found that stock price responds asymmetrically to oil price in net oil-exporting and oil-importing countries.

In an empirical analysis of some OECD countries, Jiménez-Rodríguez, and Sánchez (2005) argued that oil price impacts are non-linear on real GDP. An increase in oil price has a more significant impact than a decrease in oil price. Moreover, a decline in oil prices is found to be statistically insignificant in nearly all instances. For net oil-importing countries, shocks in oil price have an adverse effect on economic activities for all countries (Canada, Euro Area, U.S, Germany, France, and Italy) excluding Japan. For the net oil-exporting countries, Norway profited from the oil price shocks while the U.K. was adversely affected by oil price shocks within the study period.

Given the divergent results on how fluctuations in oil price affect macroeconomic variables of net oil-exporting and net oil-importing countries in Africa, the following hypothesis is formulated to show more insight into how fluctuations in oil price affect macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa.

H_0: changes in oil price do not have the same asymmetric effect on macroeconomic variables in net oil-exporting and net oil-importing countries in Africa.

H_1: Changes in oil price have the same asymmetric effect on macroeconomic variables in net oil-exporting and importing countries in Africa.

6.9 Discussion of Findings

This section reports the results obtained from econometric analyses.

6.9.1 Result from Econometric Analysis Using Panel ARDL Model.

It is reported in section 5.10.1 in chapter 5 that the variables are integrated of order zero, I (0) and order one I (1). First panel ARDL model is employed to analyse the asymmetric short run and long-run equilibrium relationship between oil price and key macroeconomic variables. Second, Granger-causality and Wald tests are employed for robust check. The Granger-causality test is employed to determine the direction of the relationship. The Granger-causality is used to test the long run causal relationship while Wald test techniques examines the short run causal relationship between oil price and variables of GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current accounts, and foreign reserves. A diagnostic test is carried out using normality test and cross-sectional dependence test. This is to establish the consistency and validity of the model used. The normality test shows how normally distributed the variables are. The existence of cross -sectional dependence can be problematic in a panel data (Baltagi 2005; Akinsola and Odhiambo 2020). As such its estimation is significant to evidence if the choice of model is valid or not. Panel ARDL model has the following advantages:

1. The model has the ability not to be biased in simultaneously showing the long-run and short-run relationship among variables
2. Unlike other models, panel ARDL model adopts a single reduced form equation instead of system equation (Pesaran and Shin 1999).
3. It is suitable for any sample size, unlike other methods which are sensitive to small sample size.
4. The estimation of the panel ARDL model t-statistics are valid even in the presence of endogenous explanatory variables (Akinsola and Odhiambo 2020).
5. Panel ARDL is suitable for estimation of variables integrated of order zero, I (0) and order one I (1).
6. In panel ARDL model the dependent and independent variables are permitted to have unrestricted number of lags (Cheratian et al.2019).

In panel ARDL analysis, if the coefficient φ of *ECT* is negative, the long-run relationship among the variables is stable (Hussain 2009). The advantages of *ECT* in panel ARDL model are as follows:

1. ECT validates the quickness of changes of the determinants for assemblage to equilibrium.
2. It also provides feedback about the long-term correlation among the determinants for the group of countries under study (Alsaleh and Abul-Rahim 2019; Salisu and Isah 2017).
3. It is useful estimating both short-term and long-term effect of one time series on another.

ECT is widely used in literature. For example, Salisu and Isah (2017) used the error correction term *(ECT)* to capture the speed of change at which the relationship between oil price and stock prices converged to long-run equilibrium in net oil-exporting and net oil-importing countries.

6.9.1.1 Discussion on Results on Hypothesis 1 Testing

The panel ARDL estimated the short-run and the long-run effect of oil price changes on GDP are reported in tables 6.10 and 6.11.

It is found that the coefficients of the *ECT* have a negative sign in both net oil-exporting and net oil-importing countries. The coefficient of *ECT* is statistically significant in net oil-exporting countries, which means that in net oil-exporting countries, the long-run equilibrium point is significantly reached at a stable rate of 14.02%. In contrast, the long-run equilibrium point is statistically insignificant in net oil-importing countries. Implying that in net oil exporting countries, there exist the presence of significant statistical causal relationship between oil price and GDP. While in net oil importing countries, the presence of long run causal relationship exists but it is insignificant.

Different effects are found of changes in oil price on GDP in net oil-exporting and net oil-importing countries. Net oil exporting countries presented a positive long run asymmetry in response of GDP to oil price change as opposed to a typical asymmetric negative long run response of GDP to changes in oil price in net oil importing countries. A 1%-point increase in oil price in the long run positively and significantly forecasted 5.5% improvement in GDP in net oil-exporting countries, while it reduces GDP by 3.7% in net oil importing countries. This result aligns with views of Awartani et al. (2020) for MENA region and Nusair and Olson (2021) for Indonesia, Korea, Singapore, and Thailand. Meaning that in the long run GDP growth in net oil exporting countries is linked to changes in oil price. Also, GDP reduction in net oil importing countries is linked to changes in oil price. These results are significant, and they can provide information for policymakers in providing long run policies that are concern with stabilizing the economies of net oil exporting and importing countries against changes in oil price.

The short run analysis presented a positive response of GDP to oil price changes as opposed to a typical negative response of GDP to oil price changes in net oil importing countries. A 1%-point increase in oil price validates a 1.7% increase in GDP in net oil-exporting countries and a 2.7% decrease in GDP in net oil-importing countries. Meaning that in the short run oil price Improves GDP growth in net oil exporting countries, while it contracts GDP growth rate in net oil importing countries. These results are consistent with the views of Elmezouar et al. (2014) for Algeria, Chiweza and Aye (2017) for South Africa and Nusair and Olson (2021) for Indonesia, Korea, Singapore, and Thailand. These results will provide a short run information for investors and policymakers to strategies and provide policy that will shield these economies from shocks in oil price.

This finding rejects Hypothesis 1, that changes in oil price do not have significant effect on the GDP growth rate of net oil-exporting and net oil-importing countries in Africa. Thus, this result supports the alternative hypothesis that oil price has predictive power over GDP growth rate both in the long run and the short-run in net oil-exporting and net oil-importing countries. This means that the coefficient of oil price is not zero as oil price has predictive power over GDP in the context of net oil exporting and importing countries both in the short run and in the long run. The results are in line with the theory of income transfer. Income transfer theory argues that with an increase in oil price, income is transferred from net oil importing countries to net oil exporting countries. It expected that the increase in oil price can cause increase in production cost in net oil importing countries to increase. This may cause reduction in productivity level, hence, reduction in GDP growth rate. While in net oil exporting countries, the income transfer from net oil importing given an increase oil price can cause an appreciation of exchange. This may enhance purchasing power of net oil exporting and ultimately increase in GDP growth rate.

From the analysis above, the result fails to reject Hypothesis 10 states that fluctuations in oil price do not have the same short-run and long-run effect on GDP in net oil-exporting and net oil-importing countries in Africa. This is because asymmetric positive relationship exists between oil price and GDP in net oil exporting countries both in the long run and short run. Also found is negative asymmetric relationship between oil price and GDP in oil importing countries both in the long run and in the short run

This study stands to accept Hypothesis 11, given that oil price positively and significantly affects GDP in net oil-exporting countries. However, its impact on GDP in net oil-importing countries is statistically significant but negative. Thus, implying that fluctuations in oil price do not have the same effect in net oil-exporting countries and net oil-importing countries when GDP is the dependent variable.

Table 6.10 Panel ARDL results on the effects of oil price changes on GDP in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.055114**	**0.382962**	**2.102333**	**0.0367**
Panel B: Short Run Equation				
COINTEQ01	-0.140243	0.069348	-2.022288	0.0444
D(LOP)	**0.017731**	0.103660	**2.100439**	**0.0369**

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Note: In this table, the long run and short run effects of oil price changes on GDP in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LGDP, the log of Gross Domestic Product. The following variables are included as independent variables: LOP, the log of oil price; LINR, the log of interest rate; LINF the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves.

Sources: Author generated 2021

Table 6.11 Panel ARDL results on the effects of oil price changes on GDP in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**-0.061407**	**1.883702**	**-1.227055**	**0.0219**
Panel B: Short Run Equation				
COINTEQ01	-0.168825	0.170560	-0.989825	0.3240
D(LOP)	**-0.027288**	**0.626483**	**-0.124964**	**0.0097**

Note: In this table, the long run and short run effects of oil price changes on GDP in net oil importing African countries are reported in Pane A and Panel B respectively. The dependent variable is LGDP, the log of Gross Domestic Product. The following variables are included as independent variables: LOP, the log of oil price; LINR, the log of interest rate; LINF the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves.

Sources: Author generated 2021

6.9.1.2 Discussion of Results on Hypotheses 2 Testing.

Tables 6.12 and 6.13 show the estimation results based on asymmetric oil price change. All the *ECT* coefficients of net oil exporting and net oil importing countries are negative but statistically insignificant. This indicates the presence of insignificant long run causal equilibrium relationship between oil price and interest rates in both net oil exporting and net oil importing countries in Africa.

In panel A the results evidenced that positive change in oil prices have significant adverse effect on interest rate in both net oil exporting and net oil importing countries in Africa. The increasing effect is greater both in its statistical and economic importance for the case of net oil exporting countries. A 1%-point increase in oil prices caused an increase in interest rate by 24.86% and 14.69% respectively in net oil exporting and importing countries in the long run. This shows that oil price effect on interest rate is higher in net oil exporting countries than in oil importing countries. This result is consistent with the views of Ratti and Vespignani (2015) who found positive innovation in oil price changes validates an adverse effect on global interest rate. In the short run, changes in oil price are insignificant in exerting effect on interest rate in both net oil exporting and net oil importing countries in Africa. These findings show more challenges for policymakers especially in net oil exporting countries. The increasing effect of oil price changes on interest rates in both net oil exporting and net oil importing countries can be explained through channel of real balance effect and monetary policy (Pierce and Enzler 1974; Brown and Yucel

2002). Increase oil price for oil exporting countries means increase private and public spending on both tradeable and non-tradeable goods in the economy. While price of tradeable goods is internationally priced, the price of non-tradeable goods and services is a function of domestic market. Increase demand for later goods creates price increase and profit margin at the detriment of domestic manufacturing and agricultural sectors (Cheratian et al. 2019). To encourage domestic manufacturing and agricultural development, import bill of tradeable goods may increase, hence, an adverse effect on interest rate. For oil importing countries, increase in oil price may affect exchange rates through terms of trade. Hence, domestic currency may depreciate creating an adverse effect on interest rates.

This finding rejects Hypothesis 2, that changes in oil price do not have significant effect on interest rates in net oil-exporting and net oil-importing countries in Africa. Thus, this result supports the alternative hypothesis that oil price has predictive power over interest rates both in the long run and the short- run in net oil-exporting and net oil-importing countries.

Table 6.12 Panel ARDL results on the effects of oil price changes on Interest rate in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.248599**	**0.661282**	**1.283264**	**0.0208**
Panel B: Short Run Equation				
COINTEQ01	-0.182615	0.095971	-1.902814	0.0584
D(LOP)	-0.478826	0.520267	-0.920346	0.3584

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LINR, the log of interest rate. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; LINF the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.13 Panel ARDL results on the effects of oil price changes on Interest rate in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.146855**	**0.745288**	**0.197044**	**0.0441**
Panel B: Short Run Equation				
COINTEQ01	-0.225891	0.219459	-1.029311	0.3051
D(LOP)	-0.169437	0.487731	-0.331192	0.7410

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LINR, the log of interest rate. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; LINF the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.3 Discussion of Results on Hypotheses 3 Testing.

Tables 6.14 and 6.15 report the estimation results based on asymmetric oil price changes. All the *ECT* coefficients in both net oil exporting and net oil importing countries are negative and statistically significant. Indicating the presence of significant 25.76% and 32.74% long run causal relationship between oil price and inflation in net oil exporting and net oil importing, respectively. This result shows that oil price-inflation nexus converges to long run equilibrium faster in net oil importing countries more than net oil exporting countries.

Panel A results indicates that positive changes in oil prices have significant adverse effect on inflation in both net oil exporting and net oil importing countries in Africa. A 1%-point positive change in oil price validate 17.89% and 8.96% increase in inflation respectively on net oil exporting and oil importing countries in Africa. This result is consistent with the views of Misati et al. (2013) who predicted a long run role of changes in oil price on inflation in Kenya. This result reveals more policy challenge especially for net oil importing countries. The increasing adverse effect of oil price changes on inflation can pass into the economy through inflation effect channel (Tang et al.2009). For example, in an open economy, when inflation is caused by increase in oil price shocks, monetary policy tightening can worsen the long-term output by increasing interest rate and reduced investment (Brown and Yucel 2002; Tang et al.2009). Thus, adverse effect of inflation is experienced.

In the short run, changes in oil price insignificantly affected inflation in net oil exporting countries while it significantly and positively influences inflation in net oil importing countries, with 1%-point change in oil price validated 4.92% increase in inflation. This finding on net oil importing countries is consistent with the views of Roeger (2005) who found a short run trade-off between changes in oil price and inflation the European region.

These findings partially reject Hypothesis 3, that changes in oil price do not have significant effect on inflation in net oil-exporting and net oil-importing countries in Africa in the long run. Thus, this result partially supports the alternative hypothesis that oil price has predictive power over inflation in the long-run in net oil-exporting and net oil-importing countries. However, this study fails to reject Hypothesis 3 for net oil exporting countries in the short run but rejected it in short run, in net oil importing countries. Meaning that changes in oil price has only long run predictive power over inflation in net oil exporting but has both short run and long run predictive power over inflation in net oil importing countries.

Table 6.14 Panel ARDL results on the effects of oil price changes on Inflation in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.178984**	**0.579961**	**2.090853**	**0.0004**
Panel B: Short Run Equation				
COINTEQ01	-0.257563	0.089117	-2.890179	0.0043
D(LOP)	-0.336893	0.331582	-1.016017	0.3108

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LINF, the log of inflation. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.15 Panel ARDL results on the effects of oil price changes on Inflation in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.089557**	**0.213484**	**3.756825**	**0.0416**
Panel B: Short Run Equation				
COINTEQ01	-0.327371	0.077705	-4.213006	0.0000
D(LOP)	**0.049226**	**0.020318**	**8.821068**	**0.0000**

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LINF, the log of inflation. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.4 Discussion of Results on Hypothesis 4 Testing.

Tables 6.16 and 6.17 show the estimation results based on asymmetric oil price changes. The coefficients of *ECT* in net oil exporting and net oil importing countries are negative. The *ECT* coefficient in net oil exporting countries is negative significant while it is negative and insignificant in net oil importing countries. This indicates the presence of significant 0.74% long run causal relationship between oil price and exchange rates in net oil exporting as opposed to insignificant long run causal relationship between oil price and exchange rates in net oil importing countries in Africa.

In the long run the effect of changes in oil price on exchange rates is positively significant in net oil exporting countries and negatively significant in net oil importing countries in Africa. A 1%-point positive change in oil price appreciated exchange rates in net oil exporting countries by 10.37%. While it depreciated exchange rates in net oil importing countries by 15.14%. The result supports the views of Beckmann et al. (2020) and consistent with the expectation of income transfer theory and effect of terms of trade channel. Income transfer theory advocated that with increase in oil price, the purchasing power of net oil importing countries increases while that of net oil importing countries decreases. This is as result of appreciation of exchange rates in net oil exporting countries and depreciation of exchange rates in net oil importing countries given a terms of trade dynamics. According to Vieira and da Silva (2018) a possible explanation for depreciating value of exchange rate especially in net oil importing countries can attributed to key issue for stimulating the exports sector (export-oriented growth strategies). The implication of this result is that policymakers should focus on long term exchange rate policy aimed at shielding the domestic currency form oil price shocks.

In the short run, exchange rates presented negative response to asymmetric change in oil price in net oil exporting countries as opposed to a typical insignificant response of exchange rate to changes in oil price in net oil importing countries. Meaning that in the short run asymmetric changes in oil price have more influence over exchange rates in net oil exporting countries than net oil importing countries. This result will provide policymakers significant understanding in dealing with exchange rates volatility caused by changes in oil price in net oil exporting and net oil importing countries.

These findings partially reject Hypothesis 4, that changes in oil price do not have significant effect on exchange rates in net oil-exporting and net oil-importing countries in Africa in the long run. The partial rejection is because the response of exchange rates in the long run is significant in both net oil exporting and importing countries while the short run exchange response to changes in oil price is significant in net oil exporting countries and insignificant in net oil importing countries. Meaning that asymmetric changes in oil price forecasted exchange rates in net oil exporting countries both in the long run and short run. However, changes in oil price predicted exchange rates only in the long run, in net oil importing countries.

Table 6.16 Panel ARDL results on the effects of oil price changes on Exchange Rates in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.103741**	**2.584980**	**0.040132**	**0.0480**
Panel B: Short Run Equation				
COINTEQ01	-0.007395	0.002584	-2.861647	0.0046
D(LOP)	-0.036235	0.058691	-0.617382	0.5377

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LIEX, the log of exchange rates. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.17 Panel ARDL results on the effects of oil price changes on Exchange Rate in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**-0.151390**	**0.113516**	**-1.333650**	**0.0145**
Panel B: Short Run Equation				
COINTEQ01	-0.160435	0.159595	-1.005263	0.3165
D(LOP)	0.026284	0.086078	0.305347	0.7606

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LIEX, the log of exchange rates. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LUNE, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.5 Discussion of Results on Hypothesis 5 Testing

Tables 6.18 and 6.19 present the estimation results based on asymmetric oil price changes. All the *ECT* coefficients of net oil exporting and net oil importing countries are negative but statistically insignificant. This indicates the presence of insignificant long run causal relationship between oil price and unemployment rate in both net oil exporting and net oil importing countries in Africa.

Panel A shows the long run effect of changes in oil price on unemployment rates. Only net oil importing countries presented a positive and significant response of unemployment rates to changes in oil price as against a typical insignificant response of unemployment rates to changes in oil price in net oil exporting countries in Africa. A 1%-point change in oil price corroborated 10.32% increase in unemployment rates in net oil importing countries. This shows that changes in oil price play a significant role in unemployment rate in net oil importing countries in Africa. This result for net oil importing countries is consistent with the views of Carruth et al. (1998) for U.S and Cheratian et al. (2019) for MENA region. This result also supports the expectation of reallocation effect theory. Theory of reallocation effect put forward that effect of changes in oil price on unemployment rates is explained through changes in production cost. Long term changes in oil price can cause potential impact on production cost, and this can lead to reduction in productivity level and change in production structure (Kocaarslan et al.2020). Potentially, this can create reallocation of labour and capital across sectors (Trang et al.2017) and consequently great impact on unemployment rate (Loungani 1986; Doğrul and Soytas 2010).

Net oil exporting countries present a negative response of unemployment rates to changes in oil price as against a typical insignificant response of unemployment rates to changes in oil price in net oil importing countries in the short run. Meaning that an asymmetric change in oil price has a short run adverse effect on unemployment rate in net oil exporting countries than in net oil importing countries. The short run result found in net oil exporting countries is consistent with the views of Cheratian et al. (2019) for MENA region. The increasing adverse effect of positive oil price on unemployment rates in net oil exporting countries can be explained through increase in employment rate as the economy experience expansion in economic activities (van Wijnbergen 1984; Olomola and Adejumo 2006). Meaning that long run and short run policies on oil price-unemployment rate dynamics should target isolating macroeconomic variables from oil price shocks.

These findings reject Hypothesis 5 that changes in oil price do not have significant effect on unemployment rates in net oil-importing countries in the long run but fail to reject it in net oil exporting countries in the long run. However, Hypothesis 5 is rejected in the short run, in net oil exporting countries but fails to be rejected in the short run, in net oil importing countries. Meaning that asymmetric changes in oil price have predictive power over unemployment rates in net oil importing countries in the long run and insignificant to predict unemployment rate in the long run, in net oil exporting countries. However, changes in oil price predicted unemployment rates only in the short run, in net oil exporting countries.

Table 6.18 Panel ARDL results on the effects of oil price changes on Unemployment Rates in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	-0.077540	0.243200	-0.318831	0.7502
Panel B: Short Run Equation				
COINTEQ01	-0.095224	0.069207	-1.375924	0.1703
D(LOP)	**-0.022477**	**0.011583**	**-1.940556**	**0.0437**

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LIUNE, the log of unemployment rates. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LEX, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.19 Panel ARDL results on the effects of oil price changes on Unemployment Rate in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.103245**	**0.093569**	**2.172144**	**0.0316**
Panel B: Short Run Equation				
COINTEQ01	-0.213243	0.217289	-0.981378	0.3281
D(LOP)	-0.021839	0.019678	1.109814	0.2690

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B, respectively. The dependent variable is LUNE, the log of unemployment rates. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LEX, the log of exchange rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.6 Discussion of Results on Hypothesis 6 Testing.

Tables 6.20 and 6.21 show the estimation results based on asymmetric oil price changes. The coefficients of *ECT* in both net oil exporting and net oil importing countries are negative but statistically insignificant to converge to long run equilibrium relationship. It means that oil price and food supply insignificantly converge to long run causal equilibrium causal relationship in net oil exporting and oil importing countries in Africa.

The long run asymmetric changes in oil price negatively and significantly forecasted food supply in net oil exporting countries while it positively and significantly affected food supply in net oil importing countries. A 1%-point positive change in oil price validates 3.64% decrease in food supply in net oil exporting countries while it substantiated 3.27% increase in food supply in net oil importing countries. This result is consistent with the views of Ibrahim (2015) who found an asymmetric influence of oil price on food supply in Malaysia. The implication is that policy that will contain effect of changes in oil price on food supply chain is necessary and significant in both net oil exporting and oil importing countries in Africa.

Coefficients relating to food supply response to changes in oil price are all positive and significant in both net oil exporting and net oil importing countries in Africa in the short run. A 1%-point positive change in oil price cause 1.04% and 3.96% increase in food supply respectively in net oil exporting and net oil importing countries. Meaning that in the short run changes in oil price has more influence in net oil importing countries than in net oil exporting countries. The short run response of food supply to changes in oil price is consistent with the views of Nwoko et al. (2016) who found a short run response of food price to changes in oil price in Nigeria. The implication is that policy should be designed to mitigate the risk posed by changes in oil price on food supply in both net oil exporting and net oil importing countries in the short run.

These findings reject Hypothesis 6 that changes in oil price do not have significant effect on food supply in net oil exporting and net oil-importing countries in the long run and in the short run. This shows that changes in oil price have a significant role in predicting variations in food supply both in net oil exporting and net oil importing countries.

Table 6.20 Panel ARDL results on the effects of oil price changes on Food Supply in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**-0.03644**	**0.007371**	**-4.917180**	**0.0000**
Panel B: Short Run Equation				
COINTEQ01	-0.060198	0.054650	-1.101528	0.2719
D(LOP)	**0.010421**	**0.002461**	**4.233591**	**0.0000**

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LIUNE, the log of unemployment rates. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LEX, the log of unemployment rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.21 Panel ARDL results on the effects of oil price changes on Food Supply in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.032659**	**0.002316**	**14.10386**	**0.0000**
Panel B: Short Run Equation				
COINTEQ01	-0.208160	0.198557	-1.048360	0.2962
D(LOP)	**0.039587**	**0.017918**	**2.209366**	**0.0287**

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B, respectively. The dependent variable is LFS, the log of food supply. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LEXD, the log of external debt; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.7 Discussion of Results on Hypothesis 7 Testing.

Tables 6.22 and 6.23 put forward the estimation results based on asymmetric oil price changes. All the *ECT* coefficients of net oil exporting and net oil importing countries are negative but statistically insignificant. This indicates the presence of insignificant long run causal relationship between oil price and external debt in both net oil exporting and net oil importing countries in Africa.

In panel A, the coefficient of external debt shows a positive long run responses to changes in oil price in both net oil exporting and net oil importing countries. This result is consistent with the views of Kretzmann and Nooruddin (2005). A 1% increase in oil price validates 68.95% and 53.79% increase in external debt respectively in net oil exporting and net oil importing countries. The implication is that effect of changes in oil price has more influence in net oil exporting countries than net oil importing countries. Adequate policy to mitigate the risk of changes in oil price on external debt is necessary and significant in both net oil exporting and oil importing countries.

The coefficient of external debt in the short run, insignificantly responded to changes in oil price in net oil exporters while it positively and significantly responded to changes in oil price in net oil importers in Africa. With 1% change in oil price validating 13.15% increase in external debt in net oil importing countries. This finding could mean to imply that, changes in oil price have no impact on external debt in net oil exporting countries while it impacts external debt in net oil importing countries through increase in import bill in the short run.

These findings reject Hypothesis 7 that changes in oil price do not have significant effect on external debt in net oil exporting and net oil-importing countries in the long run and in the short run. This shows that changes in oil price have a significant effect on external debt both in net oil exporting and net oil importing countries. Policy that encourages investment in economic yielding infrastructure including increase in manufacturing should be adopted by both net oil exporting and net oil importing countries.

Table 6.22 Panel ARDL results on the effects of oil price changes on External Debt in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.689538**	**0.551833**	**3.387869**	**0.0008**
Panel B: Short Run Equation				
COINTEQ01	-0.095687	0.099004	-0.966499	0.3349
D(LOP)	-0.080103	0.098020	-0.817213	0.4147

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LEXD, the log of external debt. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LUNE, the log of unemployment rate; LFS, the log of food supply; LINF, the log of inflation; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.23 Panel ARDL results on the effects of oil price changes on External Debt in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.537876**	**0.923103**	**2.749288**	**0.0068**
Panel B: Short Run Equation				
COINTEQ01	-0.081443	0.074530	-1.092757	0.2764
D(LOP)	**0.131516**	**0.024193**	**5.436189**	**0.0000**

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B, respectively. The dependent variable is LEXD, the log of external debt. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LEX, the log of exchange rate; LUNE, the log of unemployment rate; LFS, the log of food supply; LCA, the log of current account; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.8 Discussion of Results on Hypothesis 8 Testing.

Tables 6.24 and 6.25 report the estimation results based on asymmetric oil price changes. The coefficients of *ECT* in both net oil exporting and net oil importing countries are negative but statistically insignificant to converge to long run equilibrium. Indicating the existence of insignificant long run causal relationship between oil price and current accounts in both net oil exporting and net oil importing countries in Africa.

In the long run the asymmetric effect of oil price on current accounts remained significant in net oil exporting countries with some degree of improvement, as against net oil importing countries where the asymmetric effect of oil price to current accounts maintained a significant degree of reduction. A 1%-point change in oil price validates 61.32% increase in current accounts in net oil exporting countries. In net oil importing countries, 1%-point change in oil price substantiates 54.13% decrease in current account. This result is consistent with the findings in literature such as the views of Balli et al. (2021) who used Russia and China to conclude that oil price different effects on current account is different in net oil exporting and net oil importing countries. If income increases more than spending due to adjustment of terms of trade in oil exporting countries given an oil price increase, the current accounts position will automatically improve. However, in net oil importing countries, if income reduces due to the same level of terms of trade adjustment given an oil price increase, their current accounts will experience reduction. The policy implication of this result is that oil price has significant long run role in influencing current accounts in both net oil exporting and importing countries. As such policy aimed at isolating macroeconomic variables from oil price shocks.

In the short run, the positive change in oil price exert insignificant negative effect on current accounts in both net oil exporting and oil importing countries. This result is against the views of Arezki and Hasanow (2013) who concluded negative effect of oil price on current accounts in net oil exporting and the rest of the globe. The policy implication is that oil price may not be relevant in determining current accounts dynamics, rather fiscal policy may have contributed to current accounts adjustment.

These findings partially reject Hypothesis 8 that changes in oil price do not have significant effect on current accounts in net oil exporting and net oil-importing countries in the long run but fails to reject it in the short run. This shows that changes in oil price have a significant long run effect on current accounts both in net oil exporting and net oil importing countries but have insignificant short run effect in both group of countries. Policy that encourages shielding current accounts from oil price shocks should be adopted by both net oil exporting and net oil importing countries.

Table 6.24 Panel ARDL results on the effects of oil price changes on Current Accounts in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.613187**	**0.829493**	**1.100898**	**0.0222**
Panel B: Short Run Equation				
COINTEQ01	-0.269757	0.160914	-1.676401	0.0951
D(LOP)	-0.347510	0.295759	-1.174977	0.2413

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LICA, the log of current accounts. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LEX, the log of exchange rate; LFS, the log of food supply; LEXD, the log of external debt; LUNE, the log of unemployment rate; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.25 Panel ARDL results on the effects of oil price changes on Current Accounts in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**-0.541271**	**0.44449**	**-1.028228**	**0.0357**
Panel B: Short Run Equation				
COINTEQ01	-0.005532	0.012216	-0.452857	0.6514
D(LOP)	-0.608982	0.596646	-1.020676	0.3092

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B, respectively. The dependent variable is LCA, the log of current accounts. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LEX, the log of exchange rate; LFS, the log of food supply; LEXD, the log of external debt; LUNE, the log of unemployment rate; LFR, the log of foreign reserves. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.9 Discussion of Results on Hypothesis 9 Testing.

