Mendel University in Brno

Faculty of Business and Economics

Opportunities and Challenges of the Ghanaian Economy with the Commercial Production of Oil

Dissertation

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BRNO 2016

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ACKNOWLEDGEMENTS

I would like to thank my supervisor, Associate Professor Václav Adamec for his assistance and guidance throughout the successful execution of this dissertation. He has been an inspiration throughout this study.

I would also like to express my profound gratitude to Associate Professor, Jitka Janova, Associate Professor Josef Holoubek, Associate Professor David Hampel, Dr. Pavel Kolman, Dr. Luboš Střelec and all Staff of the Department of Statistics and Operations Research for their unique support and encouragement.

My sincere heart warm praise also goes to all the authorities of the Faculty of Business and Economics. They presented me with this opportunity to further my studies and have been the pillars behind my strength.

I will not end my acknowledgement without mentioning Dr. Samuel Antwi Darkwah. He is an inspiration to not just me but to all Ghanaian students pursuing further studies in Mendel University.

Finally, I say thank you to all who in diverse ways have contributed to the successful end of my studies but have not been mentioned here.

ABSTRACT

The study sought to answer three research questions regarding the impact of the new oil sector on the economy of Ghana. The areas covered by these questions include: oil price developments and their impact on economic activities in Ghana, the overall productive impact of the oil sector on economic multipliers and linkages of other sectors of the economy as well as the impact of the sector on traditional agriculture, manufacturing and underground economic activities in Ghana. For the first research question on the impact of shocks to crude oil prices on economic activities, the study employed a Vector Error Correction model for the analysis. The modelled variables were GDP and crude oil prices. GDP was used as the measure of economic activities. Both variables were transformed into logarithmic form. The results show that Ghana as an oil exporting country and a net oil importer is affected by fluctuations in oil prices. It suggests that a one standard error shock to crude oil prices has a transitory and negative effect on GDP in Ghana after one year. This study forecasts oil prices to slightly rise from the slump in 2015 to about $47 per barrel by the end of 2016 and about $50 per barrel by the end of 2017. GDP is predicted to grow by about 6% in 2016 and expected to remain steady at this growth rate by 2017. The study also employed input-output techniques in answering the research question on the impact of the oil sector on income and output multipliers as well as linkages and interdependence of other sectors in the economy. The results show that sectors' performance in terms of multipliers and linkages declined but the decline was attributed to the past years of energy crises in Ghana rather than the introduction of the new oil sector. The last research question was about the effect of the new oil sector on traditional agriculture and manufacturing. This research question also sought to explain the trend in shadow economic activities before and after oil discovery and production in Ghana. Historical data on sectoral growth rates and contributions to GDP were assessed. The multiple indicators and multiple causes model was also applied to investigate the developments in shadow economic activities. The results show an irregular movement in sectoral growth rates which cannot be attributed to oil production. It also show that shadow economic activities increased over the period of oil production. The data for the study was obtained from the Ghana

Statistical Service, World Development Indicators, Ghana Statistical Service and the US Energy Information Administration.

Keywords: Oil sector, oil prices, Dutch disease, economic multipliers, sectoral interdependence, Ghana, shadow economy.

ABSTRAKT

Cílem disertačni práce je odpovědět na tři výzkumné otázky týkající se vlivu nově vznikajícího ropného odvětví na ekonomiku Ghany. Tyto výzkumné otázky pokrývají oblasti vývoje cen ropy a jeho vlivu na ekonomiku Ghany, celkový produkční vliv ropného sektoru na příjmový a výdajový multiplikátor dalších sektorů ekonomiky, stejně jako vliv ropného sektoru na tradiční zemědělství a výrobu a jejich vliv na vývoj stínových ekonomických aktivit v Ghaně. Data použitá v této studii byla získána ze zdrojů: Ghana Statistical Service, World Development Indicators, Ghana Statistical Service a US Energy Information Administration. V první výzkumné otázce byl posuzován vliv cen surové ropy na ekonomickou aktivitu, v přičemž pro tyto učely byl použit vektorový model korekce chyby (VECM). Modelovanými proměnnými byly HDP a ceny surové ropy. HDP bylo použito jako ukazatel ekonomické aktivity. Obě proměnné byly zlogaritmovány. Výsledky ukazují, že Ghana jako země vyvážející ropu je ovlivněna fluktuacemi ceny ropy. Dopady byly hodnoceny s použitím metody impulzní odezvy z bivariantního VECM. Výsledkem této práce je, že kladný šok v cenách ropy má přechodný negativní efekt na HDP v Ghaně. Tento záporný efekt je pozorován v prvních dvou letech, od třetího roku přechází v pozitivní. Práce rovněž prováděla předpovědi budoucích cen surové ropy (Brent) a růstu HDP v Ghaně. Předpovědi této studie očekávají lehký nárůst cen ropy od jejího propadu v roce 2015 na cca 47 dolarů za barel na konci roku 2016 a 50 dolarů za barel na konci roku 2017. U HDP se očekává cca 6% růst v roce 2016, který zůstane stabilní až do roku 2017. V práci byla také použita vstupně-výstupní metoda při hledání odpovědi na výzkumnou otázku o dopadu ropného sektoru v oblasti příjmových a výdajových multiplikátorů, stejně jako vazeb a provázanosti ostatních sektorů v ekonomice. Výsledky ukazují, že ve sledovaných sektorech došlo k poklesu příjmových a výdajových multiplikátorů. Přítomnost ropného sektoru neovlivnila pozitivně vazby mezi ostatními sektory ekonomiky. Práce také dospěla k závěru, že nebyl k dispozici dostatek důkazů pro připsání poklesu příjmových a výdajových