Tables 6.26 and 6.27 put forward the estimation results based on asymmetric oil price changes. The coefficients of *ECT* in both net oil exporting and net oil importing countries are negative. However, it is statistically significant in oil exporters but insignificant in oil importers to converge to long run equilibrium relationship. It means that with coefficient value of 35.17%, oil price and foreign reserves significantly converge to long run causal relationship in net oil exporters but insignificantly converge to long run equilibrium relationship in oil importers in Africa.

Net oil exporting and importing countries present a long run positive response of foreign reserves to changes in oil price. Meaning that an asymmetric change in oil price has a long run improvement on foreign reserves in both net oil exporting and importing countries. A 1%-point positive change in oil price accounted for about 52.31% and 20.32% improvement in foreign reserves in net oil exporting and importing countries, respectively. This shows that in the long run changes in oil price has more positive influence in oil exporters more than oil importers. Thus, effective long run foreign reserves policy that will take cognizance of oil price shock should be put in place in both net oil exporting and oil importing countries. And such policy includes implementing of exchange rates regimes and liquidity management that will support domestic currency. This result supports the long run views of Akighir and Kpoghul (2020) on oil price- foreign reserves nexus in Nigeria.

The coefficient of foreign reserves in the short run, insignificantly responded to increase in oil price in both net oil exporters and oil importers in Africa. This implies that changes in oil price is insignificant in influencing foreign reserves in both net oil exporting and importing countries in Africa. Therefore, policy aimed at diversification including increase in non-oil exports should be encouraged to increase the volume of foreign reserves. This result supports the short run views of Shaibu and Izedonmi (2020) on oil price-external reserves relationship in Nigeria.

These findings reject Hypothesis 9 that changes in oil price do not have significant effect on foreign reserves in net oil exporting and net oil-importing countries in the long run but fails to reject it in the short run. Implying that the coefficient of oil price is not zero in predicting foreign reserves in the long run in both net oil exporting and importing countries. However, in the short run oil price is insignificant in forecasting foreign reserves in net oil exporting and importing countries. Therefore, it is imperative and significant to pursue long run policy that will shield foreign reserves from oil price shocks. Equally important is diversification policy that will encourage export of non-oil products to enhance foreign reserves increase in both net oil exporting and importing countries in Africa.

Table 6.26 Panel ARDL results on the effects of oil price changes on Foreign Reserves in Net Oil Exporting African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.523125**	**0.296433**	**1.764729**	**0.0291**
Panel B: Short Run Equation				
COINTEQ01	-0.351705	0.271882	-1.293596	0.0272
D(LOP)	-0.601884	0.499619	-1.204685	0.2297

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B respectively. The dependent variable is LIFR, the log of foreign reserves. The explanatory variables are: LOP, the log of oil price; LINR, the log of interest rate; the log of Gross domestic product; LINF, the log of inflation; LEX, the log of exchange rates; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LUNE, the log of unemployment rates. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

Table 6.27 Panel ARDL results on the effects of oil price changes on Foreign Reserves in Net Oil Importing African Countries

variable	Coefficient	Std. Error	t-Statistic	Prob.*
Panel A: Long Run Equation				
LOP	**0.203245**	**0.093569**	**2.172144**	**0.0316**
Panel B: Short Run Equation				
COINTEQ01	-0.213243	0.217289	-0.981378	0.3281
D(LOP)	-0.021839	0.019678	1.109814	0.2690

Note: In this table, the long run and short run effects of oil price changes on interest rate in net oil exporting African countries are reported in Pane A and Panel B, respectively. The dependent variable is LFR, the log of foreign reserves. The explanatory variables are: LOP, the log of oil price; LGDP, the log of Gross domestic product; LINR the log of interest rate; LINF, the log of inflation; LEX, the log of exchange rate; LFS, the log of food supply; LEXD, the log of external debt; LCA, the log of current account; LUNE, the log of unemployment rates. D(LOP) is first difference of log of oil price.

Sources: Author generated 2021

6.9.1.10 Discussion of Results on Hypothesis 10 Testing.

This study partially reject hypothesis 10 that changes in oil price do not have the same short run and long run effect on macroeconomic variables in net oil exporting and oil importing countries in Africa. Table 6.28 put forward a detail analysis that shows the short run and long run relationship between oil price and variables of GDP, interest rates, inflation, exchange rates, unemployment rates, food supply, external debt, current accounts, and foreign reserves. The highlighted areas show where this study reject Hypothesis 10 and accept alternative Hypothesis that changes in oil price have the same short run and the long run effect on macroeconomic variables in net oil exporting and net oil importing countries.

Table 6.28 Short Run and Long Run Analysis of Oil Price and Macroeconomic Variables in Net Oil Exporting and Importing Countries in Africa

Variables	Short Run Analysis		Long Run Analysis	
	Net Oil Exporters	**Net Oil Importers**	**Net Oil Exporters**	**Net Oil Importers**
GDP	GDP responded positively and significantly to changes in oil price	GDP responded negatively and significantly to changes in oil	GDP responded positively and significantly to changes in oil price	GDP responded negatively and significantly to changes in oil price
Interest Rates	Positive changes in oil price have adverse effect on interest rates	Positive changes in oil price have adverse effect on interest rates	Positive changes in oil price have adverse effect on interest rates	Positive change in oil price adverse effect on interest rates
Inflation	Significant positive relationship exists between oil price and inflation	Insignificant relationship exists between oil price and inflation	Positive change in oil price have adverse effect on inflation	Positive changes in oil price have adverse effect on inflation.
Exchange Rates	Negative significant response of exchange rates to changes in oil price	Insignificant response of exchange rates to changes in oil price	Positive significant relationship exists between oil price and exchange rates.	Negative significant relationship exists between oil price and exchange rates
Unemployment Rates	Unemployment rates negatively and significantly responded to changes in oil price	Unemployment rates responded insignificantly to changes in oil price.	Unemployment rates positively and significantly responded to oil price.	Unemployment rates insignificantly responded to changes in oil price
Food Supply	Food supply positively and significantly responded to changes in oil	Food supply positively and significantly responded to changes in oil price	Food supply significantly and negatively responded to changes in oil price.	Food supply positively and significantly responded to changes in oil price
External Debt	External debt insignificant responded to changes in oil price	Oil price forecasted external debt positively and significantly.	Eternal debt positively and significantly responded to changes in oil price	Positive and significant relationship exist between oil price and external debt.
Current Accounts	Current accounts insignificantly and negatively responded to changes in oil price	Insignificant negative relationship exists between oil price and current accounts.	Positive and significant relationship between oil price and current accounts	Current accounts negatively and significantly responded to changes in oil
Foreign Reserves	Foreign reserves insignificantly responded to changes in oil price	Oil price insignificantly predicted foreign reserves	Foreign reserves positively and significantly responded to changes in oil price	Oil price positively and significantly forecasted foreign reserves.

Sources: Author generated 2021

6.9.1.11 Discussion of Results on Hypothesis 11 Testing.

This study partially rejects Hypothesis 11 that changes in oil price do not have the same effect on macroeconomic variables in net oil exporting and net oil importing countries in Africa. Table 6.29 presents a summarised analysis of similarities and differences regarding the relationship between oil price and macroeconomic variables in net oil exporting and net oil importing countries.

Table 6.29 The Similarities and Differences on the Relationship Between Oil Price and Macroeconomic Variables in Net Oil Exporting and Net Oil Importing Countries

Variables	Similarity between Net oil exporting and importing countries	Differences between net oil Exporting and Importing Countries
GDP	The coefficient of *ECT* is negative and statistically significant in both group of countries. There exists causal significant long run equilibrium relationship between oil price and interest rate.	Positive relationship exists between oil price and GDP in oil exporters while negative relationship exists between oil price and GDP in net in importing countries.
Interest Rates	The coefficient of *ECT* is negative and statistically insignificant. There exists causal insignificant long run equilibrium relationship between oil price and interest rate. Positive and significant long run relationship between oil price and interest rates in both net oil exporting and oil importing countries in Africa. Again, oil price insignificantly forecasted interest rate in the short run in both net oil exporting and oil importing countries in Africa.	.
Inflation	The coefficient of *ECT* is negative and statistically significant. There exists causal significant long run equilibrium relationship between oil price and inflation in both group of countries. The long run relationship between oil price and inflation is positive in both group of countries.	Short run relationship between oil price and inflation is insignificant in net oil exporting countries as oppose a positive and significant relationship between oil price and inflation in net oil importing countries.
Exchange Rates	The presence of negative *ECT* coefficient in both group of countries	Coefficient *ECT* in net oil exporting countries is significant as oppose insignificant *ECT* coefficient in net oil importing countries. There exists the presence of significant causal long run equilibrium relationship in net oil exporting countries as opposed to insignificant casual long run equilibrium relationship in net oil importing countries.

		Oil price has positive long run predictive power over exchange rates in net oil exporting countries. While oil price negatively predicted exchange rates in the long run, in net oil importing countries. In the short run exchange rates presented a negative statistically significant response to changes in oil price in oil importing countries as against insignificant response of exchange rates to changes in oil price in net oil exporting countries.
Unemployment Rates	All coefficient of *ECT* is negative and statistically insignificant. The long run equilibrium causal relationship insignificantly converged	The long run response of unemployment rate is positive and significant in net oil importing countries as against insignificant long run relationship between oil price and unemployment rate in oil exporting countries. Net oil exporting countries present a negative response of unemployment rate to oil price in the short run as opposed to insignificant response of unemployment rate to oil price change in net oil importing countries in the short run.
Food Supply	The coefficient of *ECT* is negative and insignificant to converge to long run equilibrium causal relationship. The short run relationship between oil price and food supply is significant positive in both net oil exporting and oil importing countries.	Significant positive relationship exists between oil price and food price in net oil exporting countries as against significant negative relationship between oil price and food supply in net oil importing countries.
External Debt	The coefficient of *ECT* is negative and insignificant to converge to long run equilibrium causal relationship. The long run relationship is positive and significant in both net oil exporting and net oil importing countries.	The short run relationship between oil price and external debt is insignificant in net oil exporting countries while the relationship between oil price and external debt in net importing countries is positive and significant.
Current Accounts	The coefficient *ECT* in both net oil exporting and oil importing countries is negative but insignificant to converge to long run equilibrium relationship. The short run relationship between oil price and current accounts is insignificant negative in both oil exporting and oil importing countries.	The long run changes in oil price affected current accounts significantly and positively in net oil exporting countries. While in net oil importing countries, the long run relationship between oil price and current accounts is significant and negative.
Foreign Reserves	The coefficients of *ECT* are negative in both net oil exporting and net oil importing countries. Foreign reserves positively and significantly responded to changes in oil price in the long run in both net oil exporting and importing countries. The short run relationship between oil price and foreign reserves is insignificant in both net oil exporting and oil importing countries in Africa.	Oil price and foreign significantly converge to long run equilibrium relationship in net oil exporting countries. In net oil importing, oil price and foreign reserves insignificantly converge to long run equilibrium relationship.

Sources: Author generated 2021

6.10 Granger-causality Test Results

This section tests the causality between oil price and key macroeconomic variables using Granger-causality test and Wald test techniques. This is to help check the robustness of the panel ARDL results. The Granger-causality test is used to determine the direction of the long run relationship between oil price and the key macroeconomic variables.

Standard Granger Causality and Dumitrescu-Hurlin causality tests are used. The test results are reported in table 6.30. Since a nine-variable panel ARDL model is used, nine panels are generated from the software output. The tests are carried out for both net oil-exporting and net oil-importing African countries.

The result of standard Granger-causality test technique shows that the null hypothesis that oil price does not Granger-cause the key macroeconomic variables is rejected at 5% critical level in both net oil exporting and oil importing countries. Granger-causality runs from oil price to interest rates in net oil exporting countries. This result is in line with the study document by Al-hajj et al. (2017) for Malaysia. Identified also is a bidirectional causality running from oil price to interest rates and interest rates to oil price in net oil importing countries. This finding supports the views of Obadi and Korcek (2018) who found bidirectional causality running from oil price to money supply and vice versa in US. Furthermore, causality runs from oil price to foreign reserves in net oil exporting countries. This result support the views of Olayungbo (2019) who found causality running from oil price to foreign reserves in Nigeria. Besides, oil price is found to Granger-cause current accounts in net oil importing countries. This finding aligns with the views of Olayungbo (2019) for Nigeria. Causality is found to run from GDP to oil price in net oil importing countries. This finding supports the views of

Maghrebi et al. (2018) who found causality running from GDP to oil price in Saudi Arabia.

The results from Dumitrescu-Hurlin causality test shows that the null hypothesis that oil price does not Granger cause the key macroeconomic variables is rejected at 5% critical level in both net oil exporting and importing countries. Oil price is found to Granger-cause foreign reserves in net oil exporting countries. This result aligns with view of Osuji (2015) who found causality running from oil price to foreign reserves in Nigeria. Oil price and unemployment cause one other in net oil exporting countries while causality run from oil price to unemployment rates in net oil importing countries. The causality running from oil price to unemployment rates is in line with study documented by Papapetrou (2001) and Doğrul and Soytas (2010) who found causality running oil price to unemployment rate in Greece and Turkey respectively but not the other way round. Furthermore, oil price and interest rates cause each other in net oil importing countries. This result supported the findings of Raji et al. (2014) who concluded bidirectional causality between oil price and interest rate in Nigeria. Additionally, causality runs from oil price to exchange rates in net oil importing countries. This finding is consistent with views of Kim and Jung (2018) who concluded Granger-causality run from oil price to exchange rates in US.

Table 6.30 Granger Causality Test Results for Both Net Oil Exporting and Net Oil Importing Economies

Hypothesis	Standard Granger Causality Null: H_0 γ does not Granger Cause X		Dumitrescu Hurlin Panel Causality Null: H_0 γ does not homogeneously cause X		
	F-Statistic	*Prob.*	*W-Stat.*	*Zbar-Stat*	*Prob.*
Net Oil Exporting Economies					
$log_{GDP} \rightarrow log_{OP}$	1.29488	0.2758	1.06667	-0.81038	0.4177
$log_{OP} \rightarrow log_{GDP}$	0.37926	0.6347	1.14692	-0.74447	0.4566
$log_{INR} \rightarrow log_{OP}$	0.42825	0.6521	1.26032	0.65132	0.5148
$log_{OP} \rightarrow log_{INR}$	8.17498	**0.0004**	7.62793	4.57858	5.0106
$log_{INF} \rightarrow log_{OP}$	0.65388	0.5209	1.05724	-0.81812	0.4133
$log_{OP} \rightarrow log_{INF}$	2.47068	0.0867	2.76029	0.58064	0.5615
$log_{EX} \rightarrow log_{OP}$	0.03302	0.9675	2.29223	0.19621	0.8444
$log_{OP} \rightarrow log_{EX}$	0.23489	0.7908	5.53278	2.85777	**0.0043**
$log_{UNE} \rightarrow log_{OP}$	0.88063	0.4159	4.38547	1.91545	**0.0454**
$log_{OP} \rightarrow log_{UNE}$	1.49007	0.2274	4.32125	1.86271	**0.0325**
$log_{FS} \rightarrow log_{OP}$	1.90161	0.1516	2.00912	-0.03632	0.9710
$log_{OP} \rightarrow log_{FS}$	0.86620	0.4219	3.92712	1.53899	0.1238
$log_{EXD} \rightarrow log_{OP}$	0.71564	0.4899	1.19419	-0.70564	0.4804
$log_{OP} \rightarrow log_{EXD}$	1.93425	0.1468	7.61203	4.56552	5.0406
$log_{CA} \rightarrow log_{OP}$	1.56221	0.2118	1.39445	-0.54116	0.5884
$log_{OP} \rightarrow log_{CA}$	1.10629	0.3325	3.79827	1.43316	0.1518
$log_{FR} \rightarrow log_{OP}$	0.64867	0.5236	1.23401	-0.67293	0.5010
$log_{OP} \rightarrow log_{FR}$	4.23763	**0.0155**	8.39644	5.20978	2.3507
Net Oil Importing Economies					
$log_{GDP} \rightarrow log_{OP}$	3.66563	**0.0278**	4.10181	1.37373	0.1695
$log_{OP} \rightarrow log_{GDP}$	1.47577	0.2317	3.33204	0.85751	0.3912
$log_{INR} \rightarrow log_{OP}$	3.44614	**0.0343**	5.82871	2.53181	**0.0113**
$log_{OP} \rightarrow log_{INR}$	3.02824	**0.0412**	4.89205	1.90368	**0.0470**
$log_{INF} \rightarrow log_{OP}$	1.02480	0.3612	2.06968	0.01096	0.9913
$log_{OP} \rightarrow log_{INF}$	1.87216	0.1572	2.80602	0.50476	0.6137
$log_{EX} \rightarrow log_{OP}$	0.02293	0.9773	0.63156	-0.95346	0.1404
$log_{OP} \rightarrow log_{EX}$	0.47686	0.6216	1.70155	-0.23591	**0.0340**
$log_{UNE} \rightarrow log_{OP}$	0.27195	0.7622	3.94670	1.26972	0.2042
$log_{OP} \rightarrow log_{UNE}$	0.39930	0.6715	1.76193	-0.19542	**0.0451**
$log_{FS} \rightarrow log_{OP}$	0.24682	0.7816	0.56360	-0.99971	0.3175
$log_{OP} \rightarrow log_{FS}$	0.17205	0.8421	2.46775	0.27791	0.7811
$log_{EXD} \rightarrow log_{OP}$	0.21727	0.8049	1.82112	-0.15572	0.8763
$log_{OP} \rightarrow log_{EXD}$	0.12363	0.8838	1.27175	-0.52414	0.6002
$log_{CA} \rightarrow log_{OP}$	1.99397	0.1395	4.46466	1.61707	0.1059
$log_{OP} \rightarrow log_{CA}$	4.19386	**0.0168**	10.1645	5.43945	5.1008
$log_{FR} \rightarrow log_{OP}$	0.15053	0.8604	0.42919	-1.08919	0.2761
$log_{OP} \rightarrow log_{FR}$	1.91723	0.1504	4.07520	1.35589	0.1751

Note: logOP =log of oil price, logINR = log of interest rate, logINF =l log of inflation, log EX =e log of exchange rate, logUNE = log of unemployment rate, logFS =log of food supply, logEXD= log of external debt, logCA =log of current account & logFR= log of foreign reserves.

Sources: Author generated 2021

6.11 Wald Test Result

In addition to the Granger-causality test, this section tests if a short-run Granger Causality exists between log of oil price and key macroeconomic variables in both net oil-exporting and net oil-importing African countries using Wald test. The lag length was selected based on the Akaike Information criteria at lag 1 in 6.4 table, 6.4 section 6.4 of this chapter. Wald test which tests the null hypothesis that oil price coefficient is zero in the key macroeconomic variables equations in both net oil exporting and oil importing countries is carried out. The results are reported for net oil exporting and importing African countries in table 6.31 and 6.32, respectively.

In panels A to I, the probability value of the Wald test evidence that, this study accepts the hypothesis that changes in oil price are statistically significant at 5% level in causing variables of GDP, interest rates, exchange rates, unemployment rates, food supply, current accounts, and foreign reserves in net oil exporting countries. This finding supports the views of Aliyu (2011) who found short run causality running from oil price to economic variables in Nigeria. It is also consistent with the study documented by Nwoke et al. (2016) for Nigeria with respect to oil price and food price. Panel A to I report the short run Granger causality experienced by Wald test using the probability value in net oil importing countries. The result revealed that oil price Granger-cause variables of GDP, interest rate, exchange rates, inflation, unemployment rates, food supply, external debt, current accounts, and foreign reserves.

Table 6.31 Wald Test results on the effects of oil price changes on key macroeconomic variables in Net Oil Exporting African Countries

Test Statistic	Value	df	Probability
Panel A: Wald test on whether changes in oil prices cause changes in GDP in the short run			
t-statistic	0.417788	210	0.6765
F-statistic	0.174547	(1, 210)	0.6765
Chi-square	0.174547	1	0.6761
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.031620	0.075685
Panel B: Wald test on whether changes in oil prices cause changes in interest rates in the short run			
t-statistic	1.499696	210	0.1352
F-statistic	2.249089	(1,210)	0.1352
Chi-square	2.249089	1	0.1337
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.369638	0.246475
Panel C: Wald test on whether changes in oil prices cause changes in inflation in the short run			
t-statistic	5.381947	210	0.0000
F-statistic	28.96536	(1, 210)	0.0000
Chi-square	28.96536	1	0.0000
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.922905	0.171482
Panel D: Wald test on whether changes in oil prices cause changes in exchange rates in the short run			
t-statistic	0.230340	210	0.8181
F-statistic	0.053057	(1, 210)	0.8181
Chi-square	0.053057	1	0.8178
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.2.442829	10.60531
Panel E: Wald test on whether changes in oil prices cause changes in unemployment rates in the short run			
t-statistic	0.114282	210	0.9091
F-statistic	0.013060	(1,210)	0.9091
Chi-square	0.013060	1	0.9090
Null Hypothesis C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.014654	0.128225
Panel F: Wald test on whether changes in oil prices cause changes in food supply in the short run			
t-statistic	0.016336	210	0.9870
F-statistic	0.000267	(1,201)	0.9870
Chi-square	0.000267	1	0.9870
Null Hypothesis C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		1.856488	113.6423

Panel G: Wald test on whether changes in oil prices cause changes in external debt in the short run			
t-statistic	4.512006	210	0.0000
F-statistic	20.35820	(1,210)	0.0000
Chi-square	20.35820	1	0.0000
Null Hypothesis C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		1.162436	0.257632
Panel H: Wald test on whether changes in oil prices cause changes in current accounts in the short run			
t-statistic	1.076942	210	0.2827
F-statistic	1.159804	(1,210)	0.2827
Chi-square	1.159804	1	0.2815
Null Hypothesis C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.762831	0.708331
Panel I: Wald test on whether changes in oil prices cause changes in foreign reserves in the short run			
t-statistic	-0.6088341	210	0.5436
F-statistic	0.370079	(1,210)	0.5436
Chi-square	0.370079	1	0.5430
Null Hypothesis C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.159366	0.083209

Notes: LOP= log of oil price*, logINR = log of interest rate, logINF =I log of inflation, log EX =e log of exchange rate, logUNE = log of unemployment rate, logFS =log of food supply, logEXD= log of external debt, logCA =log of current account & logFR= log of foreign reserves.*

Sources: Author generated 2021

Table 6.32 Wald Test results on the effects of oil price changes on key macroeconomic variables in Net Oil Importing African Countries

Test Statistic	Value	df	Probability
Panel A: Wald test on whether changes in oil prices cause changes in GDP in the short run			
t-statistic	-0.744536	137	0.4578
F-statistic	0.554334	(1,137)	0.4578
Chi-square	0.554334	1	0.4566
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-0.460170	0.618063
Panel B: Wald test on whether changes in oil prices cause changes in interest rates in the short run			
t-statistic	-0.238454	137	0.8119
F-statistic	0.056860	(1,137)	0.8119
Chi-square	0.056860	1	0.8115
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-0.022894	0.096010
Panel C: Wald test on whether changes in oil prices cause changes in inflation in the short run			
t-statistic	-1.526759	137	0.1291
F-statistic	2.330994	(1, 137)	0.1291
Chi-square	2.330994	1	0.1268

Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-0.123334	0.080781
Panel D: Wald test on whether changes in oil prices cause changes in exchange rates in the short run			
t-statistic	-0.118908	137	0.9055
F-statistic	0.014139	(1, 137)	0.9055
Chi-square	0.014139	1	0.9053
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-0.001708	0.014367
Panel E: Wald test on whether changes in oil prices cause changes in unemployment rates in the short run			
t-statistic	-0.202436	137	0.8399
F-statistic	0.040980	(1, 137)	0.8396
Chi-square	0.040980	1	0.8396
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-0.004513	0.022295
Panel F: Wald test on whether changes in oil prices cause changes in food supply in the short run			
t-statistic	-0.013687	**137**	0.9891
F-statistic	0.000187	**(1,137)**	0.9891
Chi-square	0.000187	**1**	0.9891
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		*Value*	*Std. Err.*
C(LOP)		-0.552468	40.36428
Panel G: Wald test on whether changes in oil prices cause changes in external debt in the short run			
t-statistic	-0.400425	137	0.6895
F-statistic	0.161340	(1, 137)	0.6895
Chi-square	0.160340	1	0.6888
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		*Value*	*Std. Err.*
C(LOP)		-0.09808	0.244760
Panel H: Wald test on whether changes in oil prices cause changes in current accounts in the short run			
t-statistic	1.076942	137	0.2827
F-statistic	1.159804	(1, 137)	0.2827
Chi-square	1.159804	1	0.2815
	Null Hypothesis: C(LOP)=0		
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		0.762831	0.708331
Panel I: Wald test on whether changes in oil prices cause changes in foreign reserves in the short run			
t-statistic	-1.390748	137	0.1666
F-statistic	1.934180	(1, 137)	0.1666
Chi-square	1.934180	1	0.1643
Null Hypothesis: C(LOP)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(LOP)		-1726272	1241254

Notes: logINR = log of interest rate, logINF =I log of inflation, log EX =e log of exchange rate, logUNE = log of unemployment rate, logFS =log of food supply, logEXD= log of external debt, logCA =log of current account & logFR= log of foreign reserves.

Sources: Author generation 2021

6.12 Summary

In this chapter the researcher was able to establish the properties of the data using descriptive analysis. Also, the duly analysed is the panel unit root test and it was observed that the variables are either integrated of order zero *1(0)* or integrated of order one *1(1).* There is existence of cointegration relationship among the variables. The optimal lag selection was carried to avoid spurious regression and Akaike Information criteria was chosen as the best fit for the analysis. The correlation matrix between oil price and the key macroeconomic variables was duly analysed. It was identified that oil price correlate with most of the variables both in net oil exporting and importing countries in Africa. Duly developed are the hypotheses that help to analyse the relationship between changes in oil price and key macroeconomic variables in net oil exporting and net oil importing countries. Panel ARDL model is used to analyse the relationship between changes in oil price and the key macroeconomic variables to establish the validity of the formulated hypotheses. The panel ARDL model is used to estimate the asymmetric long run and short run relationship between oil price and the key macroeconomic variables. The panel ARDL model review the existence of long run and short run relationship between oil price and some of the key macroeconomic variables in net oil exporting and importing countries in Africa.

An overview discussion on Granger-causality was presented to check the robustness of the ARDL model. The Standard Granger Causality and Dumitrescu-Hurlin causality tests were used to establish a long run Granger-causality between oil price and some of the key macroeconomic variables. Equally evidenced is short run Granger-causality between oil price and some of the key macroeconomic variables in net oil exporting and oil importing countries.

Chapter Seven

Conclusion Limitations and Recommendations

7.0 Introduction

This chapter reflects on the formulated hypothesis and the key findings as presented in the previous chapters, Equally, contributions, limitations, recommendations, and possible suggestions for future research work are discussed. Before continuing, a recap of the of the research aim set to achieve is discussed.

This study is set out to examine whether variations in macroeconomic variables of net exporting and net oil-importing countries in Africa respond asymmetrically to changes in oil price. In trying to achieve the aim of this study, this study discusses the theoretical framework and channels through which changes in oil price affects macroeconomic variables. Specifically, the study explores theories of investment under uncertainty, reallocation effect, income shift and real business cycle to understand how asymmetric changes in oil price affect macroeconomic variables in net oil exporting and importing countries in Africa.

Furthermore, terms of trade channel, real balance effect and monetary policy, oil demand shocks and oil supply shocks are the channels are used to provide deeper insight on the relationship between oil price and macroeconomic variables in net oil exporting and importing countries in Africa. There are relevant studies at the country-specific level (Fowowe 2014; Chiwneza and Aye 2018; Kocaarslan et al. 2020), at the net oil-exporting level (Omojolaibi and Egwaikhide 2013; Omolade et al.2019; Alao and Payaslioglu 2021), at net oil-importing level (Taghizadeh-Hesary et al. 2016; Akinsola and Odhiambo 2020) and net oil-exporting and net oil-importing level (Salisu and Isah 2017; Lin and Bai 2021; Olayungbo 2021) that have discussed oil price-macroeconomic relationship in developed and developing countries. An empirical study on the asymmetric relationship between changes in oil price and macroeconomic variables in net oil exporting and importing countries is still lacking in developing countries of Africa. Previous studies suggest that further research should extend to examining the asymmetric relationship between oil price and macroeconomic relationship in net oil exporting and importing countries in Africa (Omojolaibi and Egwaikhide 2013; Akinsola and Odhiambo 2020). Hence, this this study provides empirical evidence using panel data of net oil-exporting and net oil-importing countries in Africa to analyse this relationship and spur a comparative analysis.

This study account for asymmetric effects by adopting a panel ARDL technique as presented in Shin et al. (2014) time series panel data model. The short run and long run asymmetric relationship between changes in oil price and macroeconomic variables is examined in a sample of net oil exporting and importing countries in Africa. The results from panel ARDL model covering $1996q_1$ to $2016q_4$ show asymmetric long run and short run effect of changes in oil price on most of the key macroeconomic variables in both net oil exporting and oil importing countries in Africa. Thus, to model the asymmetries in oil price-macroeconomic relationship, this study accounts for non-stationarity and heterogeneity, which are significant underlying dynamic statistical features of panels with large T (Salisu and Isah 2017).

This chapter is structured as follows. Section 7.0 put forward the introduction. Section 7.1 present a reflection and summary of the analysed hypotheses. Section 7.2 discusses the contribution to knowledge. Policy implication based on research find is discussed in section 7.3. The limitations of the study and suggestions for further research is presented in section 7.4.

7.1 Summary of Key Findings in Relation to the Literature

This section provides a reflection on the outcome of the analysed empirical study based on the formulated hypothesis. The importance of this research study consists of an investigation of how changes in oil price cause variations in macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. The long-run and short-run analyses are conducted to give a deeper insight and spur a comparative analysis of net oil-exporting countries (Nigeria, Algeria, and Egypt) and net oil-importing countries (Kenya and South Africa). The econometric quarterly data analysis from 1996q1 to 2016q4 is employed to test the validity of the formulated hypothesis presented in chapter 6.

Hypothesis 1 analyses show that oil price significantly and positively predicted GDP in net oil exporting countries as opposed a significant negative effect on GDP in net oil importing countries both in the long run and in the short run. This finding reflects the views of Ghosh et al. (2009) and Gbatu et al. (2017). It suggests that oil price play a significant role in forecasting GDP growth rate both in net oil exporting and importing countries in the short run and in the long run. For example, Ghosh et al. (2009) used reduced form of ADL framework to conclude that oil price has negative effect on US economy both in the short run and in the long run. Implying that oil price is a very significant predictor of GDP growth in the US.

Hypothesis 2 analysis indicates that interest rates negatively and statistically responded to oil price in the long run both in the net oil exporting and oil importing countries in Africa. This suggest that oil price has a significant role in predicting interest rate both net oil exporting and oil importing countries in the long run. This is consistent with the views of Ratti and Vespignani (2015) for US.

Ratti and Vespignani (2015) used global factor-augmented error correction model and establish a negative relationship between oil price and interest rate through money supply dynamics in US economy. The found that oil price has negative effect on interest rate through positive shocks of money supply cause significant change in oil price through global CPI and global industrial production. This means monetary policy dynamics affect oil price-interest rate relationship.

The short run analysis showed that interest rates negatively responded to oil price changes in net oil importing countries as opposed to insignificant response to changes in oil price in net oil exporting countries. This implies that oil price has more influence on interest rates in net oil importing countries than oil exporting countries in the short run. It equally suggests oil price is significant in forecasting interest rates in the short run, in net oil importing countries. This result is consistent with the study documented by Steidtmann (2004) for US.

Hypothesis 3 analysis shows that both net oil exporting and importing countries experienced negative and significant response of inflation to oil price in the long run as Reicher and Utlaut (2010) documented for US. and Misati et al. (2013) documented for Kenya. The result shows the significance of oil price in predicting inflation in both net oil exporting and net oil importing countries in the long run.

Misati et al. (2013) used Granger-causality test and structural vector autoregressive (SVAR) model and examine the dynamic linkage between oil price and inflation in Kenya. They found a persistent long run relationship between oil price and inflation in Kenya. This implies that persistent effect of oil price on inflation may affect the consumption level in Kenya, especially the low-income earners.

The short run analysis revealed positive significant response of inflation to oil price in net oil importing countries as Kibunyi et al. (2018) documented for Kenya. While in net oil exporting countries, it is insignificant. This is consistent with views of Oyelami and Omomola (2016) who found insignificant relationship between oil price and inflation in Nigeria. This suggests that oil price is significant in predicting inflation in the short run-in net oil importing countries but insignificant in oil exporting countries.

For example, Kibunyi et al. (2018) used ARDL model to evidence that inflation responded significantly and positively to oil price in the long run in Kenya. The implication is that when oil price create volatility on production cost, with increase in production cost, inflation will increase. Therefore, policy aimed at minimizing the effect of oil price on inflation should be encouraged.

Hypothesis 4 analysis evidence that the long run effect of oil price appreciated exchange rates in net oil exporting countries while it depreciated exchange rate in net oil importing countries. This suggests that oil price has a significant role in determining exchange rates dynamics in both net oil exporting and net oil importing countries in Africa. This result is consistent with views of Chen and Chen (2007) and Qurat-Ul-Ain and Tufail (2013). For example, Chen and Chen (2007) employed a panel of G7 countries and evidence that real oil price is statistically significant in predicting real exchange rate variation. The implication is that if a country is highly dependent on oil, oil price can cause the price of tradeable goods to rise relative to price of nontraceable goods in the domestic country would increase more than the price in the US. Hence, this may cause depreciation of domestic currency against the US dollar.

The short run effect of oil price depreciated exchange rates in net oil exporting countries, while it is insignificant in net oil importing countries. Implying that oil price has more influence in net oil importing countries more than oil exporting countries in the short run. The insignificant short run relationship between oil price and exchange rate in oil exporting countries contrast the short run view of Musa et al. (2020) for Nigeria. While the short run result on oil price- exchange rates nexus in net oil importing countries is consistent with the views of Castro and Jiménez-Rodríguez (2020) for US. Their finding concluded that oil price forecasted depreciation of exchange rate in the short run for any period. Suggesting that inflationary pressure from changes in oil price could be offset by adequate monetary policy. Furthermore, investors and risk management need to take consideration of this relationship when creating portfolios.

Hypothesis 5 analysis reveal that the long run effect of oil price on unemployment rate remained significant and increased in net oil importing countries as Doğrul and Soytas (2010) Kocaarslan et al. (2020) found in Turkey and US. respectively. For example, Kocaarslan et al. (2020) employed NARDL model and conclude that increase in oil price cause increase in unemployment rate in the US. The implication is that an increase in oil price reflects a worsening economic condition as companies operates against shrinking profit given an increase in production cost. hence, unemployment may increase.

The long run effect of oil price on unemployment rates in net oil exporting countries is insignificant. This result contrast the views of Cheratian et al. (2019) for MENA region. Suggesting that oil price is insignificant in determining unemployment rates in net oil porting countries in the long run. This could mean that an increase in oil price may have appreciated the domestic currency, causing the domestic industries to operate effectively and efficiently, hence job retain and job creation is constant.

The short run effect of oil price presented significant negative effect on unemployment rates in net oil exporting countries as opposed insignificant effect on unemployment rates in net oil importing countries. Meaning that in the short run oil price has more influence on unemployment rates in net oil exporting countries than oil importing countries. The short run effect in net oil exporters is consistent with the views of Cheratian et al. (2019) for MENA region. The overall negative effect of oil price on unemployment rates following oil price shocks present a challenging task for policymakers, therefore, improving energy security by diversifying away from oil may lessen the responsiveness of unemployment rates to oil price shocks.

Hypothesis 6 analysis shows that in the long run oil price significantly increased food supply in net oil importing countries as opposed its significant reduction of food supply in net oil exporting countries. This is a typical indication that changes in oil price have more influence in net oil importing countries than net oil exporting countries in the long run. The long run relationship between food supply and oil price in net oil importing countries is consistent Ibrahim (2015) documentation for Malaysia. He used NARDL model and affirm the presence of asymmetric long run relationship between oil price and food price. The implication is that the adjustment cost associated with this relationship may have impact on low income earns.

Both net oil exporting and oil importing countries experienced positive significant short run response of food supply to asymmetric changes in oil price. Oil price more significant in the short run-in influencing food supply in net oil importing countries than in net oil exporting countries. The short run effect found in both group of countries is consistent with the views of Ibrahim (2015) for Malaysia and Nwoko et al (2016) for Nigeria. Just as explained in the last paragraph, the adjustment cost associated with the oil price-food price relationship may have effect on low-income earners.

Hypothesis 7 analysis shows that in the long run, both net oil exporting and oil importing countries presented significant positive response of external debt to oil price. With oil price having more influence on external debt in oil exporting countries more than oil importing countries. This result suggests that oil price is a significant predictor of external debt in both net oil exporting and importing countries in Africa in the long run. This finding is consistent with the views of Kretzmann and Nooruddin (2005) for net oil exporting and net oil importing countries. The implication is that debt burden hinders any opportunity of long-term economic growth as interest rates on the loan can worsen the external debt situation.

Net oil importing countries showed that in the short run external debt responded positively and significantly to oil price as against an insignificant response of external debt to oil price in oil exporting countries. Meaning that oil price has more influence in net oil importing countries more than net oil exporting countries in the short run. The response of external debt to oil price in net oil importing countries is consistent with views of Namaki et al. (2020) for Iran. While the insignificant response of external debt to oil price in net oil exporting countries opposes the views of Adamu (2019) who found evidence of short run effect of oil price on external debt in Nigeria. The policy implication is that if adequate policy is not formulated to hedge external debt from oil price shocks the economies of these countries may not grow if the debt is not well utilized, and the economy is not well diversified, especially net oil importing countries of Africa.

Hypothesis 8 analysis show that the long run effect of oil price on current accounts accounted for a very significant improvement in current accounts of net oil exporting countries as Gnimassoun et al. (2017) documented for Canada. In the long run a 1% increase in oil price improves current accounts of oil exporting countries by 91.32%. This is larger than its negative effects on current accounts in net oil importing countries that is reduced to 54.13%. Meaning that oil price as a significant predictor of current accounts has more influence in net oil exporters more than oil importers in the long run. This finding is consistent with the views of Allegret et al. (2014) for net oil exporting countries and Mohammed (2015) for net oil importing countries. For example, Mohammed (2015) used panel of 46 net oil importing countries to evidence the adverse effect of oil price on current accounts of these economies. The implication of his finding is that economy without a buffer against oil price is vulnerable to external shocks from oil price. Hence adequate financial system should be put in place to hedge against current accounts from external shocks.

Both net oil exporting and net oil importing countries presented insignificant short run relationship between oil price and current accounts. Meaning that oil price does not have predictive power over current accounts both in net oil exporting and importing countries in the short run. This result contrast the views of Allegret et al. (2014) on a sample of oil exporting countries.

Hypothesis 9 analysis indicates that the long run effect of oil price forecasted 52.31% and 20.32% improvement in foreign reserves in net oil exporting and oil importing countries, respectively. The effect is larger in net oil exporting more than oil importing countries. The implication of this that oil price has more influence on net oil exporters more than oil importers. Furthermore, it implies that the dependency on oil price to build foreign reserves of net oil exporting and oil importing countries can be feasible in the long run. This finding is consistent with views of Kaka and Ado (2020) for Nigeria.

Net oil exporting and importing countries exhibited insignificant short run relationship between oil price and foreign reserves as opposed the views of Olayungbo (2019) who found short run effect of oil price on foreign reserves in Nigeria. However, the result is consistent with views of Shaibu and Izedonmi (2020) for Nigeria. This implies that oil price cannot predict foreign reserves variations both in net oil exporting and importing countries in the short run.

The overall analyses showed that hypothesis 10 is partially rejected in some areas and accepted in some areas. For example, hypothesis 10 is rejected as oil price positively and significantly affected GDP both in the short run and in the long run, in net oil exporting countries. Furthermore, oil price significantly and negatively affected GDP in the short run and long-run in net oil importing countries. It suggests that oil price have the same predictive power over GDP in the long run and short run both in net oil exporting and net oil importing countries. This find is consistent with the views of Charfeddine and Barkat (2020) for Qatar. They used both ARDL and NARDL models to show that oil price has the same effect on GDP in the long run and short run. This implies that these economies are highly dependent on oil. Hence, policy aimed at diversifying the economy to non-oil exports should be encouraged.

Furthermore, hypothesis 11 is partially rejected from the overall analyses. For example, oil price significantly and positively affected interest rates in net oil exporting and oil importing countries in the long run. It suggests that oil price has a significant role in the long run, in predicting interest rates in net oil exporting and oil importing countries of Africa. Although, the effect of oil price on interest rate is in net oil exporting countries than in net oil importing countries of Africa. Furthermore, oil price has the same positive and significant effect on external debt in net oil exporting and oil importing countries in the long run. However, the finding suggests that the effect of oil price on external debt is greater in net oil exporting than in net oil importing countries of Africa.

In another vein, this study fails to reject Hypothesis 11. For example, the effect of oil price appreciated exchange rates in the long run, in net oil exporting countries while it depreciated exchange rate in the long run, in net oil importing countries. This finding supports the expectation of income transfer theory discussed in chapter 4. Equally in net oil exporting countries, GDP responded positively and significantly to oil price. While in net oil importing countries, GDP negatively and significantly responded to oil price changes. This finding is consistent with the views of Nusair and Olson (2021) for Indonesia, Singapore, Malaysia, and Philippines. They used ARDL model to show that asymmetric changes in oil price have varying effect on output of some of the countries considered. This implies that investors wishing to invest in different countries need to consider oil price-macroeconomic relationship in those countries before investing. Hence, policymakers should put this finding into consideration when formulating policy that would shield macroeconomic variables from oil price shocks both in net oil exporting and importing countries in Africa.

7.2 Contribution to Knowledge

This study contributed to knowledge through the methodology employed in giving deeper insight in understanding how changes in oil price affect variations in macroeconomic variables in the context of net oil-exporting and net oil-importing countries in Africa. This study contributes to the empirical literature in the following ways:

7.2.1 Contribution to Literature

The original contribution of this study to literature is that this study has reviewed the asymmetric relationship between oil price and macroeconomic variables not only in the context of net oil exporting countries in Africa but also in the context of net oil importing countries in Africa. This has presented information to stakeholders on oil price-macroeconomic relationship in the context of net oil exporting and oil importing countries of Africa. This is significant because the information provided by this study which is not present in previous studies including Akinsola and Odhiambo (2020) can help policymakers to formulate long run and short run policies to hedge macroeconomic variables from oil price shocks in this group of net oil exporting and oil importing countries in Africa. The information will also enable investors to make informed investments decisions. The awareness of this seemly information can form a key aspect that could be addressed in future research.

7.2.2 Contribution to Methodology

In this section, the discussion how this study contributed to methodology is presented. The initial analysis in chapters 2 and 5 reveals the relationship between oil price and macroeconomic variables using extended literature review and scattered diagram of regression analysis to give further insight on how oil price influence macroeconomic variables in the context of net oil exporting and importing countries in Africa. The extended literature review provided more understanding on oil price influence macroeconomic variables by reviewing the findings of previous scholars on this relationship. In reviewing this relationship using extended literature review, related major oil price events from $1996q_1$ to $2016q_4$. The significance of this analysis is to understand how macroeconomic variables respond to oil prices following a major oil price shock event. For example, Hou et al. (2015) analysed the response of macroeconomic variables to oil price following the oil price shocks between 2014 and 2015. They found that following the oil price plunge between 2014 and 2015, the current account balance of oil exporters in Africa reduced while that of oil importers in Africa improved. This is a result of reduction in the value of oil exports of African countries to developed countries by 17%. While the value of oil import of country like Tanzania dropped by 20%. The implication is for policymakers to adjust their macroeconomic policy based on uncertainties associated with the oil price shock events.

Again, this study contributed to methodology by using scattered diagram of regression analysis to visually present the relationship between oil price and the key macroeconomic variables. The variable of oil price is plotted against each of the key macroeconomic variable's indexes at group and individual country level. The visual presentation of the relationship not only enable readers to understand how oil price influence the key macroeconomic variables by mere looking at the diagrams but also it would help those who cannot understand the technicalities involved in empirical analysis or those who are not mathematically inclined to look at the diagram and understand how oil price have influence on the key macroeconomic variables. The findings from this analysis provide information exploitable by policymakers and investors for policy formulation and investment decision making.

7.3 Policy Implication of the Research Study

This section put forward the policy implication identified in analysing oil price-macroeconomic relationship within the context of net oil exporting and oil importing countries in Africa. The empirical analysis of this study can be used to assess the effectiveness of economic reforms and policy plans by net oil-exporting and net oil-importing countries and directions for future improvement. This study offers some significant suggestions for policymakers in net oil-exporting and net oil-importing countries in Africa.

First, the different results obtained from the long run and the short run panel ARDL model in net oil-exporting countries, for example, on inflation will help policymakers take long run and short run hedging strategies against inflationary pressures coming from shocks in oil price. Also, from the panel ARDL result of oil price-inflation relationship particularly in net oil importing countries, inflation is found to positively and significantly responded to oil price in the short run and in the long run. Scholars including Ahuru, and James (2015) pointed out that the essential reason why oil price has fluctuating effect on inflation in the short run and in the /long run is because oil is a commodity product, whose price is in US dollars. If there is any change in US dollar it will affect the exchange rate of countries whose currencies are not dominated in US dollar. The exchange rates dynamics created by petrol-dollar nature of oil can affect purchasing power of firm and individual consumers (Beckmann et al.2017). Hence, this can create inflation dynamics.

In addition, considering GDP response to the short run and the long-run fluctuations in oil price, it is significant in net oil-exporting countries to encourage policy that will ensure diversification strategies of exporting non-oil products to enhance increase of foreign earnings and GDP growth rate since oil seen to play a significant role in forecasting GDP. Furthermore, policies that encourage infrastructural, manufacturing, and agricultural development should be put in place. This will help boost the economy if oil price declines. For net oil importing countries, it was discovered that sustained increase in oil price affects GDP negatively. Thus, policies that will enable oil price decline to improve external and fiscal balance which will support economic growth should be pursued. This will boost savings and economic growth during oil price decline to reduce the effect of shocks coming from oil price increase on macroeconomic variables.

Since this study has shown that the magnitude of most of the long-run and short-run effects of oil price on macroeconomic variables differ in net oil-exporting and net oil-importing countries in Africa, it is therefore, recommended that policymakers should pursue long run and short run strategies to hedge macroeconomic variables from oil price shocks. The government of these countries and private investors seeking investment opportunities that will enhance economic activities and growth should cautiously evaluate the fundamental dynamics of the long run and short run effect of oil price on macroeconomic variables as confirmed in this study before formulating policies or investing.

This finding is also significant to monetary policy institutions in Africa who are continually under pressure to promote and ensure economic stability. Their ability to achieve this significant objective is directly connected to their ability to employ efficient and effective monetary policies that will hedge macroeconomic variables from the pressure of shocks from oil prices, especially towards exchange rate and inflation. Given the increasing suggestion of the robust relationship between oil price and macroeconomic variables, including the findings in this study, it is virtually difficult to forecast variations in macroeconomic variables without including oil price as a predictor.

7.4 Limitations of the Study and Suggestions for Further Studies

This study contributes to methodology and literature on the relationship between oil price and macroeconomic variables. For example, this study reviewed the asymmetric relationship between oil price and macroeconomic variables not only in net oil exporting countries in Africa but also in net oil importing countries in Africa. Also, this study used extended literature review and scattered diagram of regression analysis to determine the correlation between oil price and macroeconomic variables. The significance of this analysis is to understand how macroeconomic variables respond to oil prices following a major oil price event. However, this study is limited by data, time, COVID-19 pandemic, and lack of funding, among others. The identified issues for further research are as follows:

In analysing the relationship between changes in oil price and variations in macroeconomic variables, this study used quarterly data of oil price, GDP, interest rate, inflation, exchange rate, unemployment rate, food supply, external debt, current accounts, and foreign reserves to empirically test the formulated hypotheses. However, it is possible to used monthly data covering large time (*T*) and fewer variables if data availability is assured. This will enable obtaining large observation that covers most of the different shocks in oil price including the effect of COVID-19 pandemic.

Apart from increasing the data, it is equally recommended that more countries in the context of net oil-exporting and net oil-importing countries in Africa should be included in the analysis to give a wider coverage of the region.

This study only considered in quantitative terms changes in oil price in examining variations in macroeconomic variables in the context of net oil-exporting and net oil-importing countries. It is recommended that mixed method should be considered in analysing the asymmetric relationship between oil price and macroeconomic variables. With the mixed method other factors including political, social, and institutional factors would be incorporated in the analysis. In doing this, the mix method could be used to show the quantitative aspect of the analysis and the qualitative aspect of the analysis to provide more robust information for policy formulation and investment decisions.

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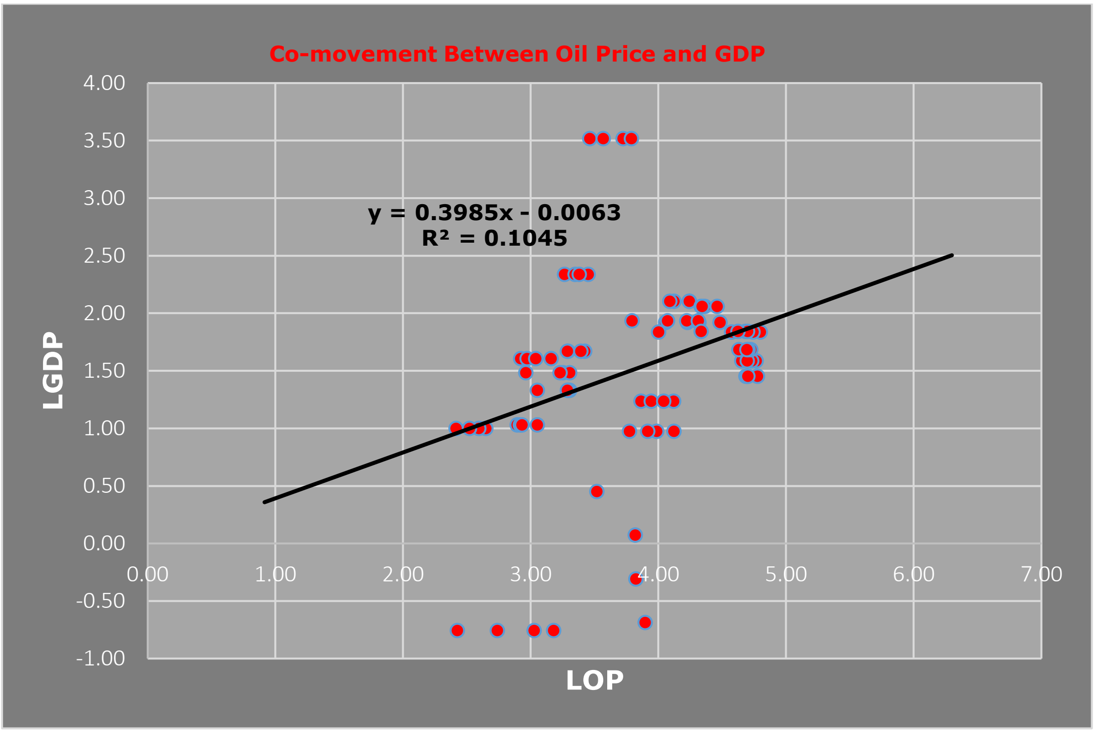
APPENDIX

Nigeria: Figure 6.1 Co-movement Between Oil Price and GDP



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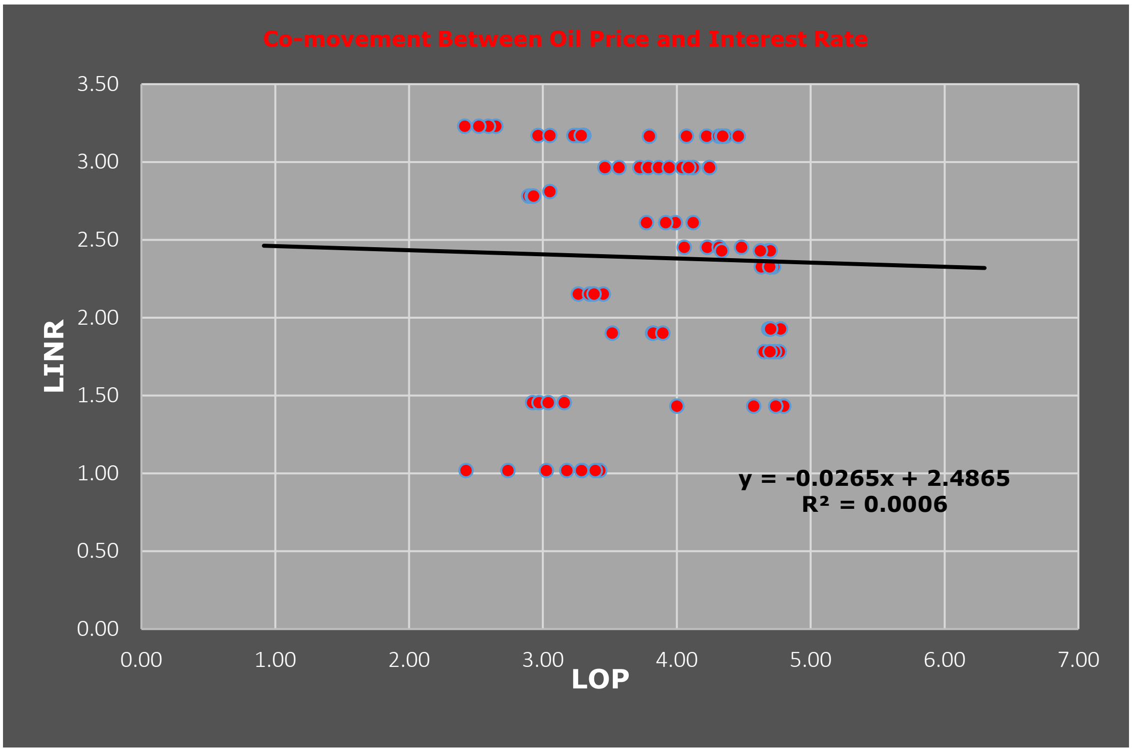

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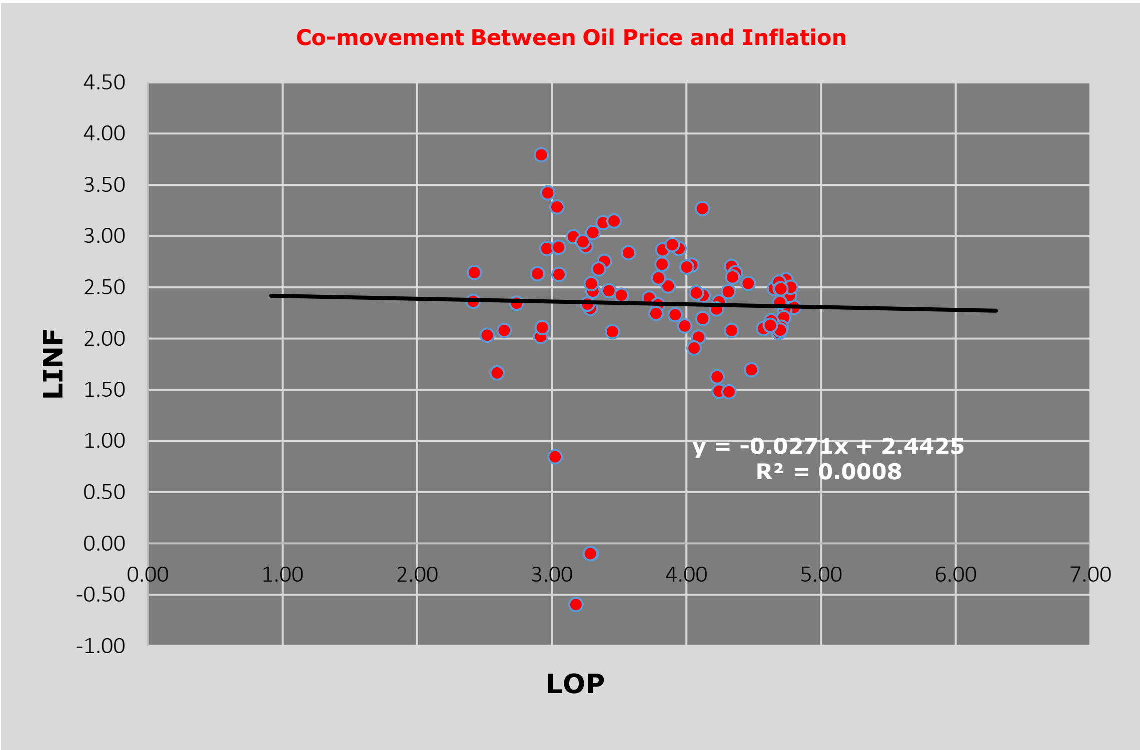

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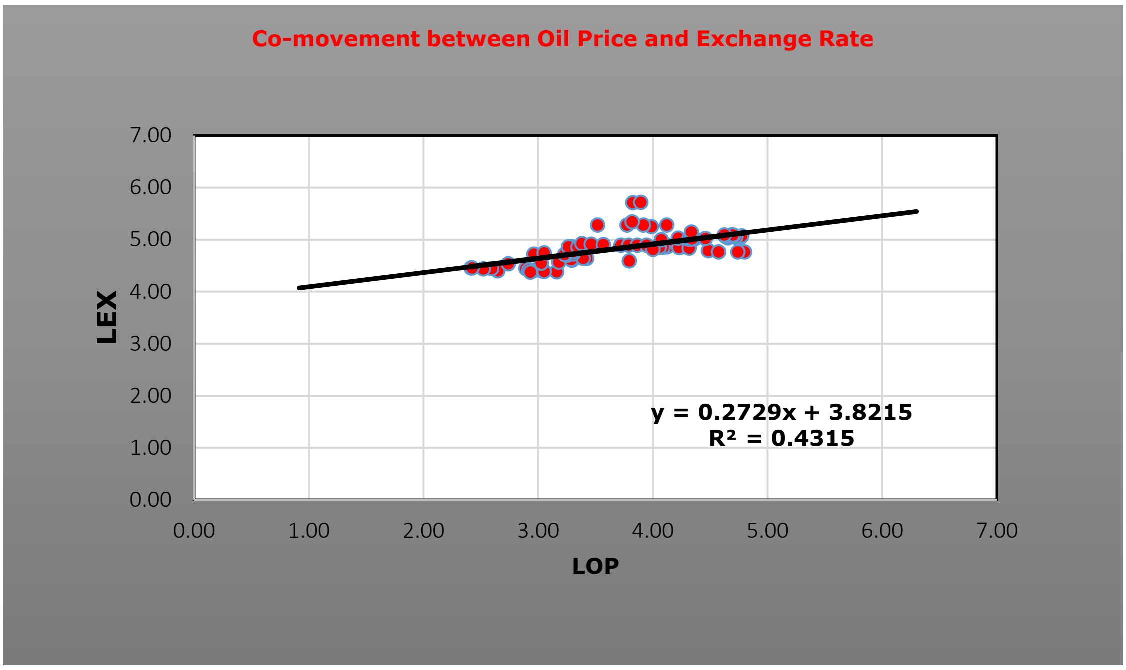

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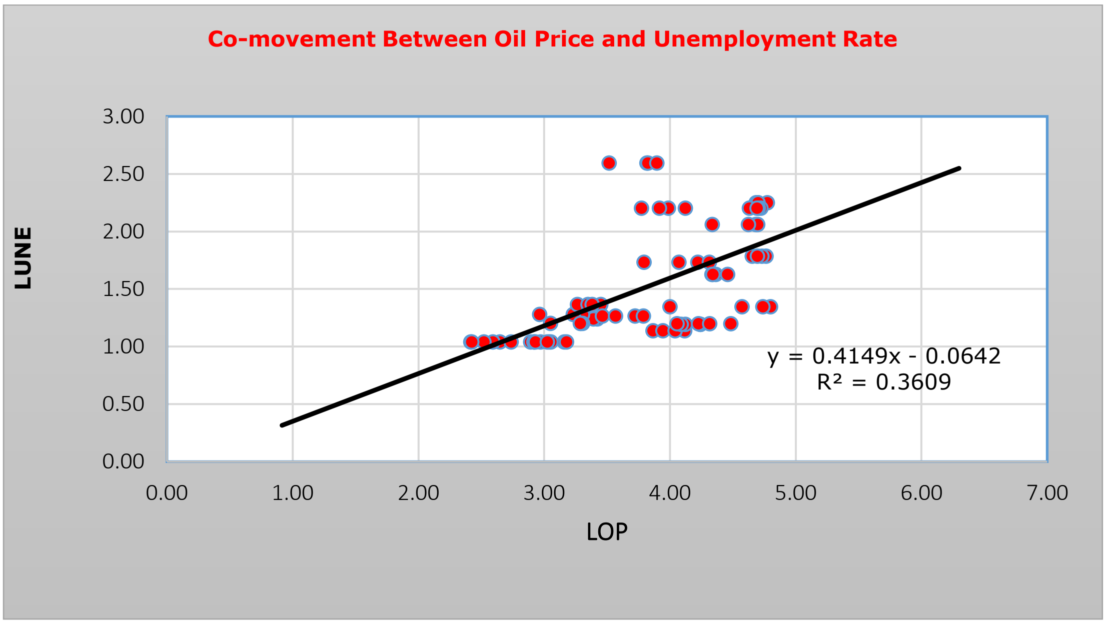

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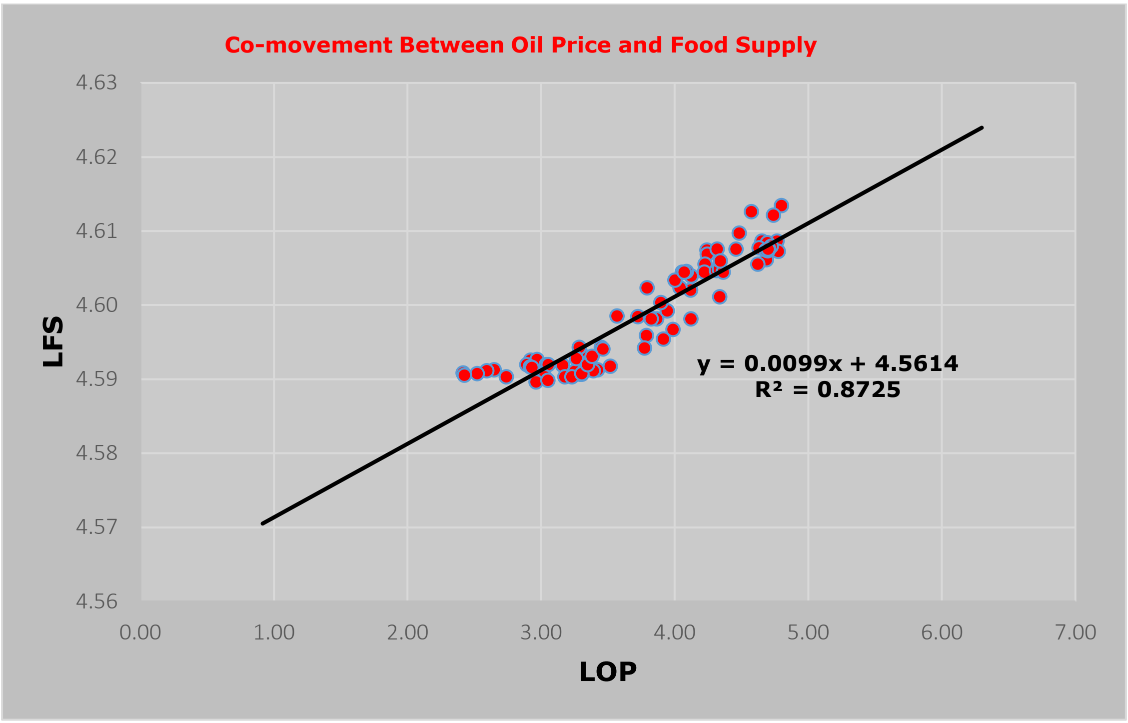
Nigeria: Figure 6.6 Co-movement Between Oil Price and Food Supply



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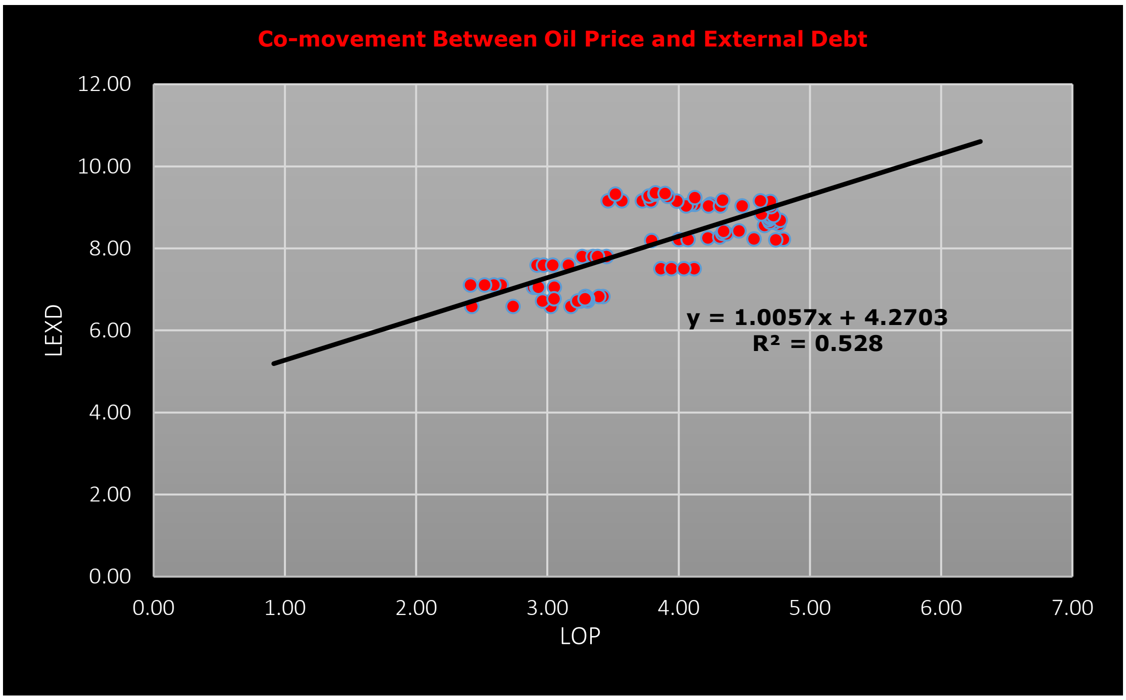
Nigeria: Figure 6.7 Co-movement Between Oil Price and External Debt



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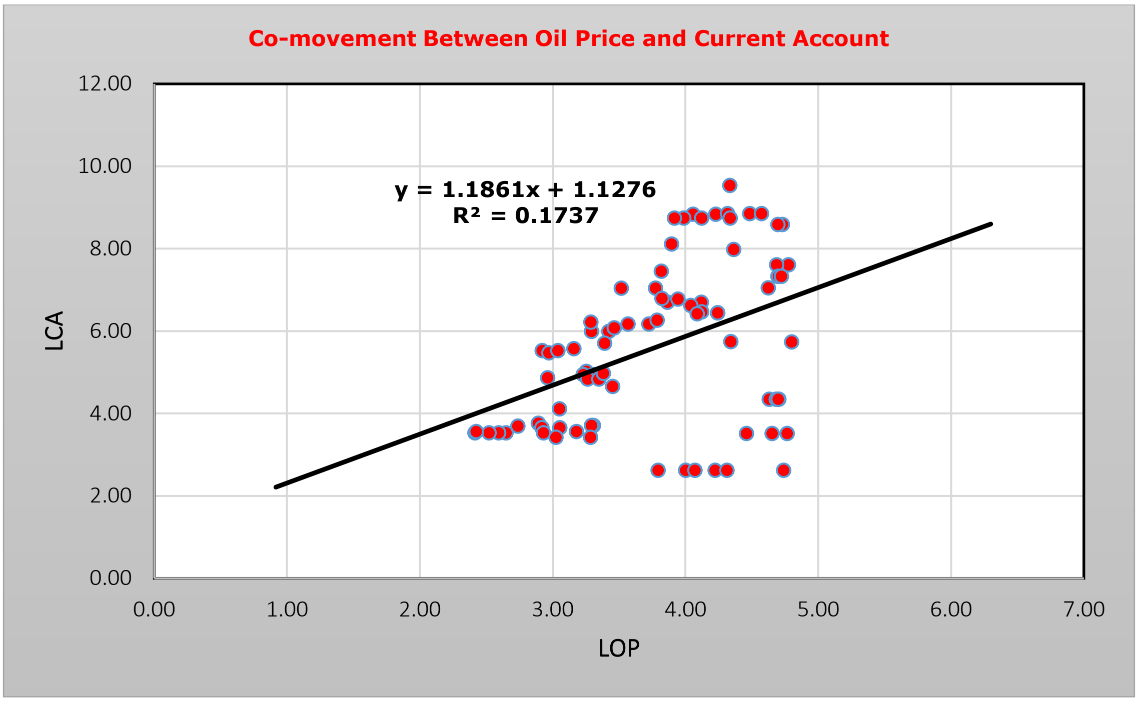
Nigeria: Figure 6.8 Co-movement Between Oil Price and Current Accounts



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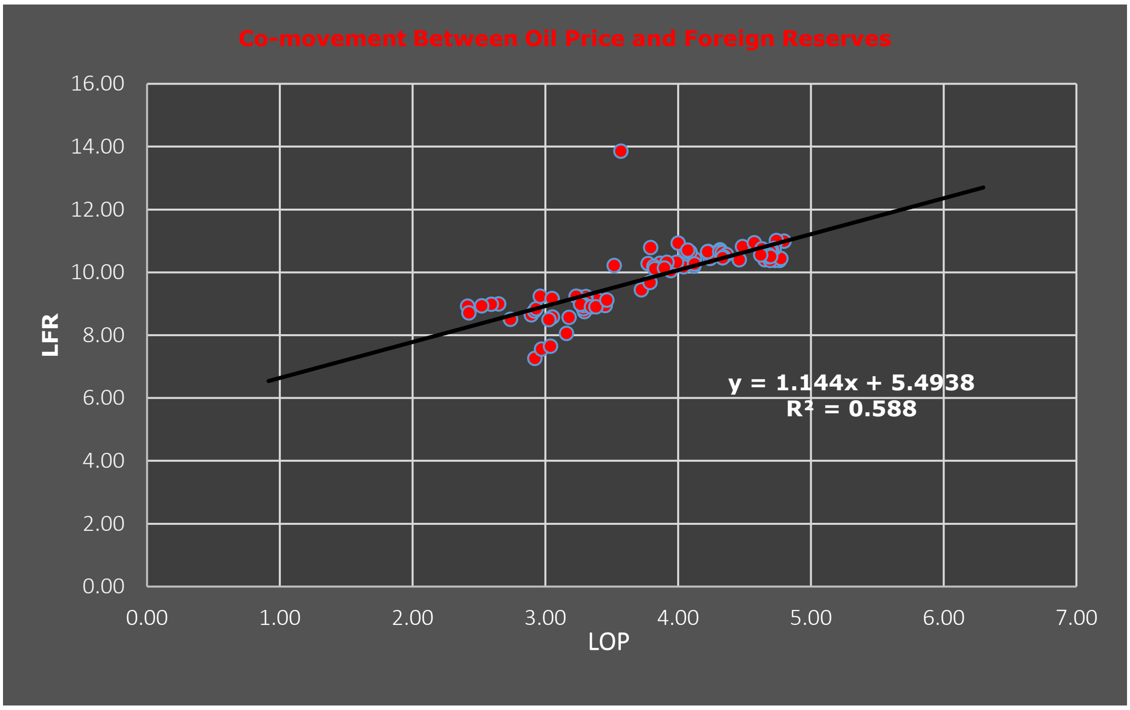
Nigeria: Figure 6.9 Co-movement Between Oil Price and Foreign Reserves



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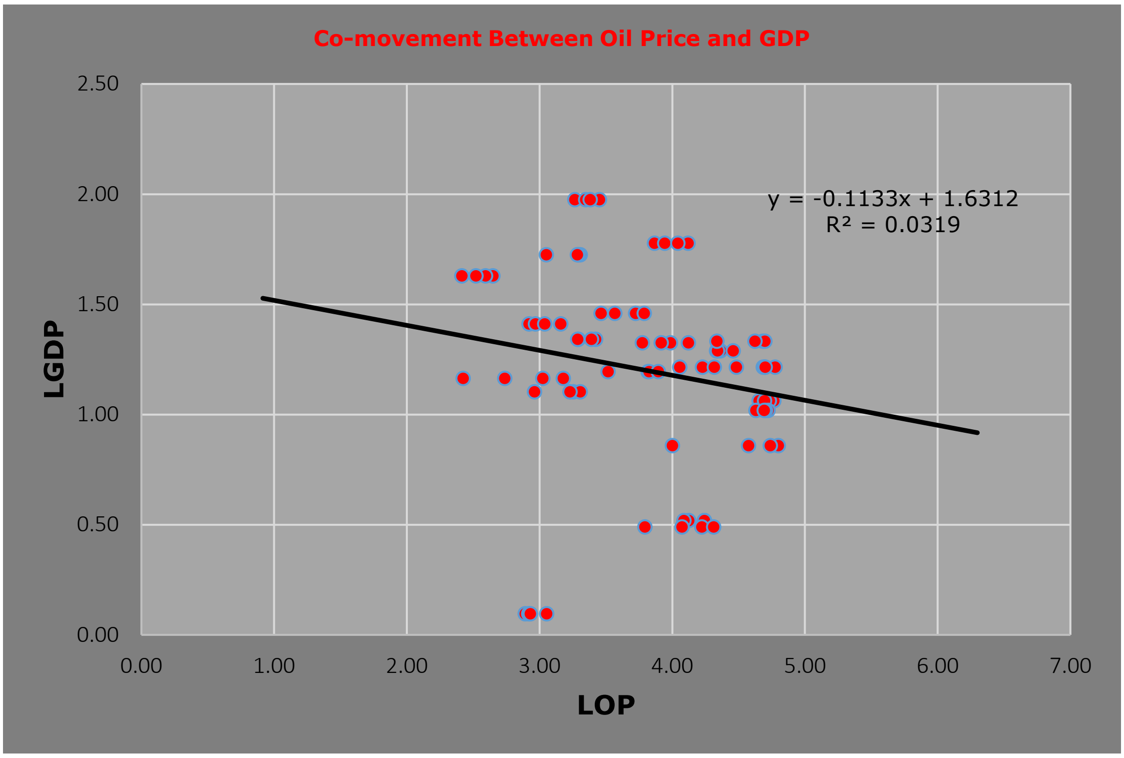
Algeria: Figure 6.10 Co-movement Between Oil Price and GDP



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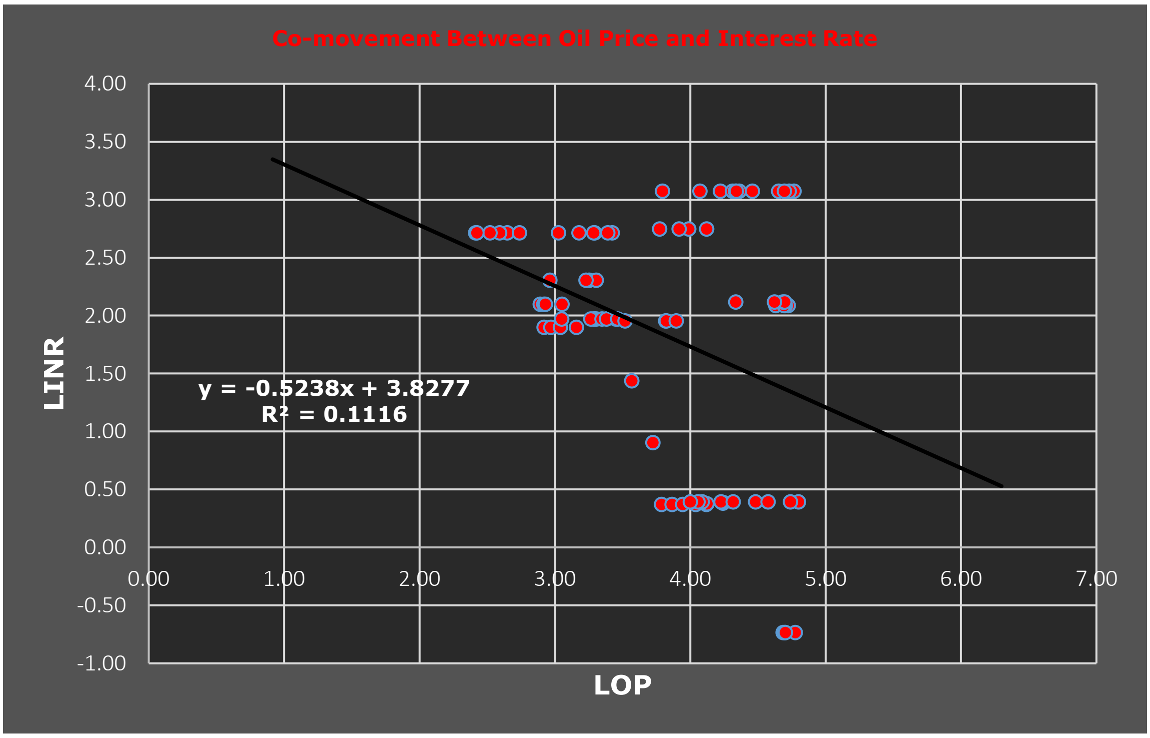

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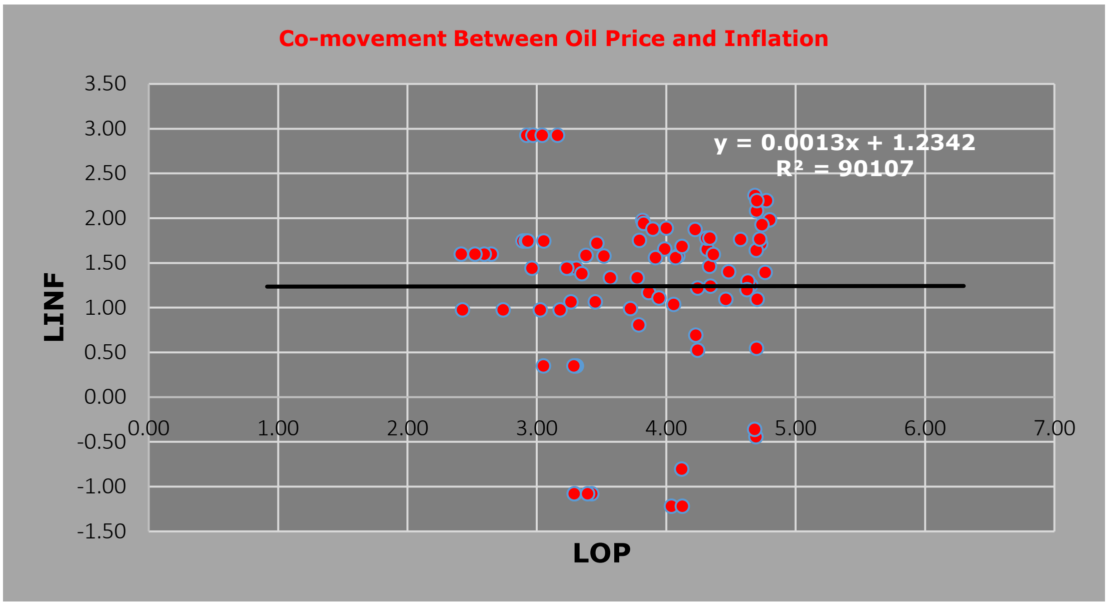

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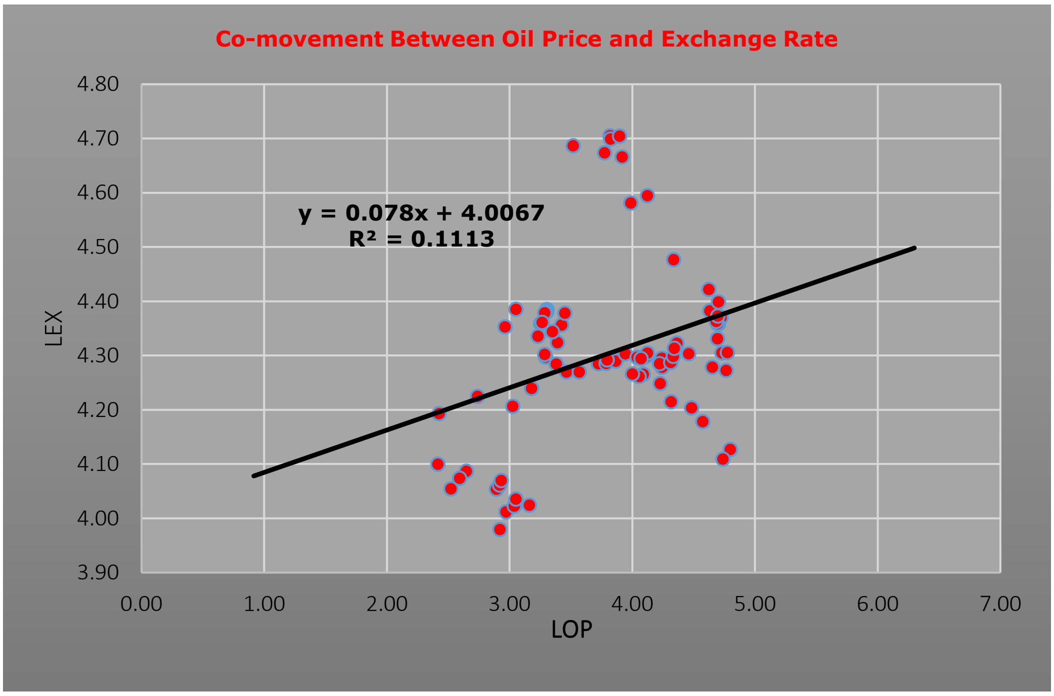
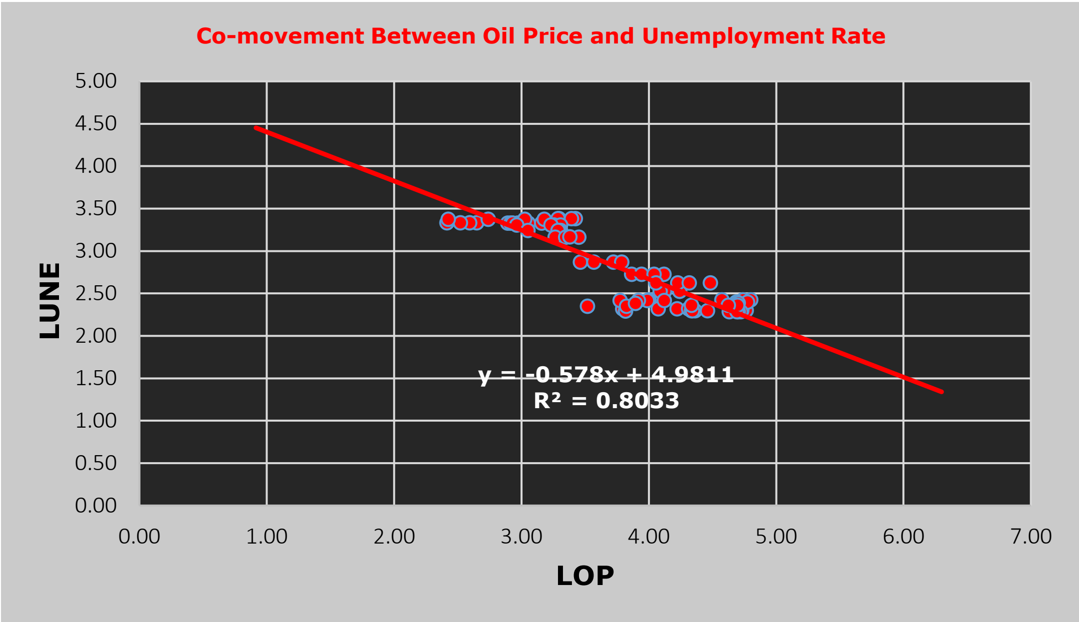


Sources: Author generated 2021

Algeria; Figure 6.14 Co-movement Between Oil Price and Unemployment Rates



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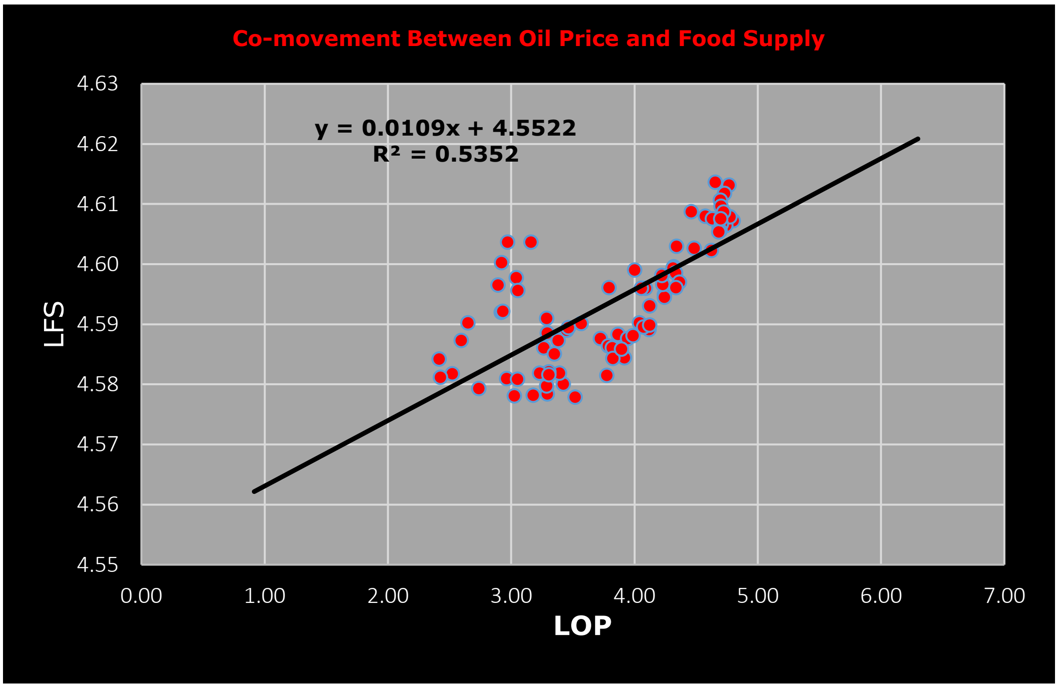
Algeria: Figure 6.15 Co-movement Between Oil Price and Food Supply



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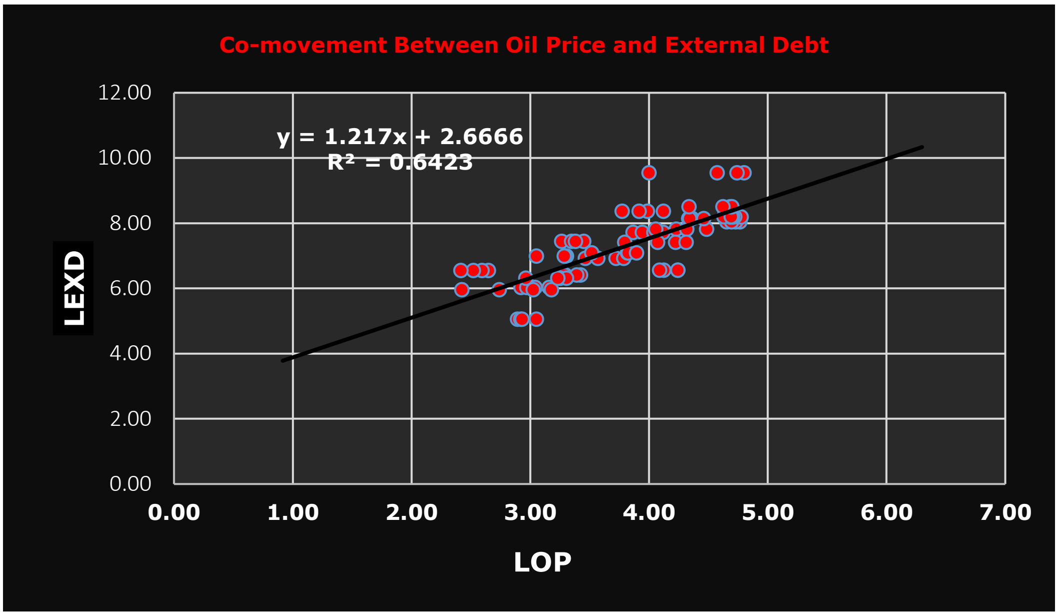
Algeria: Figure 6.16 Co-movements Between Oil price and External Debt



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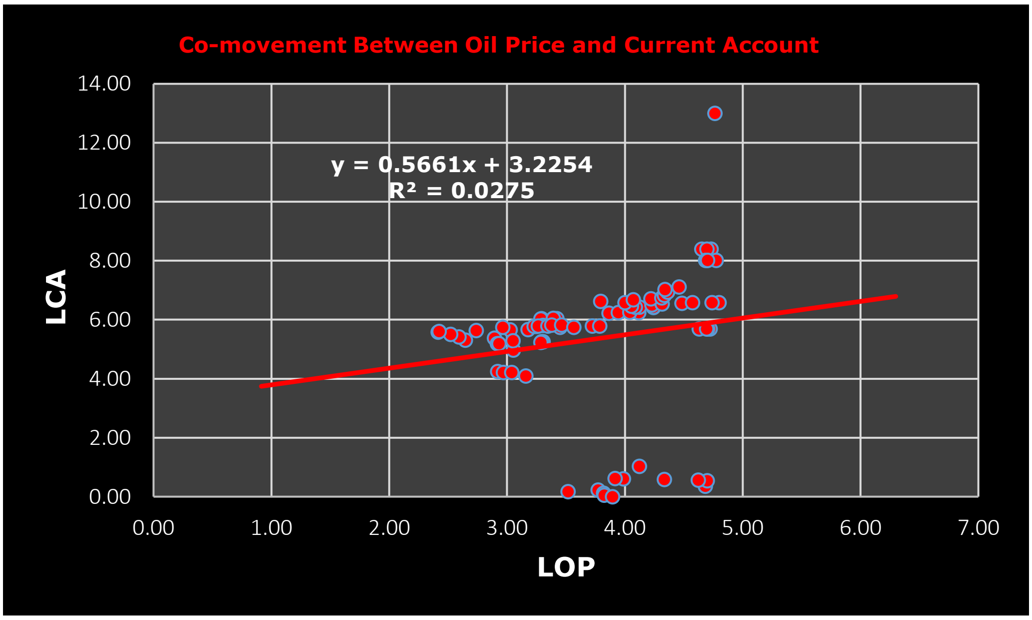
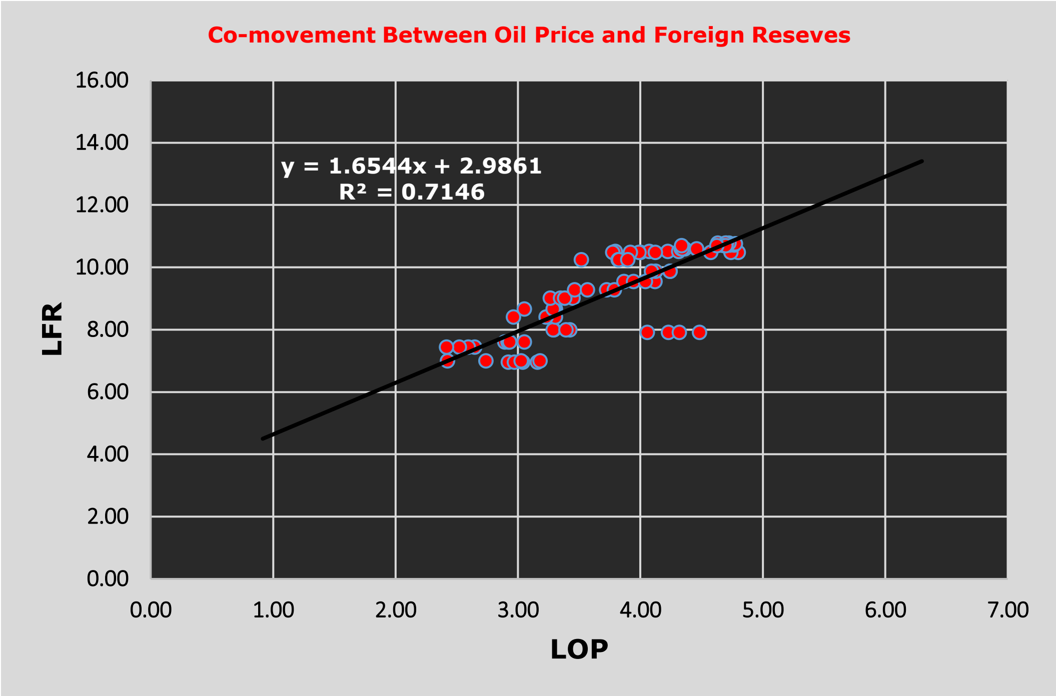
Algeria: Figure 6.17 Co-movements Between Oil Price and Current Accounts



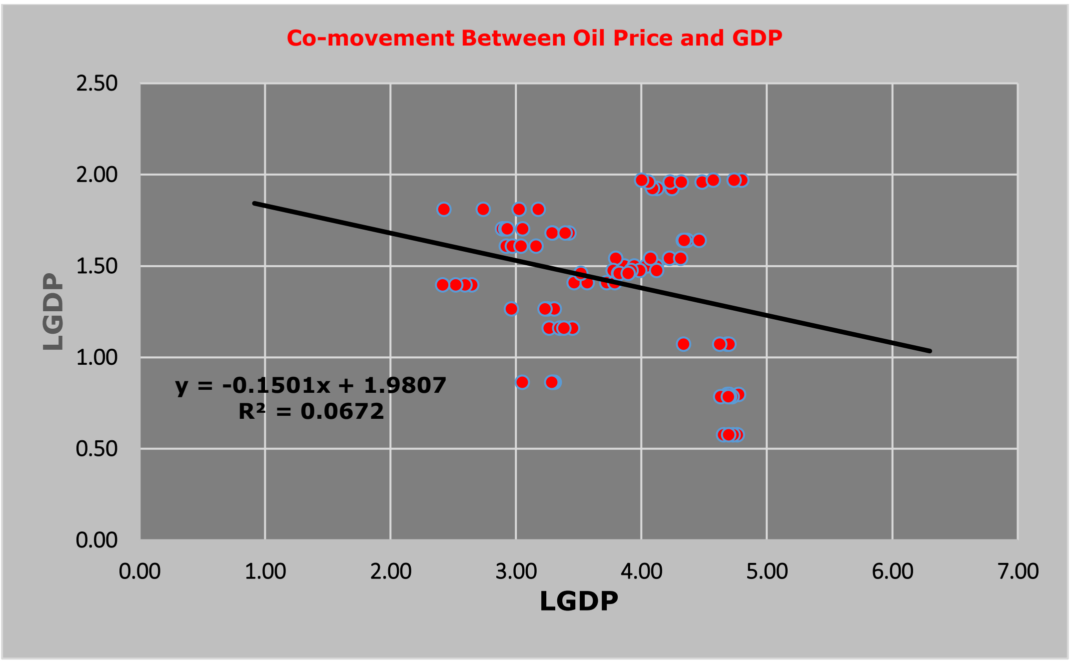
Sources: Author Generated 2021

Algeria: Figure 6.18 Co-movement Between Oil Price and Foreign Reserves



Sources: Author generated 2021

EGYPT: Figure 6.19 Co-movement Between Oil Price and GDP



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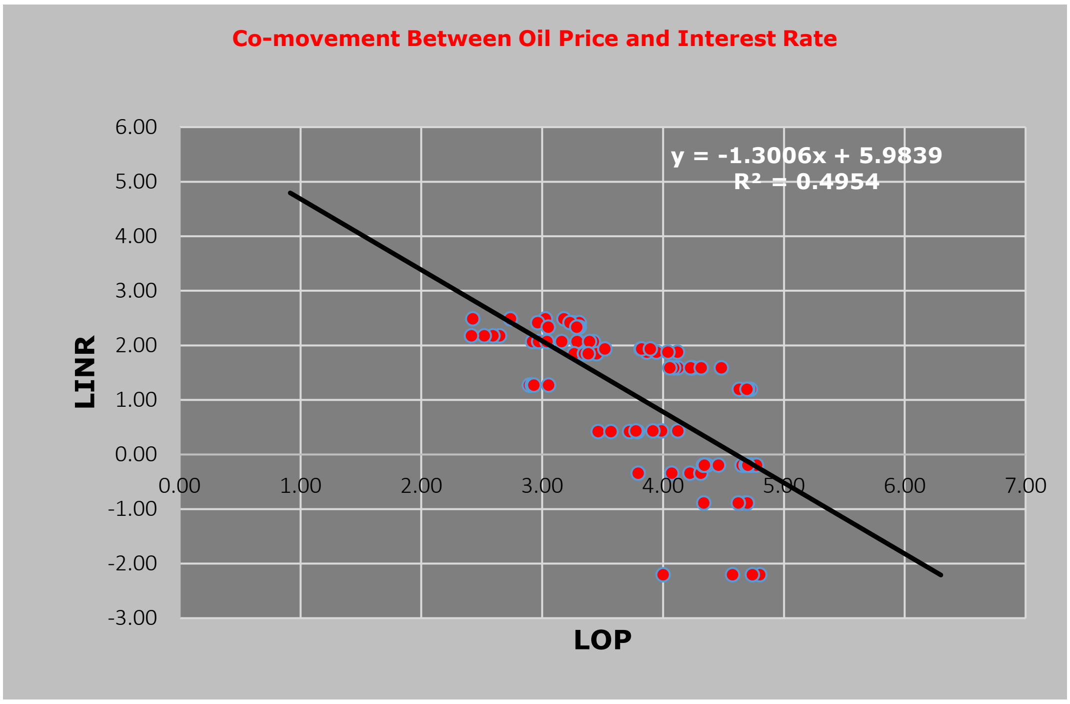
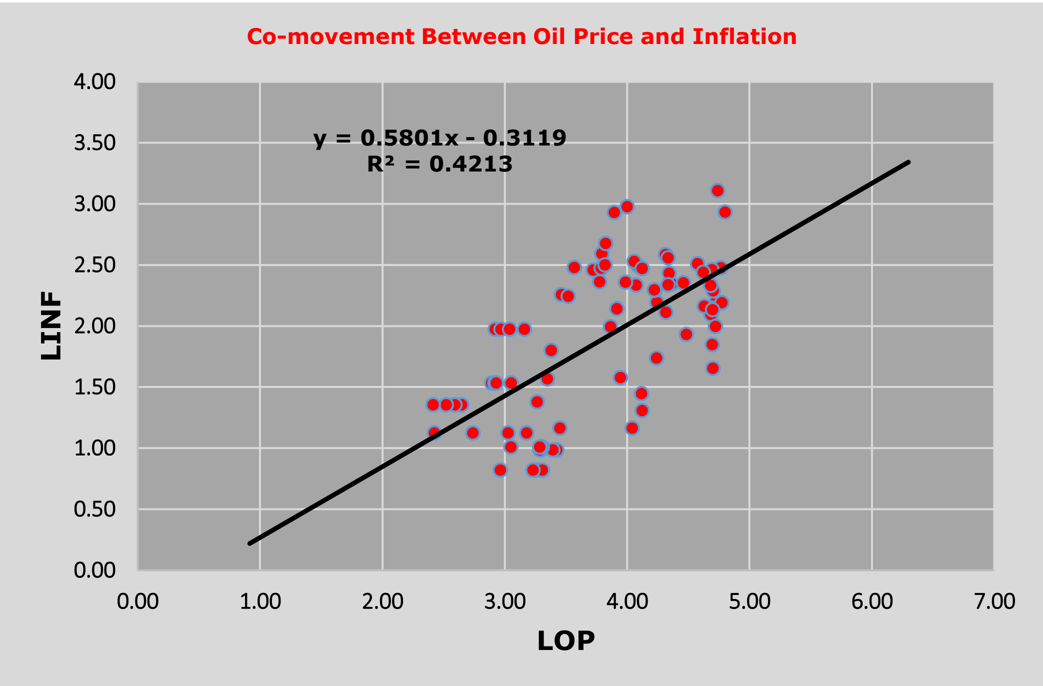
Egypt: Figure 6.20 Co-movements Between Oil Price and Interest Rates



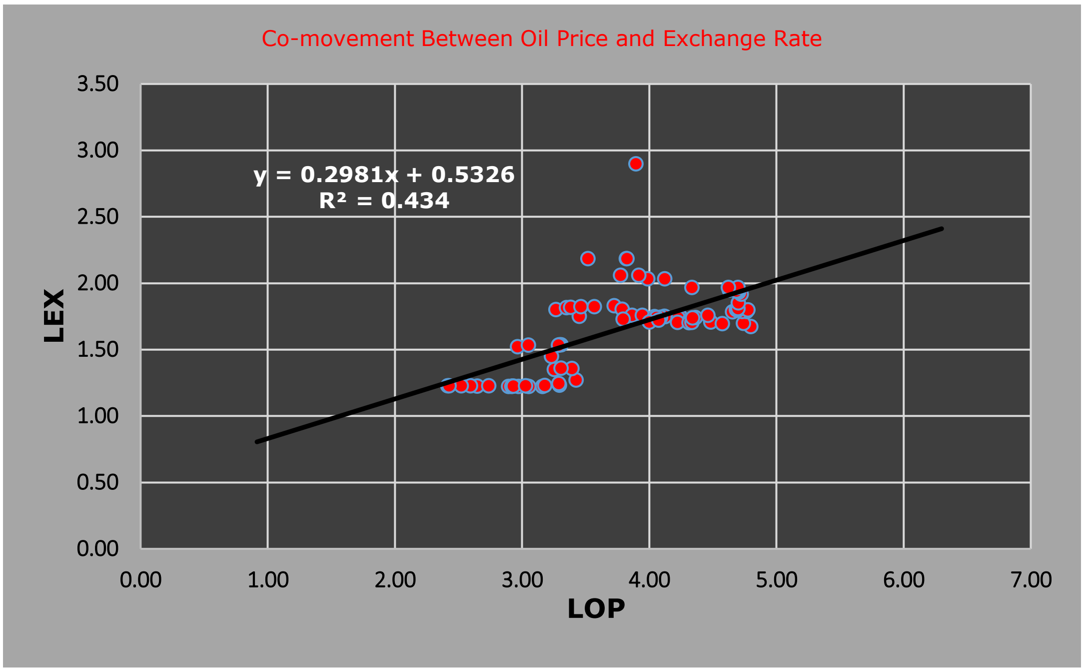
Sources: Author generated 2021

Egypt: Figure 6.21 Co-movement Between Oil Price and Inflation



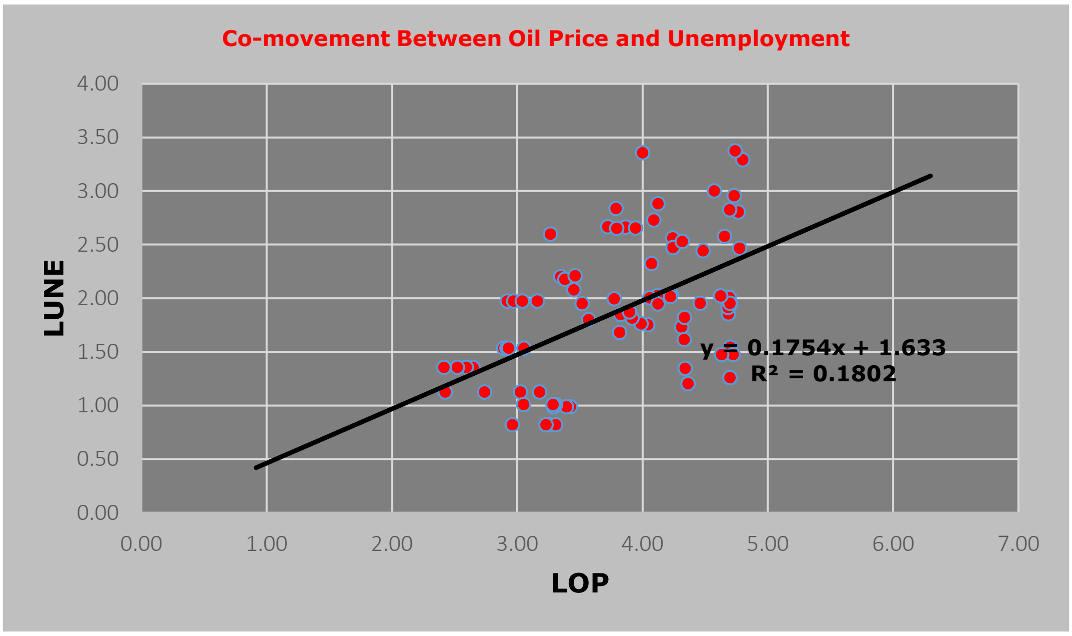
Sources: Author generated 2021

Egypt: Figure 6.22 Co-movements Between Oil Price and Exchange Rates



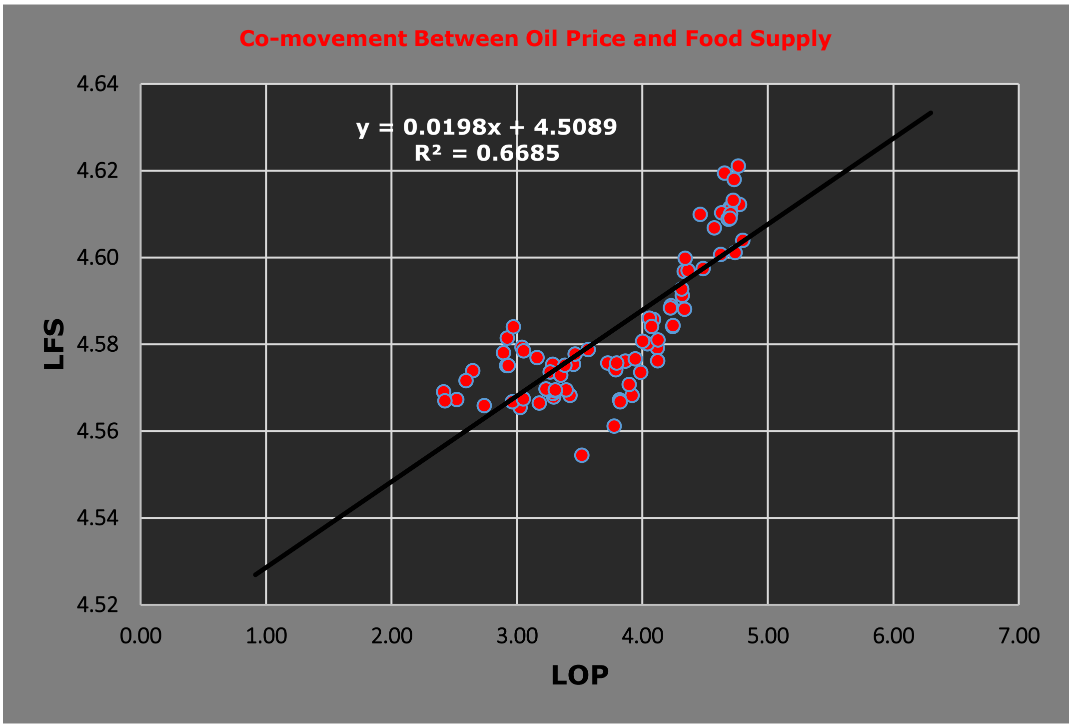
Sources: Author generated 2021

Egypt: Figure 6.23 Co-movement Between Oil Price and Unemployment Rates



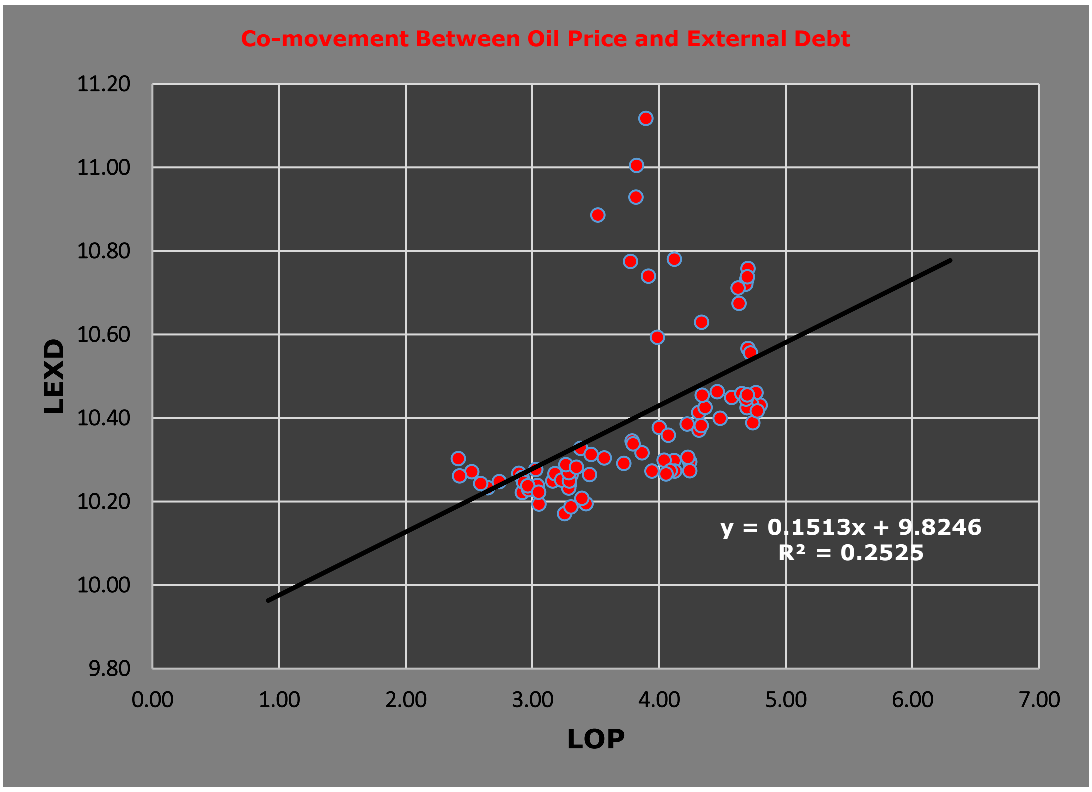
Sources: Author generated 2021

Egypt: Figure 6.24 Co-movement Between Oil Price and Food Supply



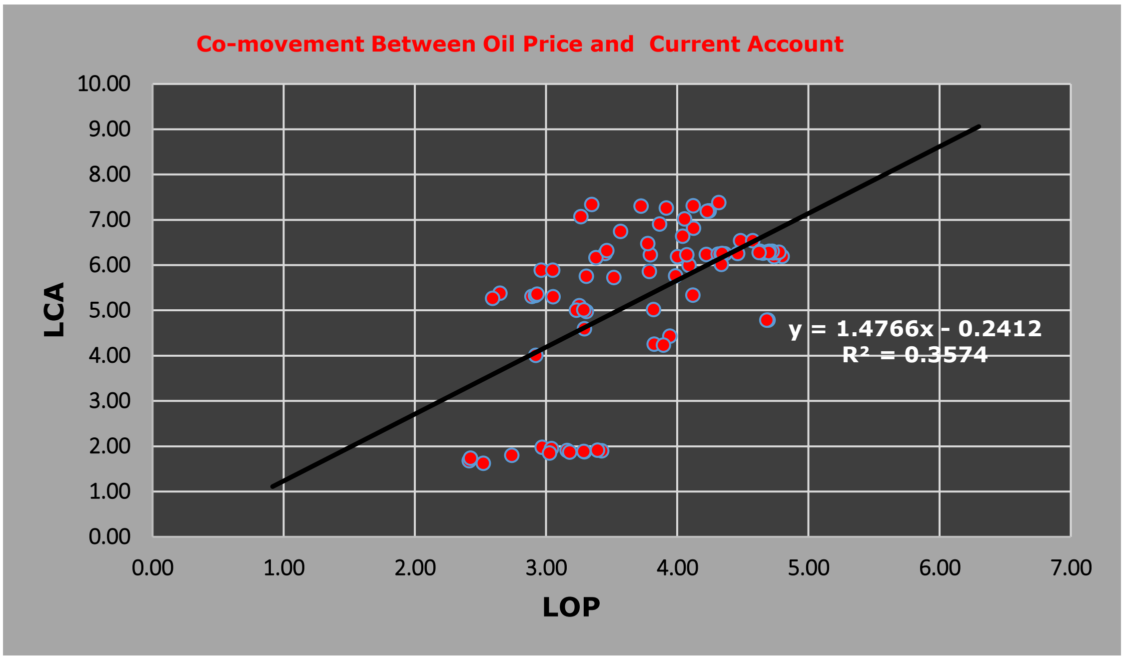
Sources: Author generated 2021

Egypt: Figure 6.25 Co-movement Between Oil Price and External Debt



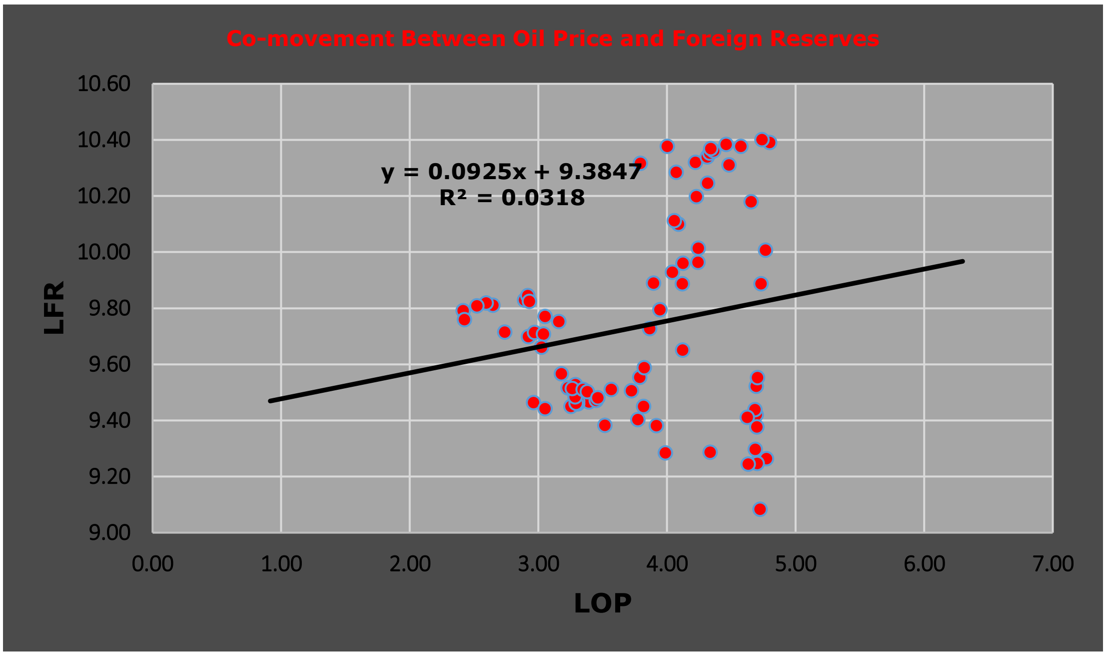
Sources: Author generated 2021

Egypt: Figure 6.26 Co-movement Between Oil Price and Current Accounts



Sources: Author generated 2021

Egypt: Figure 6.27 Co-movement Between Oil Price and Foreign Reserves



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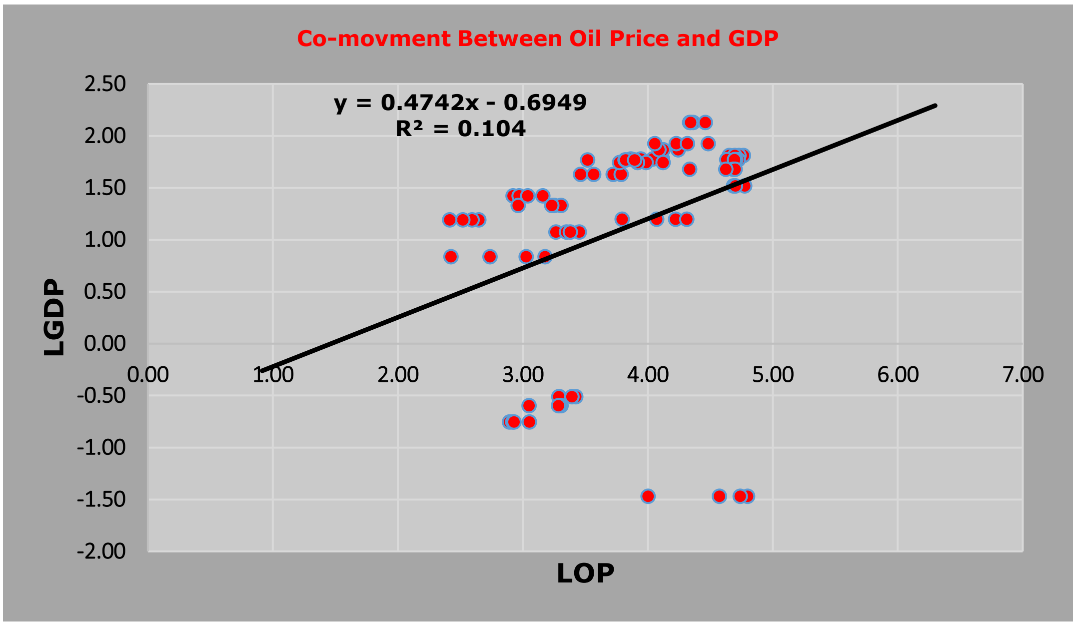
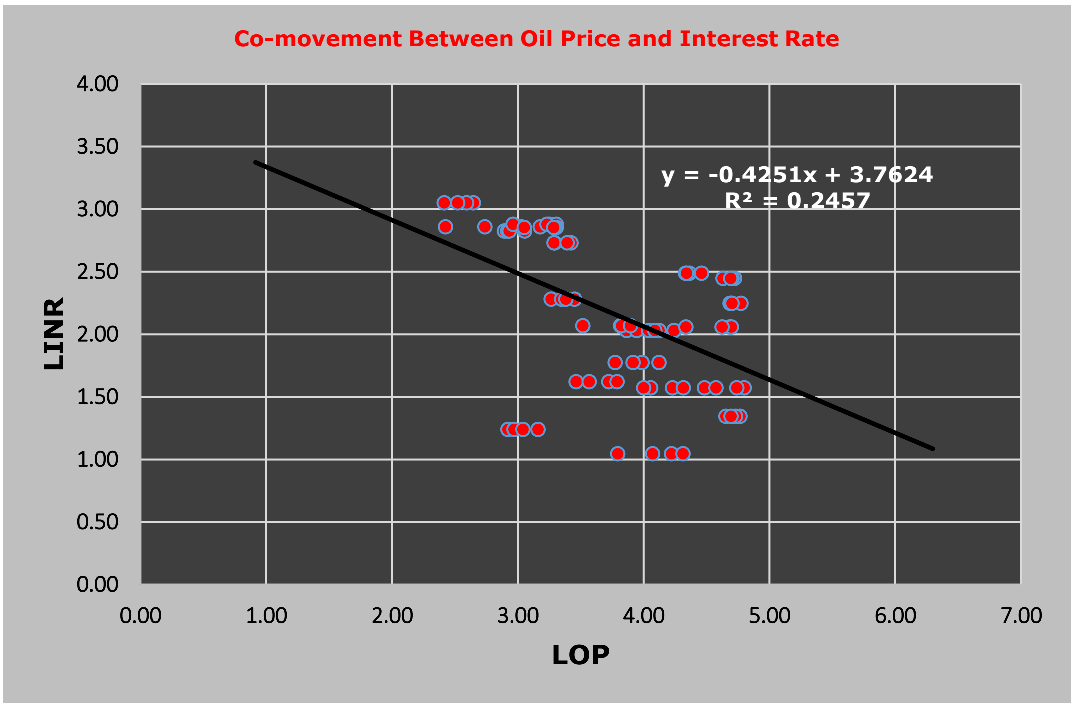
Kenya: Figure 6.28 Co-movements Between Oil Price and GDP



Sources: Author generated 2021

Kenya: Figure 6.29 Co-movement Between Oil Price and Interest Rates



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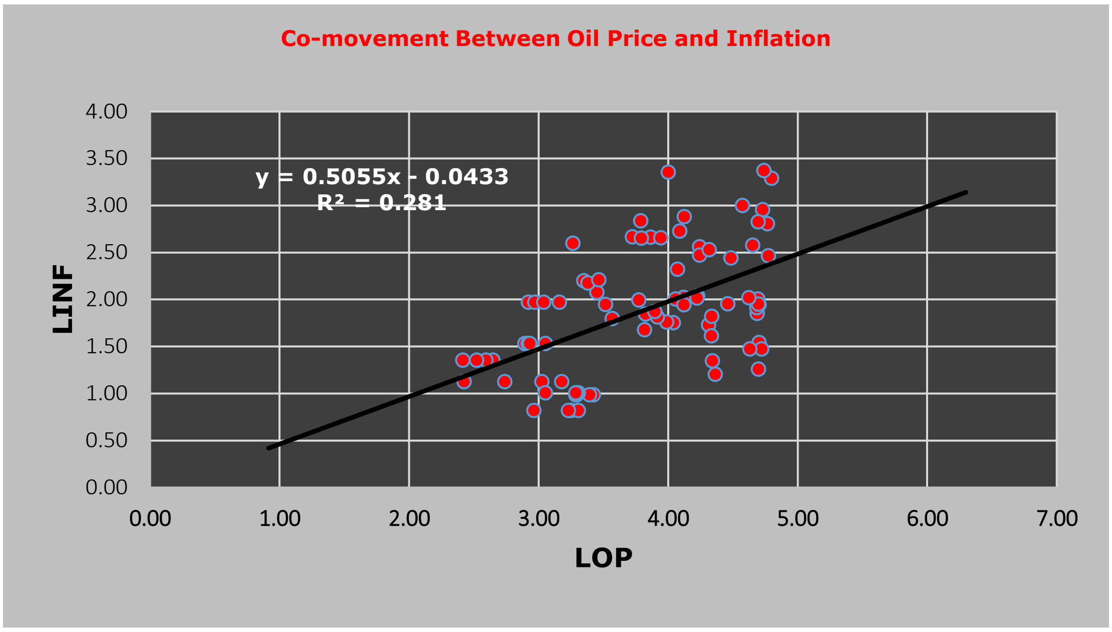
Kenya: Figure 6.30 Co-movement Between Oil Price and Inflation



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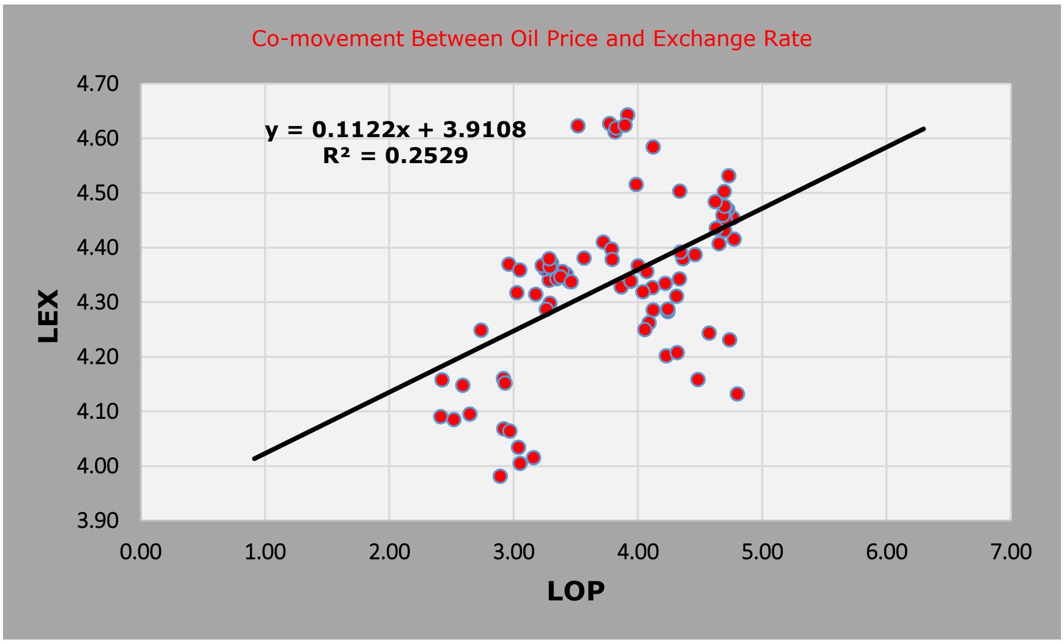
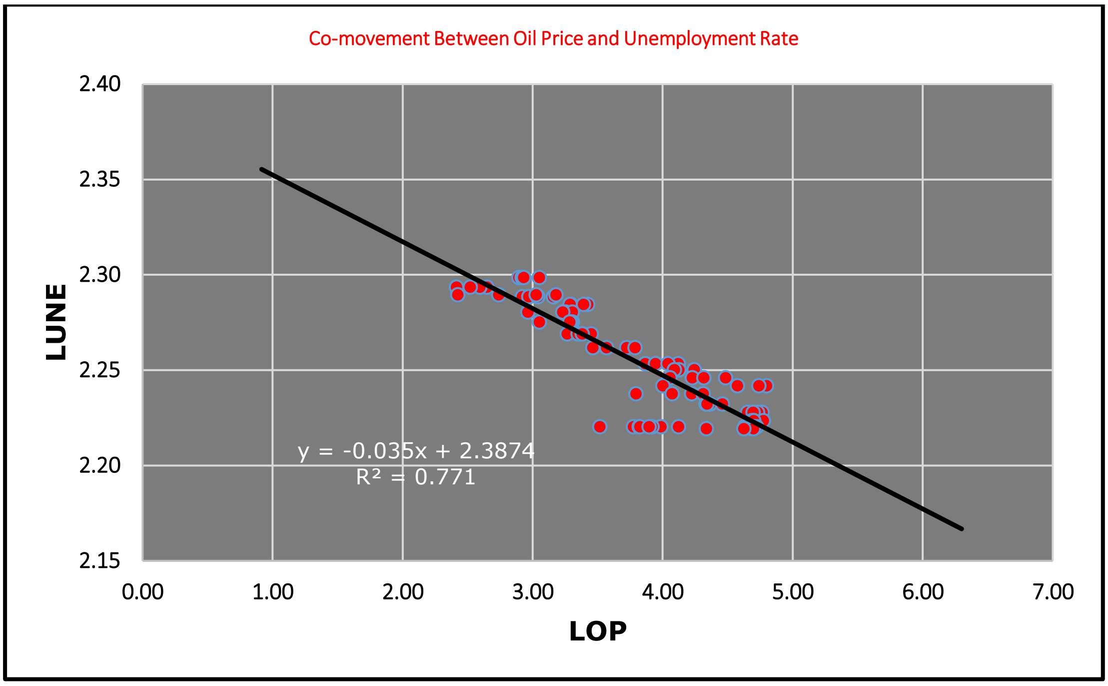
Kenya: Figure 6.31 Co-movements Between Oil Price and Exchange Rates



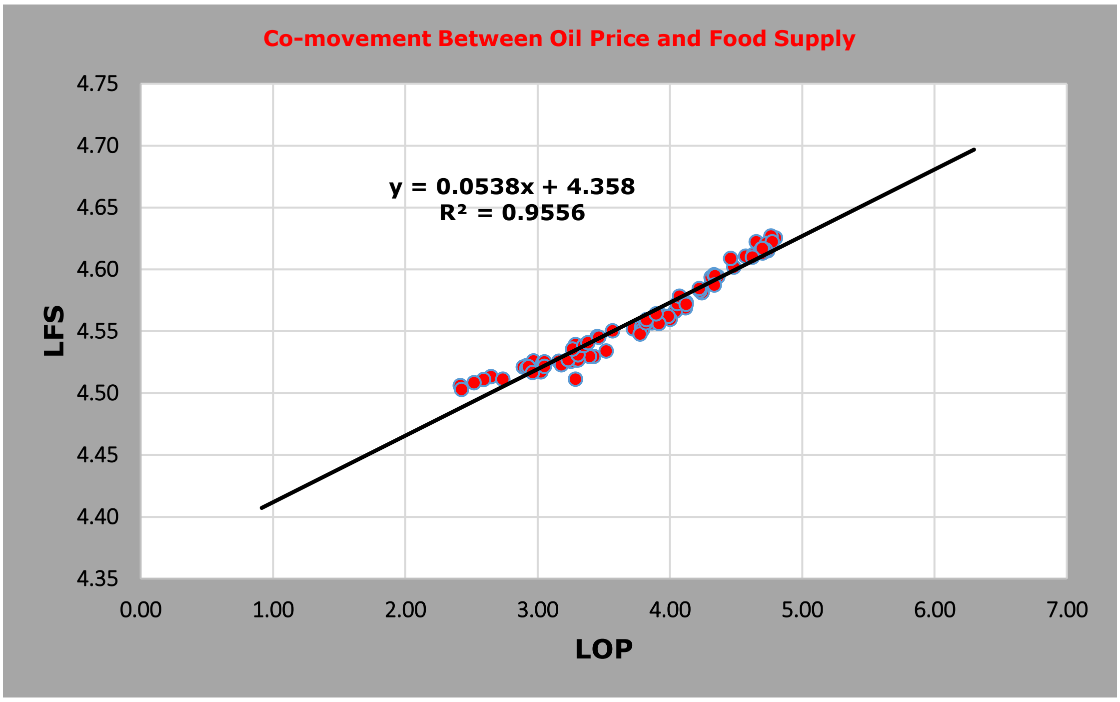
Sources: Author generated 2021

Figure 6.32 Co-movements Between Oil Price and Unemployment Rates



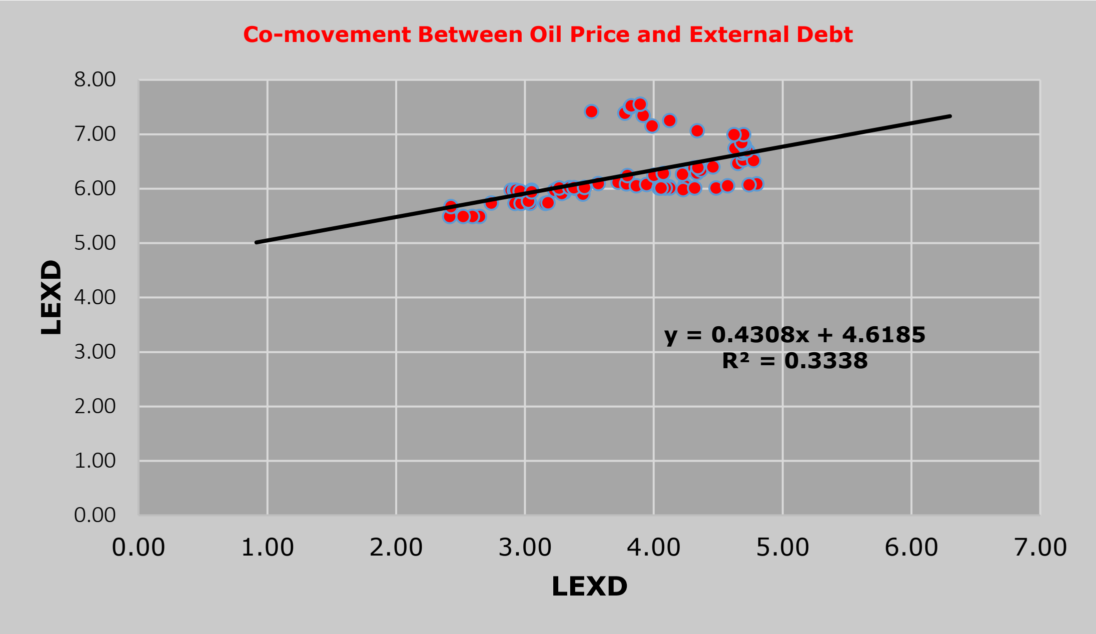
Sources: Author generated 2021

Kenya: Figure 6.33 Co-movements Between Oil Price and Food Supply



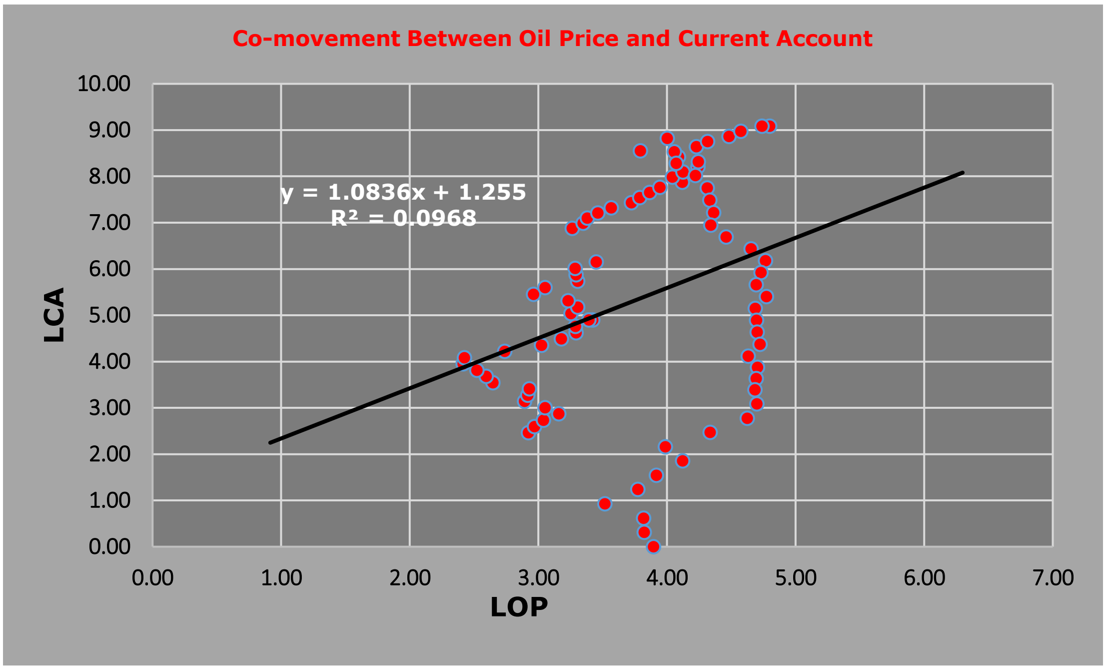
Sources: Author generated 2021

Kenya: Figure 6.34 Co-movements Between Oil price and External Debt



Sources: Author generated 2021

Kenya: Figure 6.35 Co-movements Between Oil Price and Current Accounts



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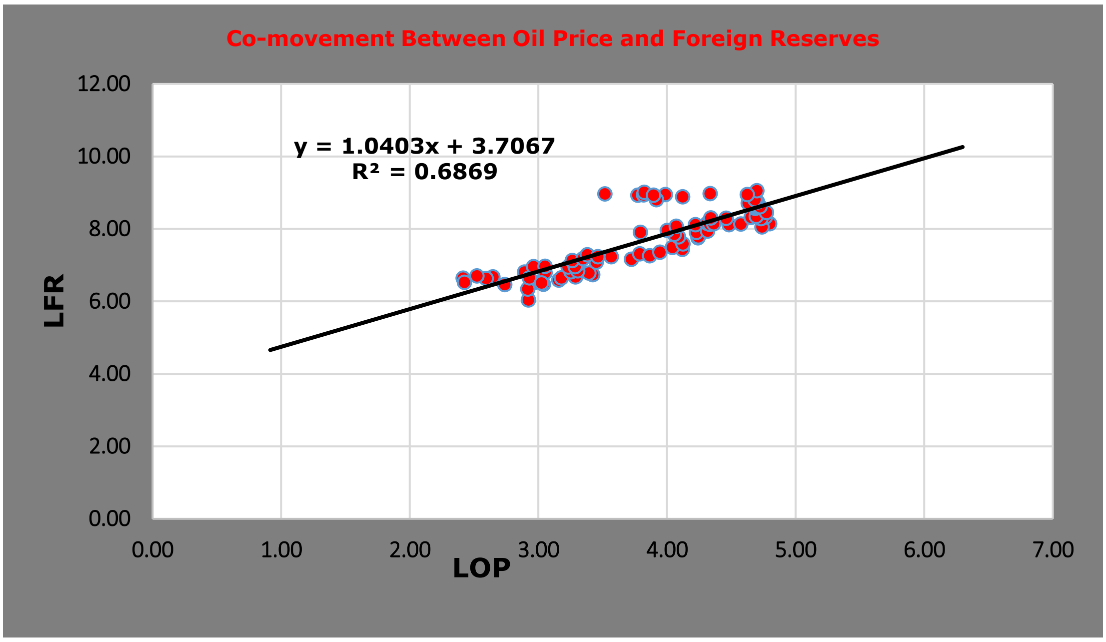
Kenya: Figure 6.36 Co-movement Between Oil Price and Foreign Reserves



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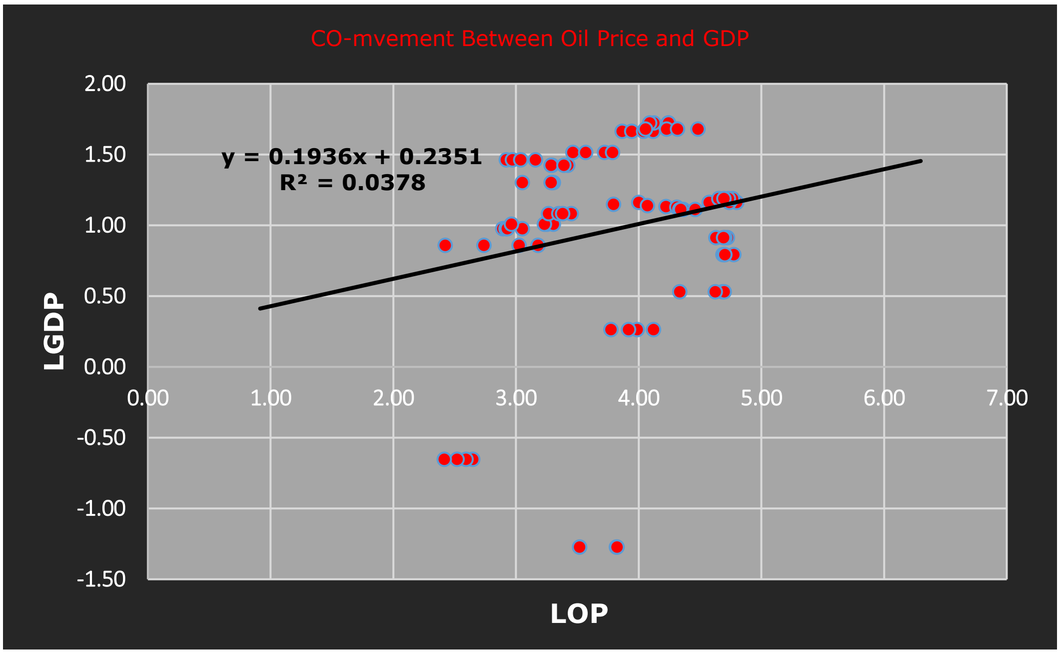
South Africa: Figure 6.37 Co-movement Between Oil Price and GDP



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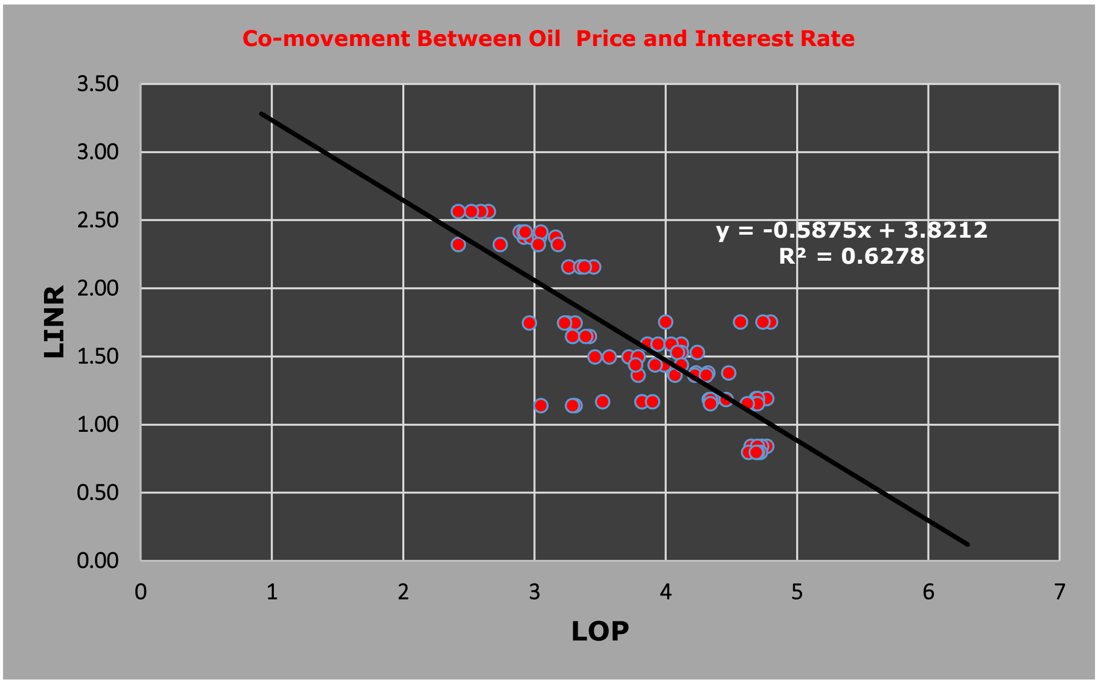
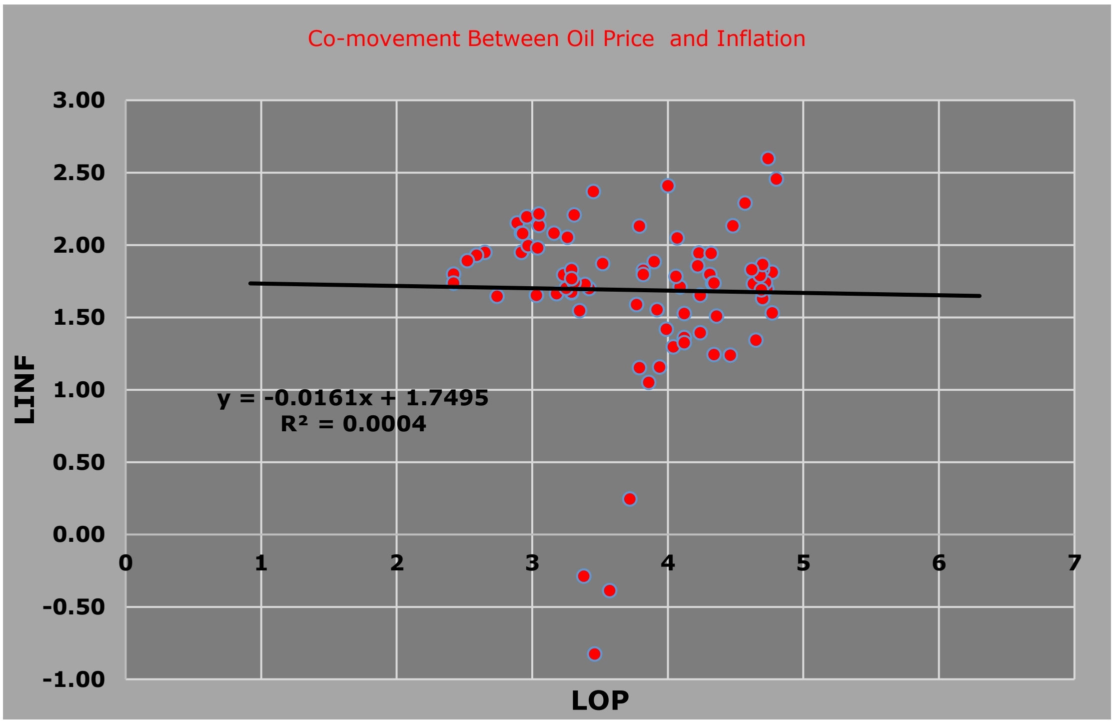
South Africa: Figure 6.38 Co-movement Between Oil Price and Interest Rates



Sources: Author generated 2021

South Africa Figure 6.39 Co-movement Between Oil Price and Inflation



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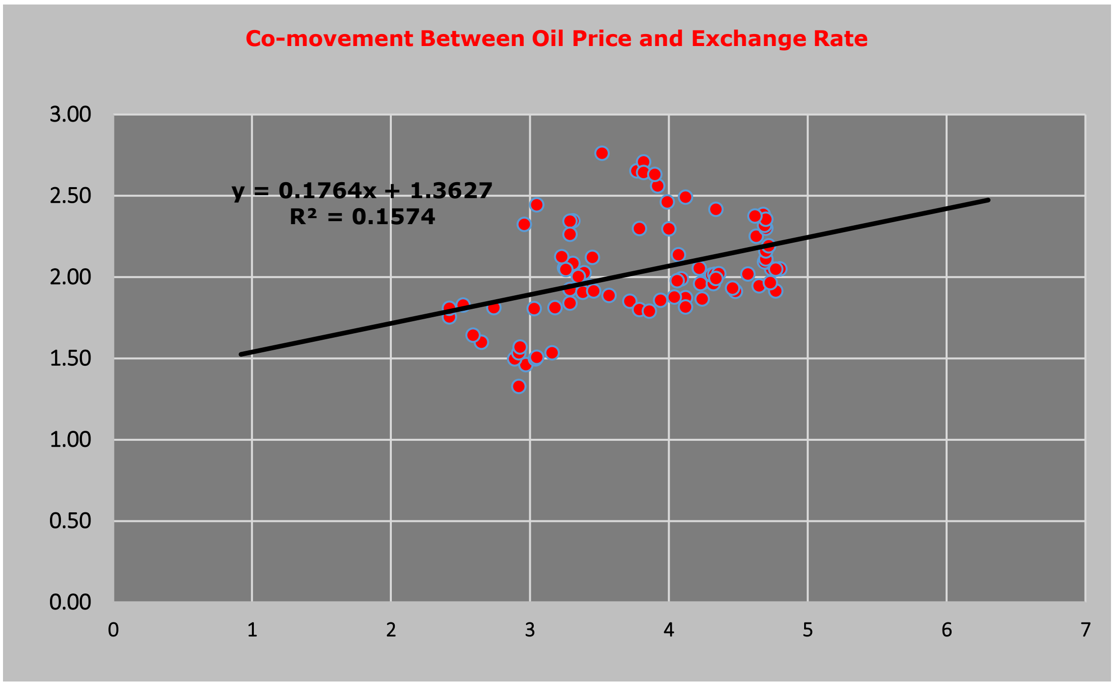
South Africa: Figure 6.40 Co-movement Between Oil Price and Exchange Rates



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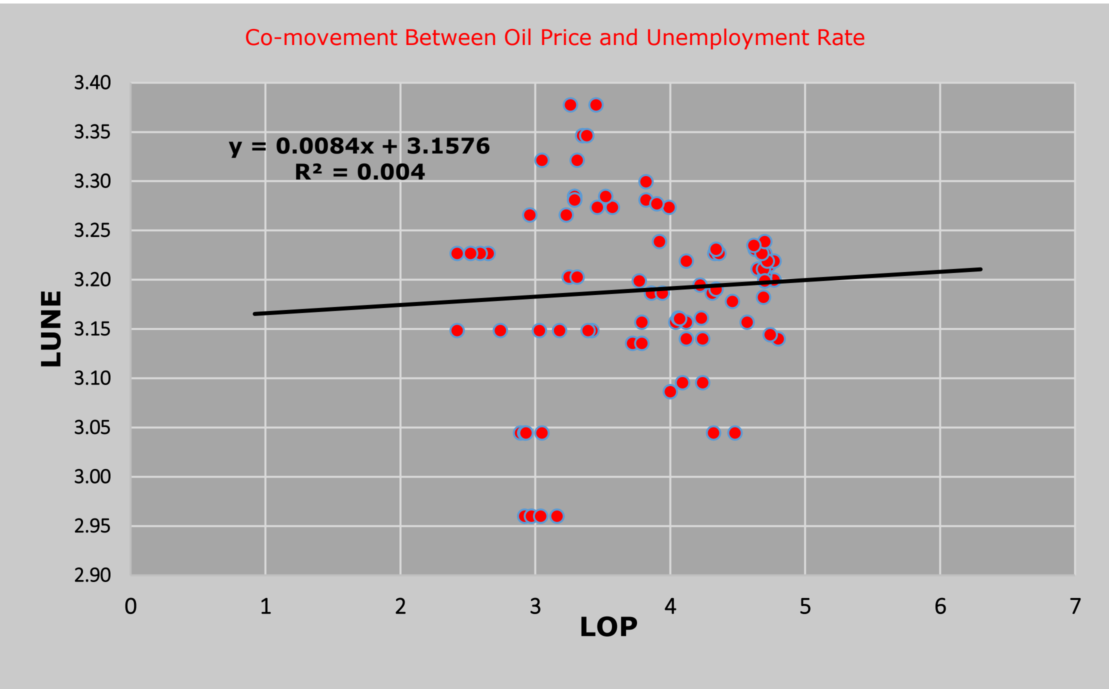
South Africa: Figure 6.41 Co-movement Between Oil Price and Unemployment Rates



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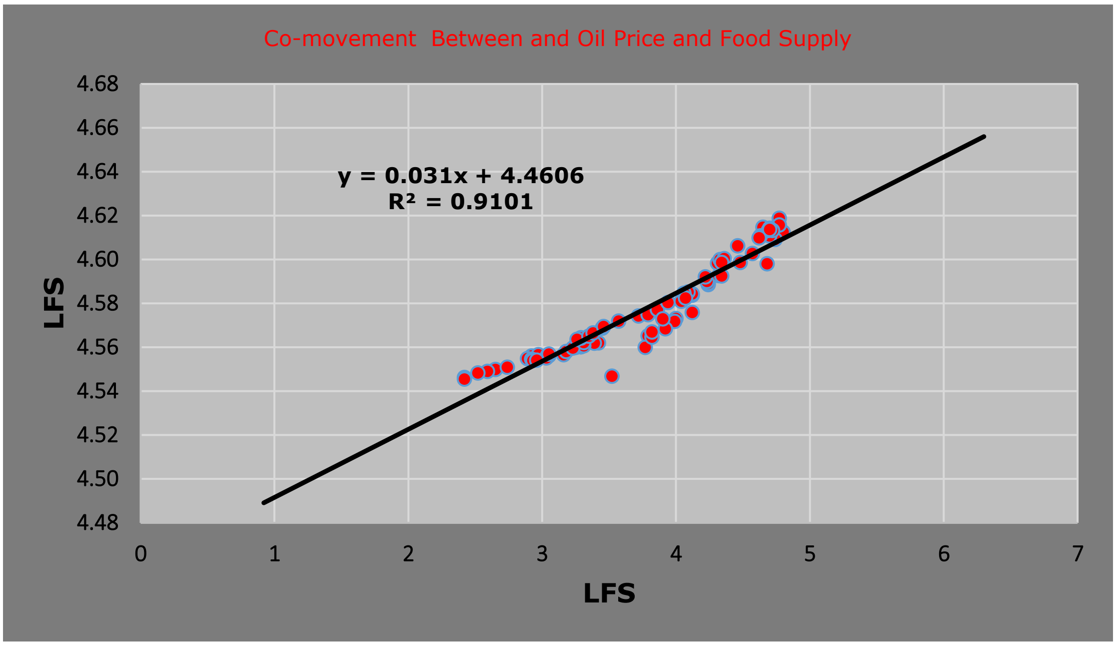
South Africa: Figure 6.42 Co-movements Between Oil Price and Food Supply



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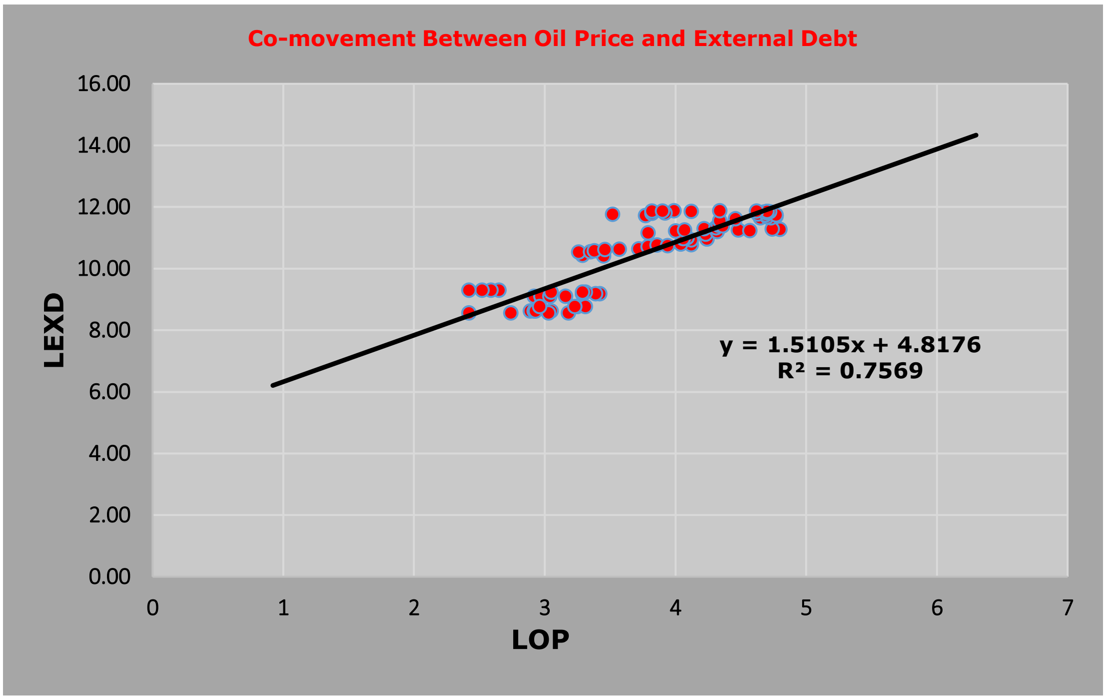
South Africa: Figure 6.43 Co-movement Between Oil Price and External Debt



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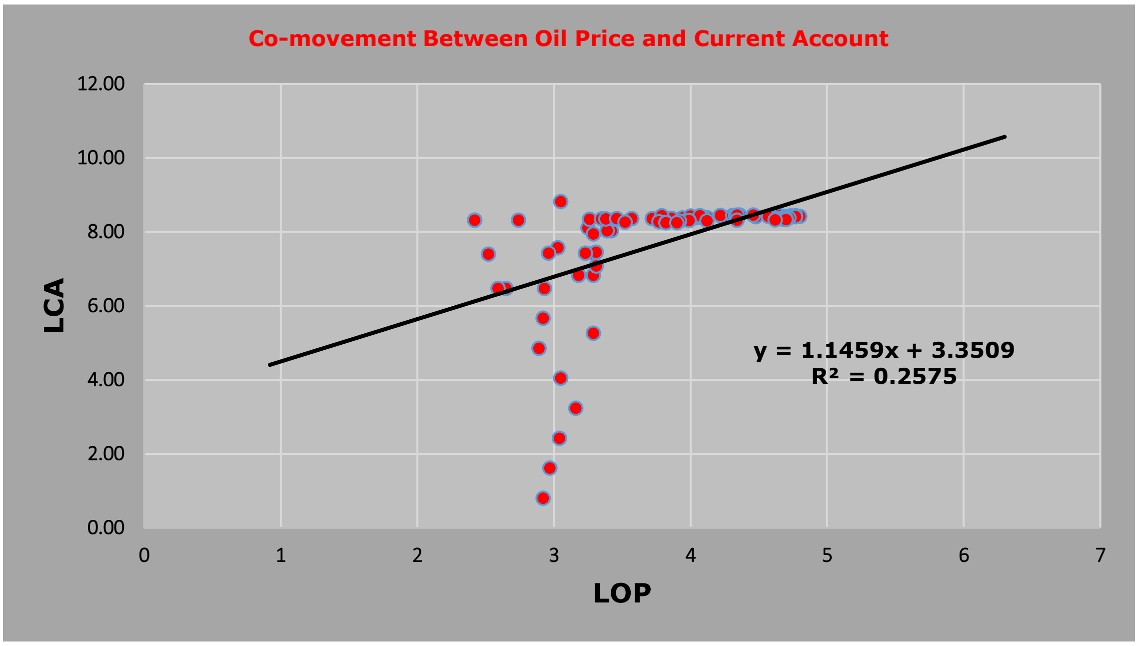
South Africa: Figure 6.44 Co-movement Between Oil Price and Current Accounts



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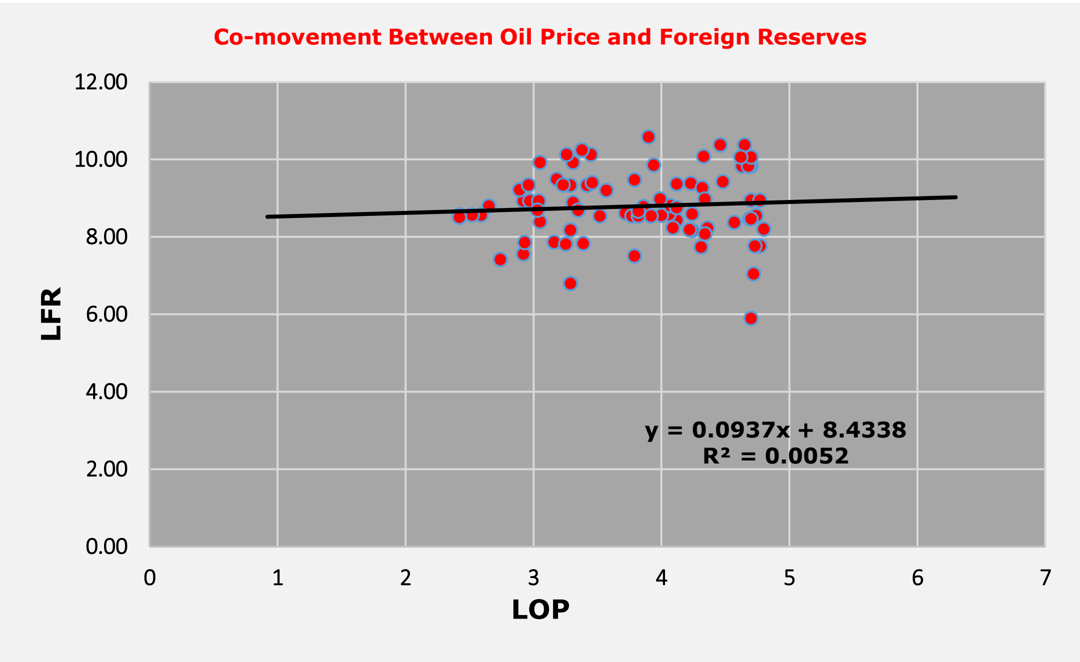
South Africa: Figure 6.45 Co-movement Between Oil Price and Foreign Reserves



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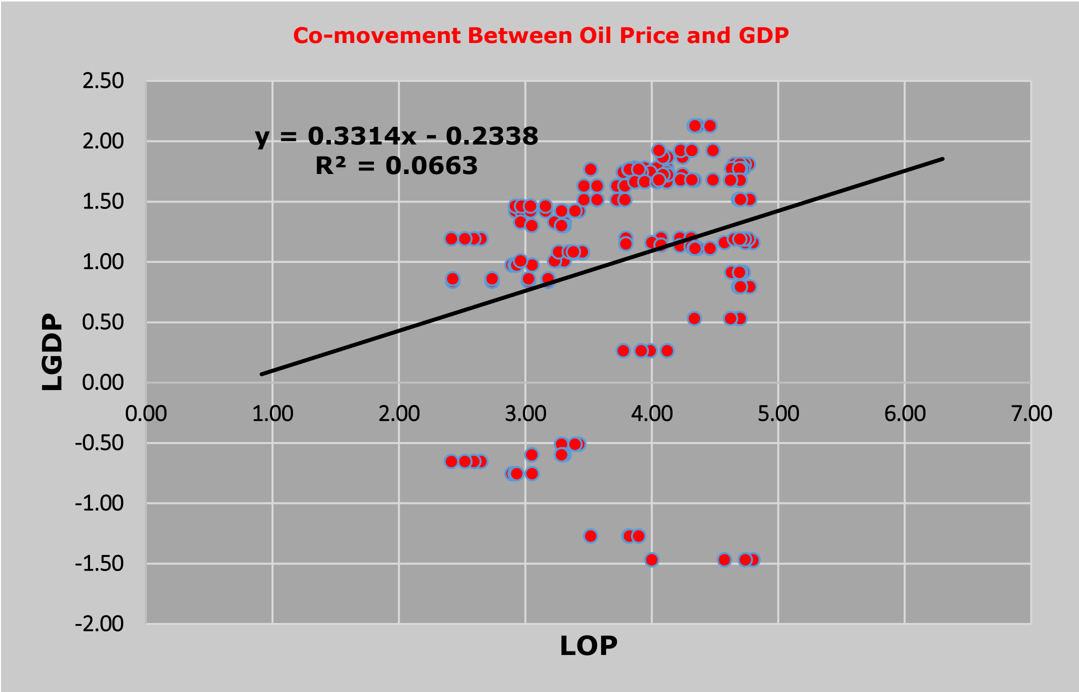
Net Oil Importers: Figure 6.46 Co-movement Between Oil Price and GDP



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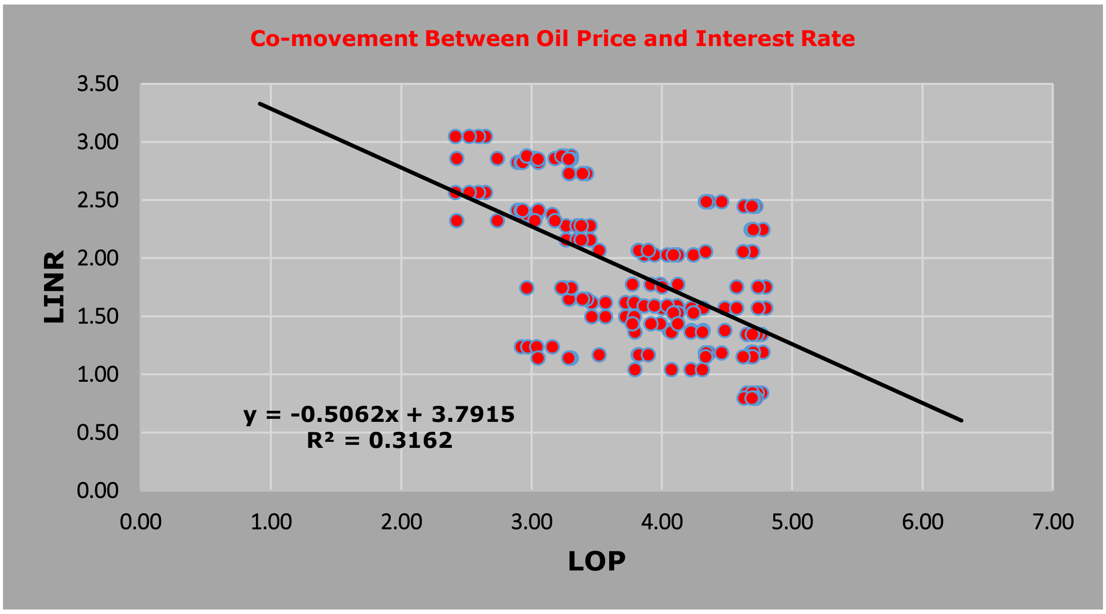
Net Oil Importers: Figure 6.47 Co-movement Between Oil Price and Interest Rates



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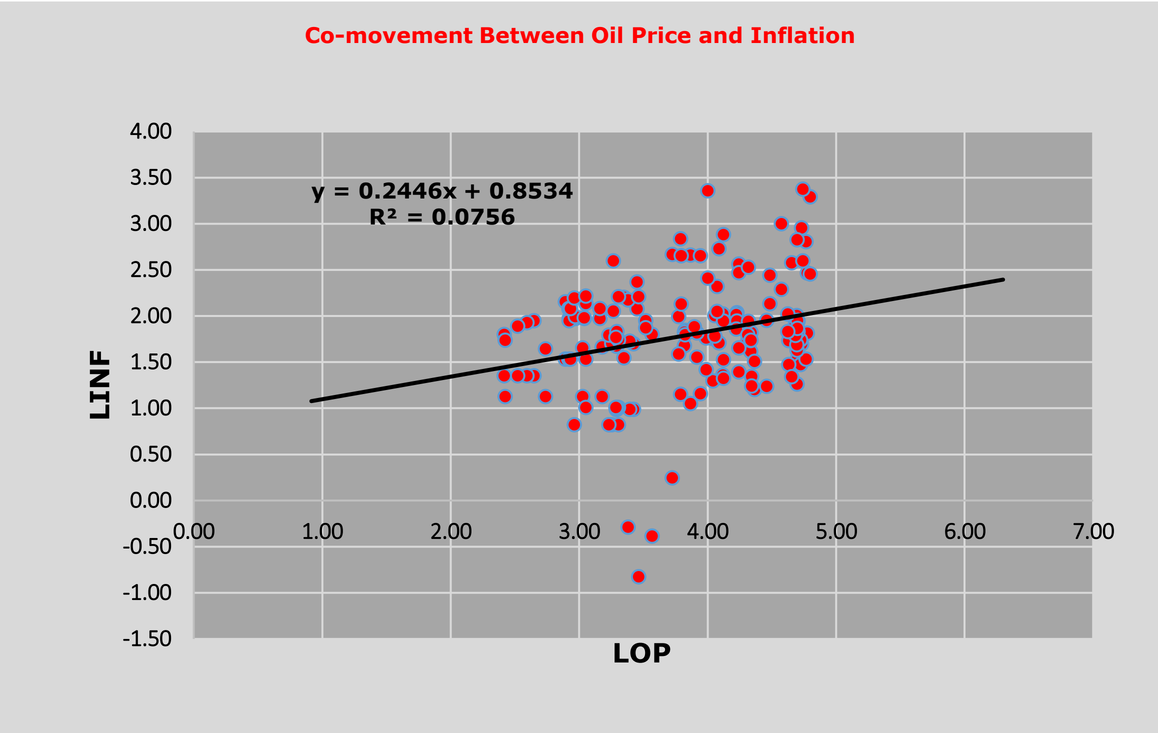
Net Oil Importers: Figure 6.48 Co-movement Between Oil Price and Inflation



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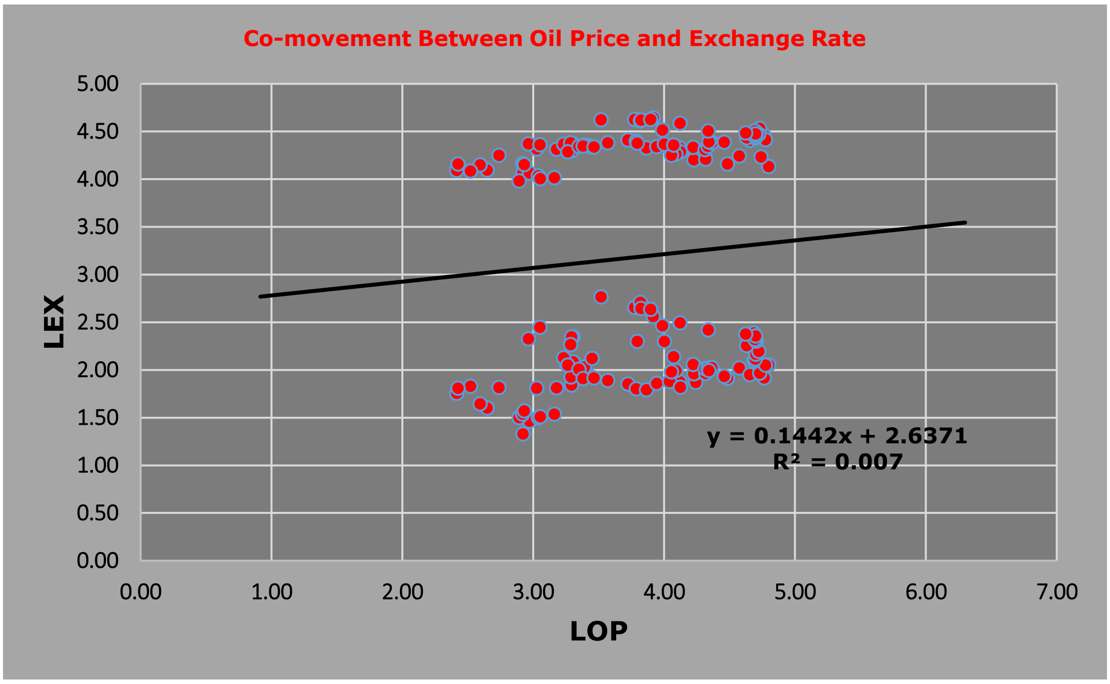
Net Oil Importers: Figure 6.49 Co-movement Between Oil Price and Exchange Rates



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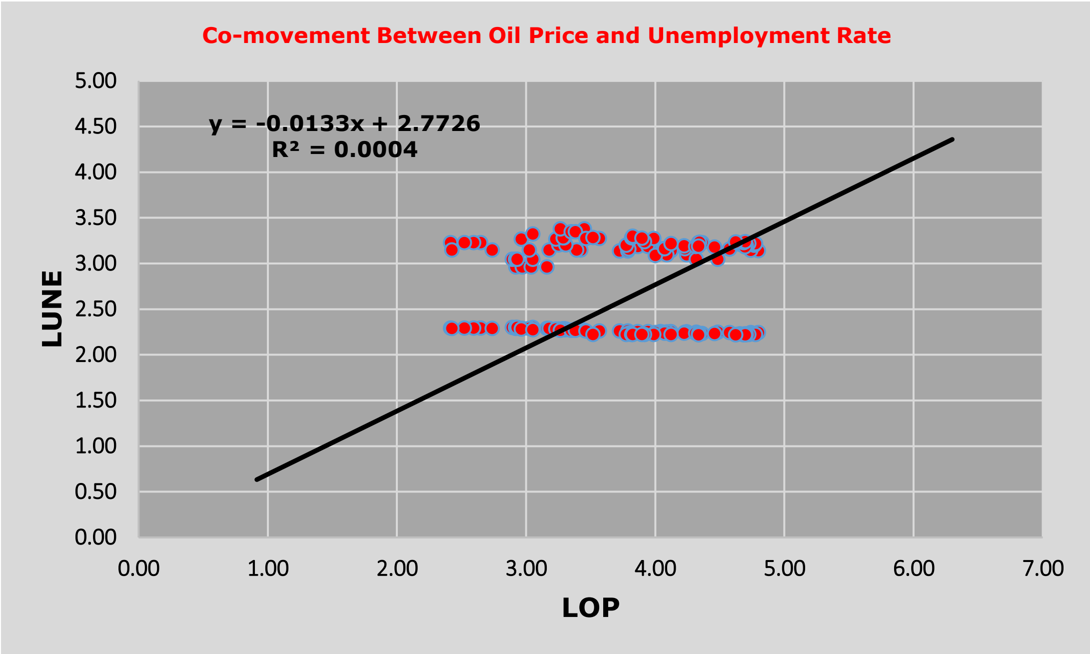
Net Oil Importers: Figure 6.50 Co-movement Between Oil Price and Unemployment Rates



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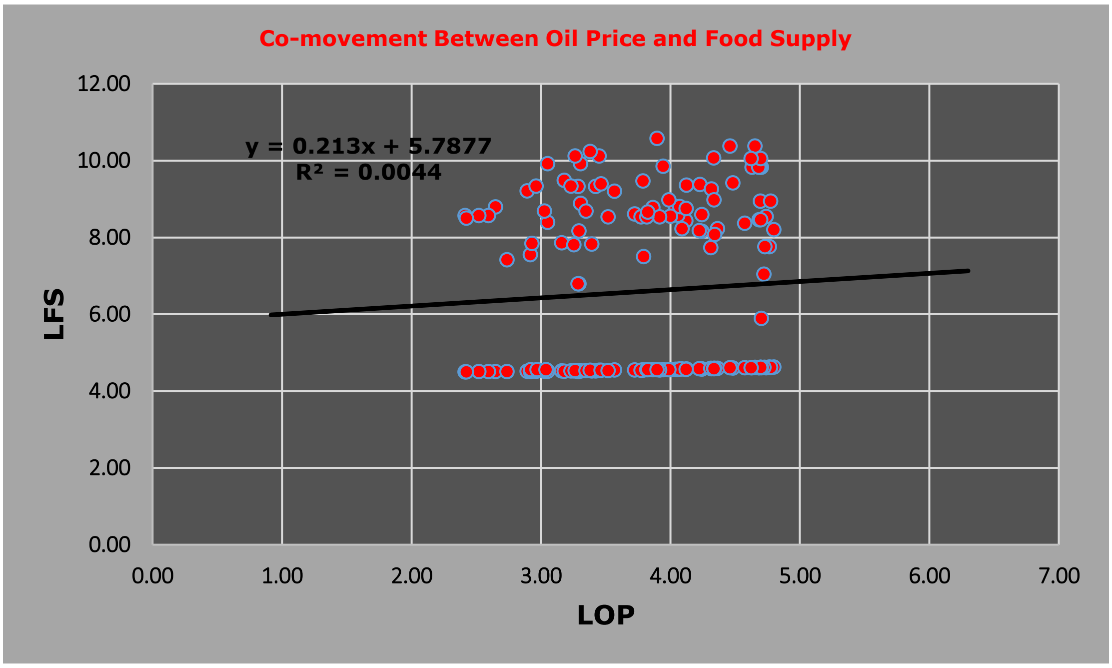
Net Oil Importers: Figure 6.51 Co-movements Between Oil Price and Food Supply



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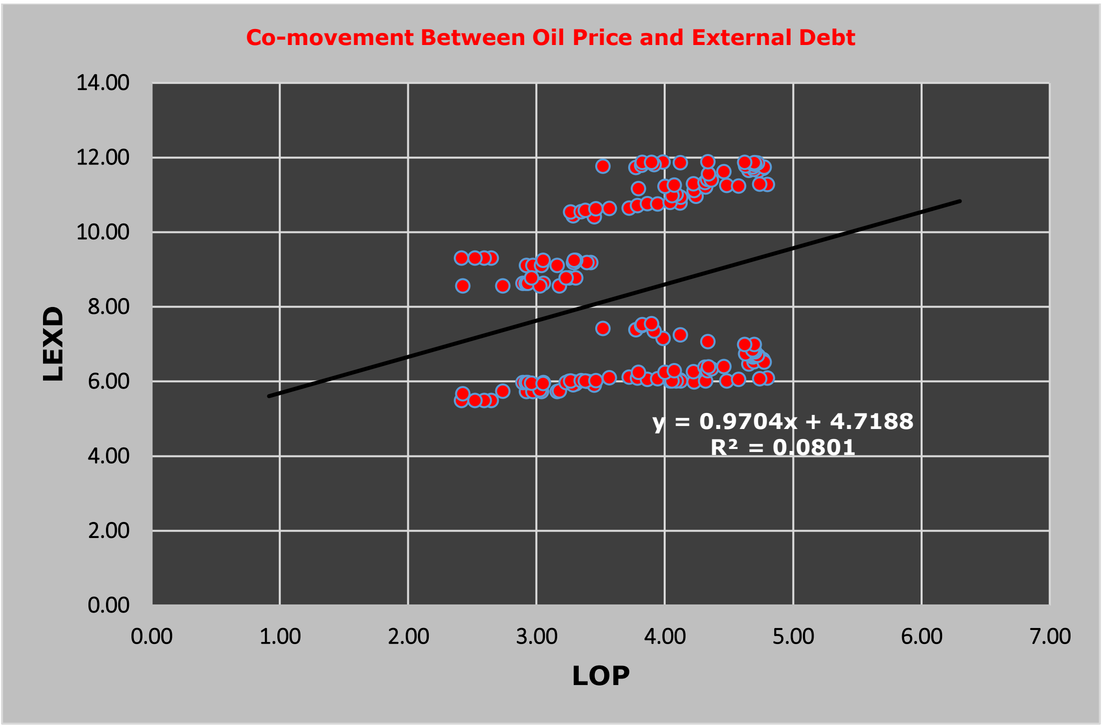
Net Oil Importers: Figure 6.52 Co-movements Between Oil Price and External Debts



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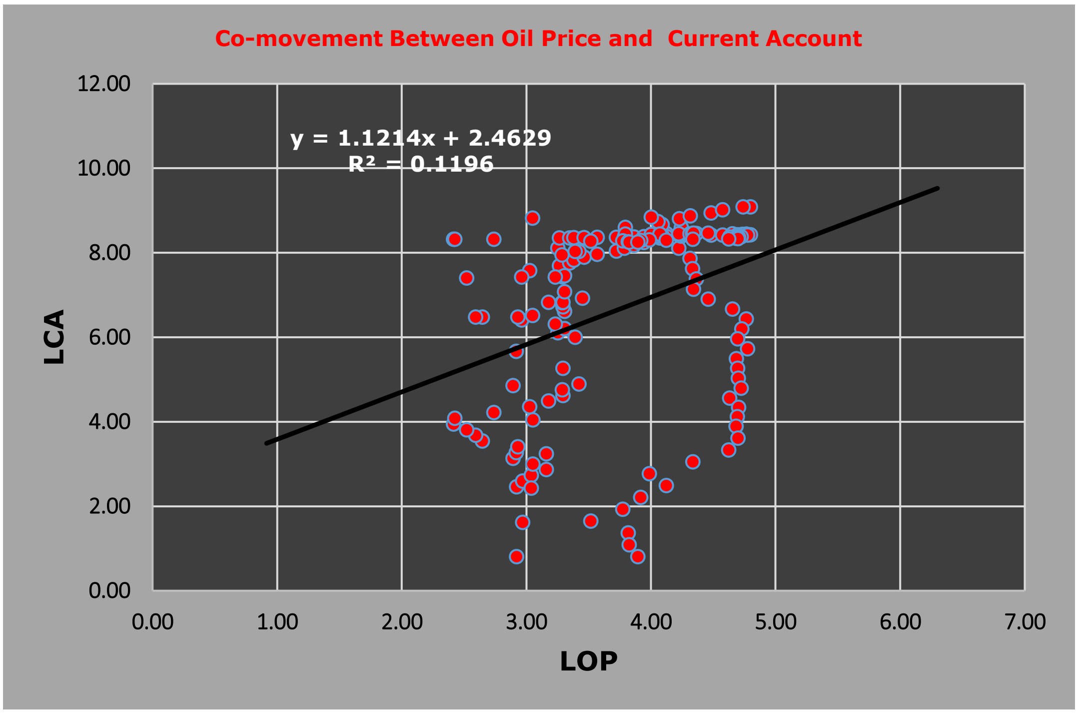
Net Oil Importers: Figure 6.53 Co-movements Between Oil Price and Current Accounts



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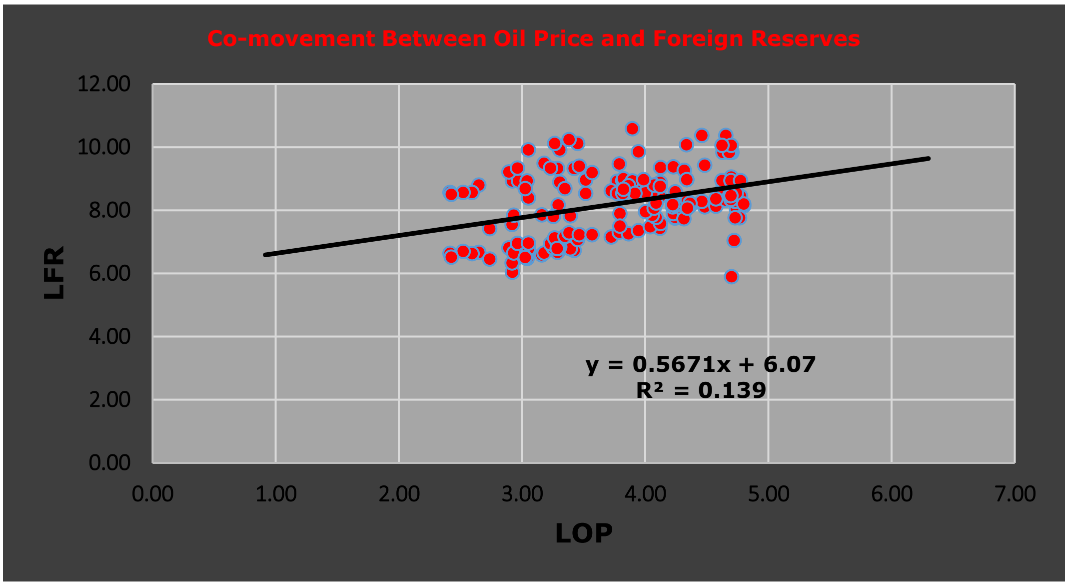
Net Oil Importers: Figure 6.54 Co-movements Between Oil Price and Foreign Reserves



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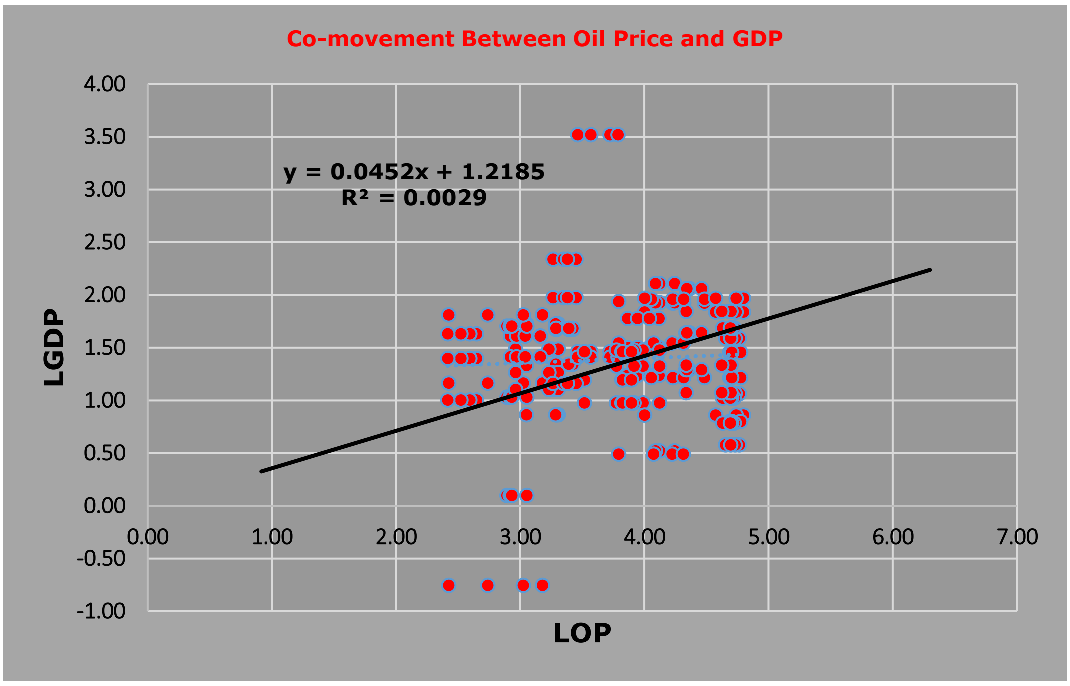
Net Oil Exporters: Figure 6.55 Co-movement Between Oil Price and GDP



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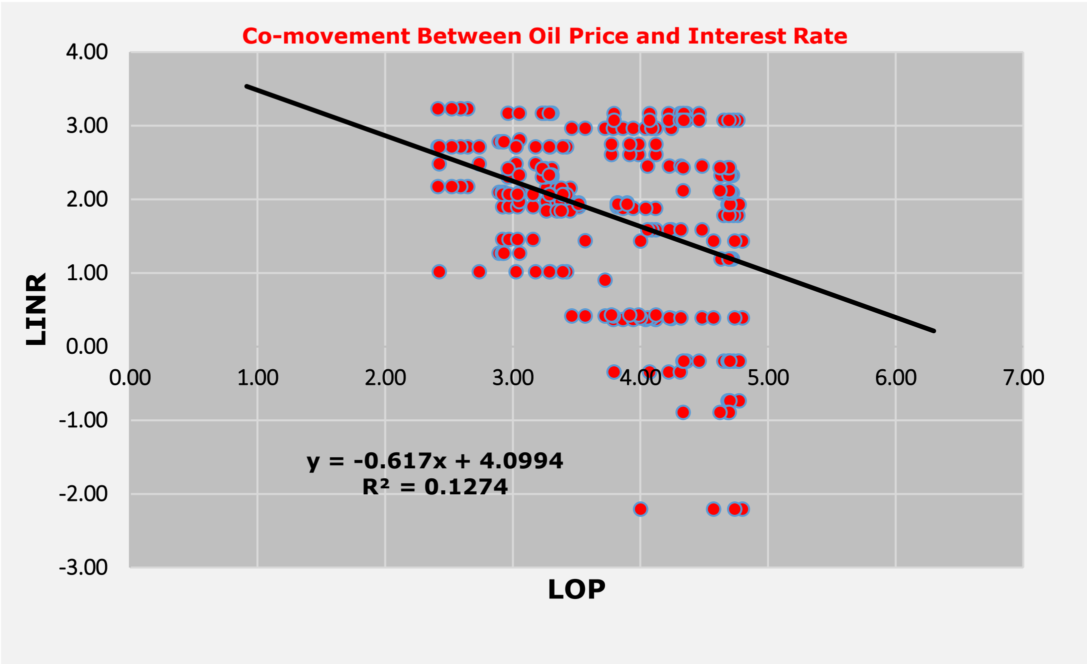
Net Oil Exporters: Figure 6.56 Co-movement Between Oil Price and Interest Rates



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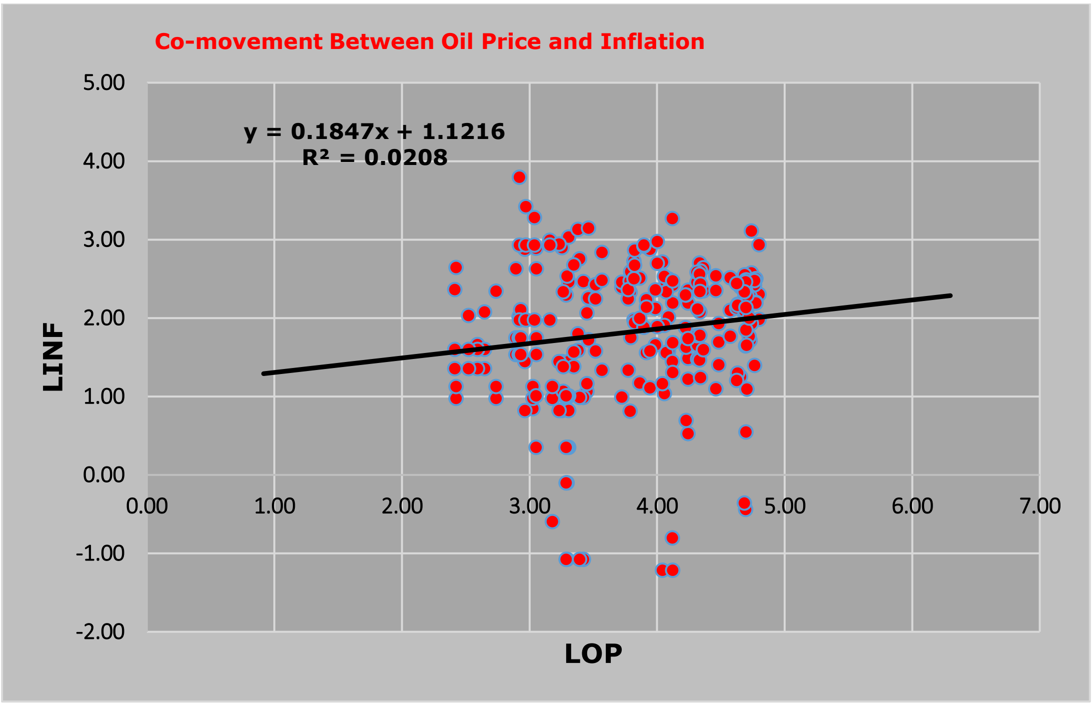
Net Oil Exporters: Figure 6.57 Co-movement Between Oil Price and Inflation



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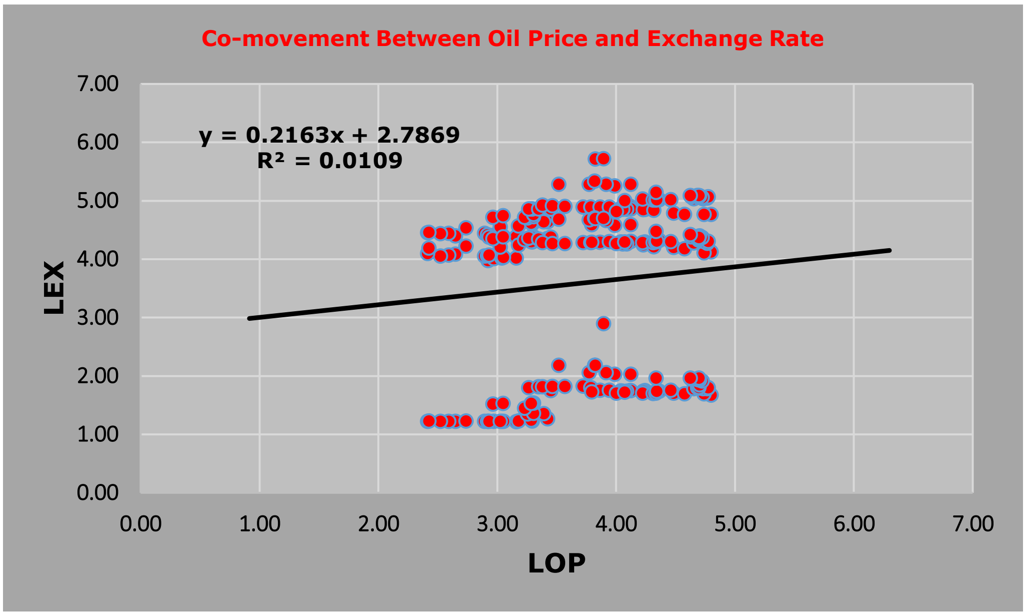
Net Oil Exporters: Figure 6.58 Co-movement Between Oil Price and Exchange Rates



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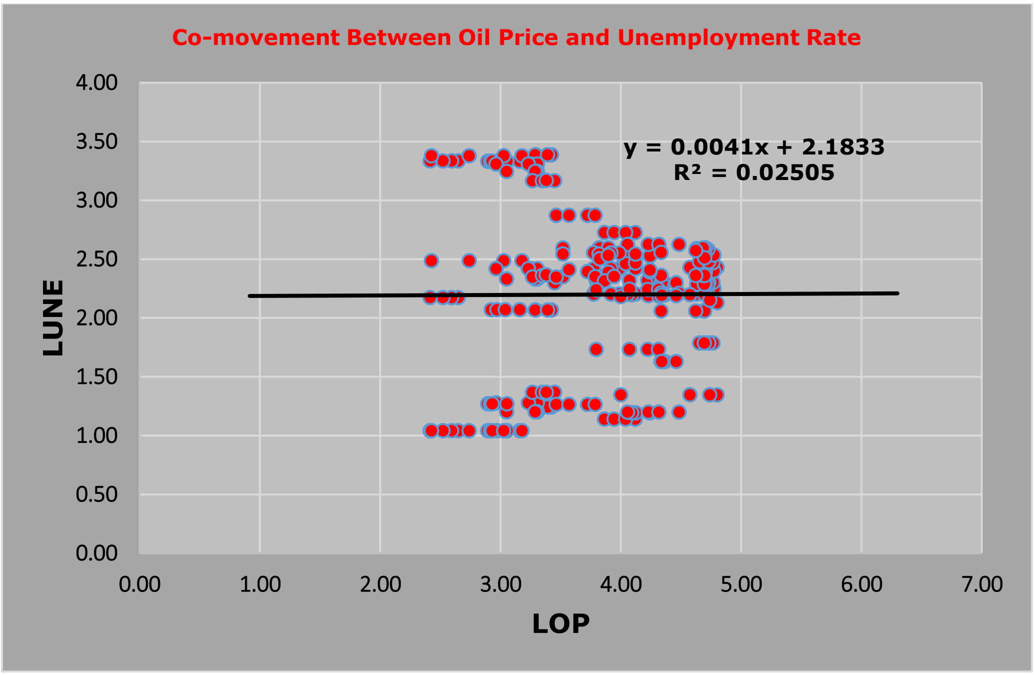
Net Oil Exporters: Figure 6.59 Co-movement Between Oil Price and Unemployment Rate



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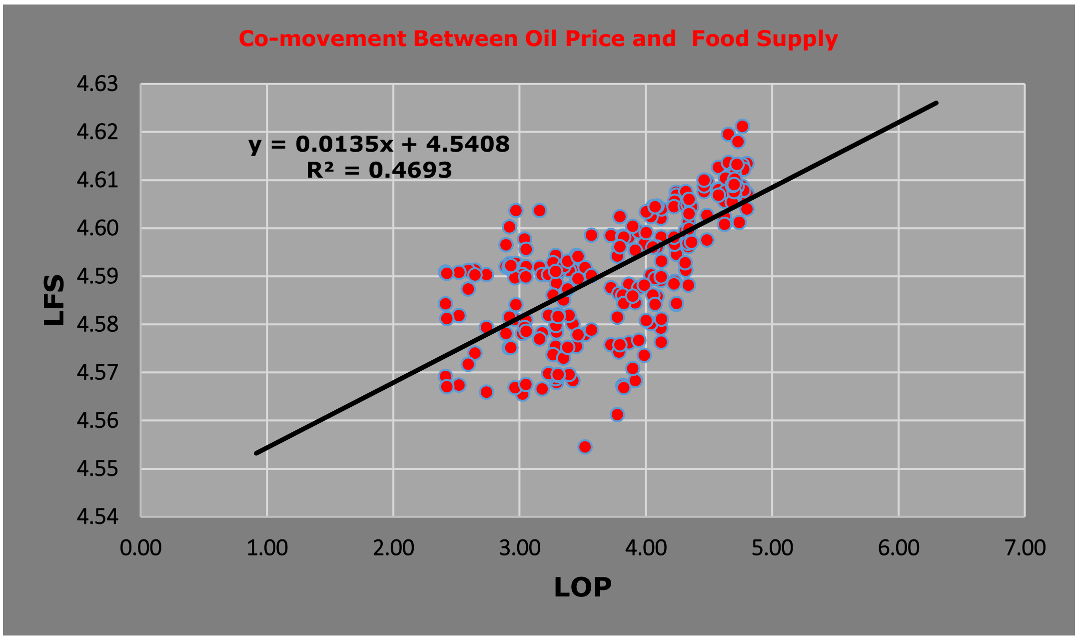
Net Oil Exporters Figure 6.60 Co-movement Between Oil Price and Food Supply



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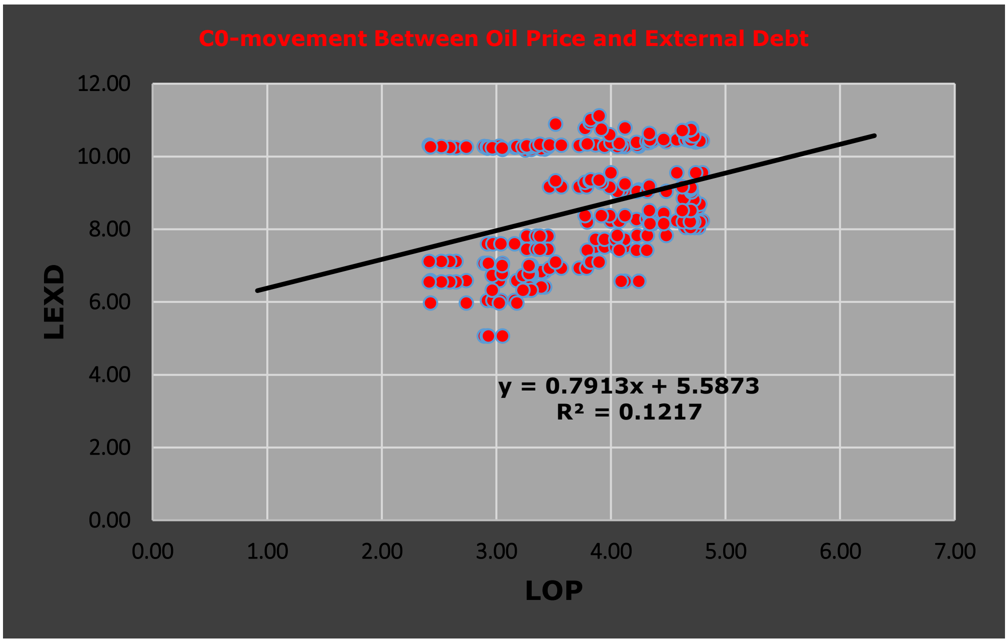
Net Oil Exporters: Figure 6.61 Co-movement Between Oil Price and External Debt



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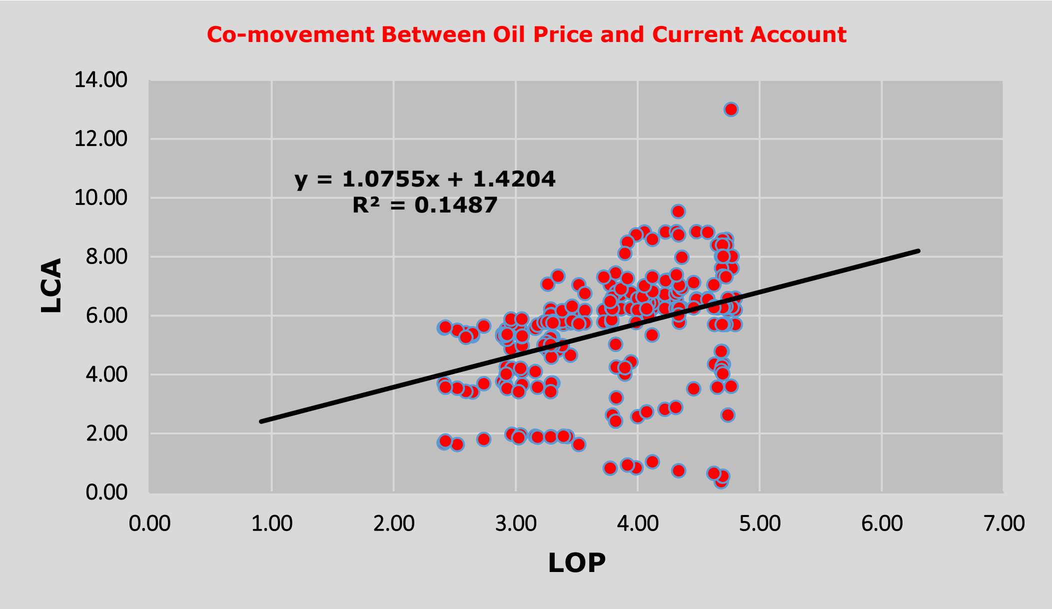
Net Oil Exporters: Figure 6.62 Co-movement Between Oil Price and Current Accounts



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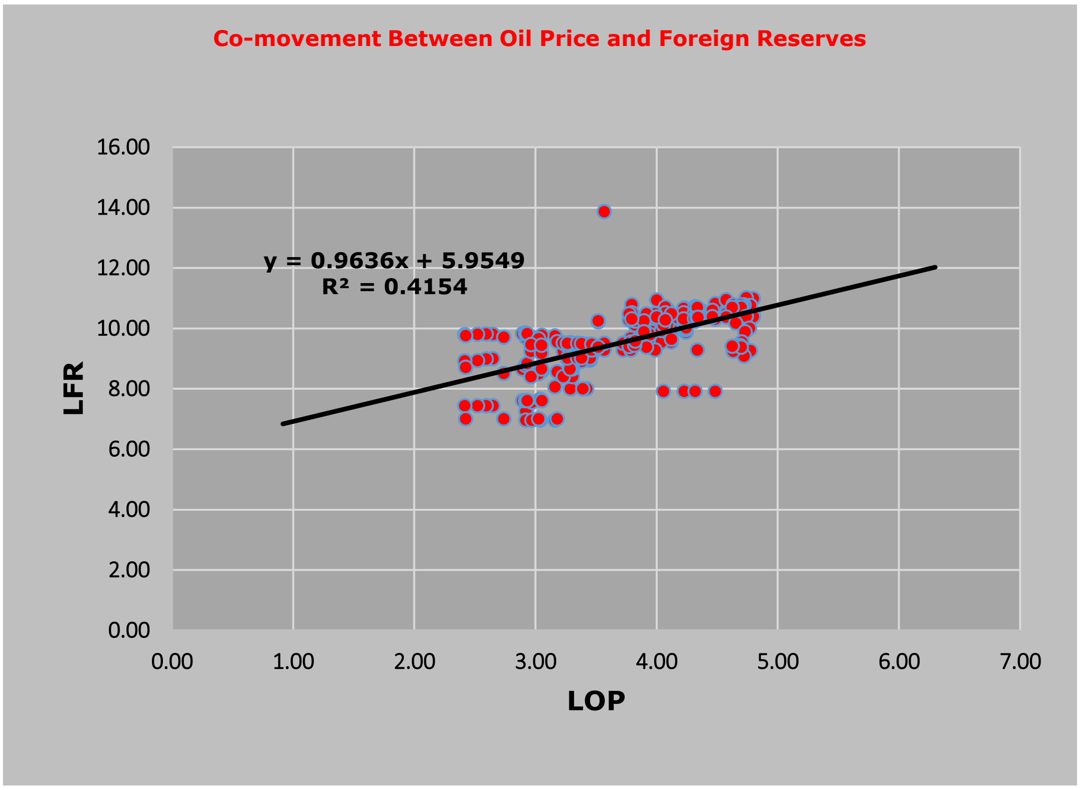
Net Oil Exporters: Figure 6.63 Co-movement Between Oil Price and Foreign Reserves



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