multiplikátorů ostatních sektorů na vrub nového ropného sektoru. Ghana jako země procházela od roku 2006 lety chronické energetické krize, která ovlivnila výkonnost průmyslu, a která se jeví jako nejpravděpodobnější příčina poklesu sektorové výkonnosti. Poslední výzkumná otázka byla zaměřena na vliv nového ropného sektoru na tradiční zemědělství a výrobu. Tato výzkumná otázka se rovněž pokoušela vysvětlit trend ve stínové ekonomice před a po vstupu nového ropného sektoru. Byla vyhodnocena historická data tempa růstu v jednotlivých odvětvích a jejich podíl na HDP. Při zkoumání vlivu ropného sektoru na stínové ekonomické aktivity bylo sledováno větší počet indikátorů a použito více modelů. Výsledky ukazují na nepravidelnosti v růstu jednotlivých sektorů, které nemohou být přiřazeny na vrub ropné produkce. Také ukazují nárůst stínových ekonomických aktivit v období produkce ropy.

Klíčová slova: odvětví těžby ropy, cena ropy, Dutch disease, economické multiplikátory, odvětvové vazby, Ghana, stínová ekonomika.

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LIST OF ABBREVIATIONS

ABFA	Annual Budget Funding Amount
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
API	American Petroleum Institute
AR	Autoregressive
BIC	Bayesian Information Criterion
BPD	Barrels per Day
CEPA	Center for Policy Analysis
CFI	Comparative Fit Index
DF	Dickey Fuller
ECT	Error Correction Term
EU	European Union
FoD	First Order Difference
FPE	Final Prediction Error
GDP	Gross Domestic Product
GHF	Ghana Heritage Fund
GNP	Gross National Product
GNPC	Ghana National Petroleum Commission
GSF	Ghana Stabilization Fund
HQC	Hannan Quinn Information Criterion
ISIC	International Standard Industrial Classification
ISSER	Institute for Statistical Social and Economic Research
IRF	Impulse Response Functions

JB	Jarque-Bera
LL	Log Likelihood
LR	Likelihood Ratio
MENA	Middle Eastern and North African Countries
MIMIC	Multiple Indicators and Multiple Causes
ML	Maximum Likelihood
MoF	Ministry of Finance
OECD	Organization for Economic Corporation and Development
OPEC	Organization of Petroleum Exporting Countries
ORB	OPEC Reference Basket
PRMA	Petroleum Revenue Management Act
REER	Real Effective Exchange Rate
RMSE	Root Mean Square Error
RMSEA	Root Mean Standard Error of Approximation
RW	Random Walk
SEM	Structural Equation Model
SOE	State Owned Enterprises
SME	Small and Medium Scale Enterprises
SRMR	Standard Root Mean Residual
SUT	Supply and Use Table
VAR	Vector Autoregressive
VECM	Vector Error Correction Model
WANEP	West African Network for Peacebuilding
WTI	West Texas Intermediate

1 INTRODUCTION

Oil production activities in Ghana can be traced back to several years ago (1970s) though most of these activities were exploratory. They were regarded as such because most of the oil companies were making frantic efforts to discover oil deposits. Such companies managed to produce output but it was part of the exploratory process and was low hence was not commercialized. Production on commercial basis began in 2010 after major discoveries in 2007. The first major field was discovered in 1970 and began producing in 1975. The activities of oil companies however during this period were classified as exploratory. Between 1978 and 1985 a total of about 3.47 million barrels of oil was produced.

Ghana has an estimated oil reserve of at least 1.8 billion barrels. After producing an average of only 8,880 barrels per day (bpd) in 2010, Ghana's oil production increased to 84,737 barrels per day by late 2011. Production levels have continued to rise for example, 102,000 barrels per day in 2014. A study by Nchor and Klepáč (2016) predicts that at the current level of production and given the available recoverable resources, oil will be depleted by 2060 in Ghana.

The formation of the Ghana National Petroleum Corporation (GNPC) in 1985 marked the beginning of major and sustained exploration activities. The country passed its first petroleum law in 1983. In 1987, a separate tax regime was provided for the Petroleum sector with the enactment of the Petroleum Income Tax Law.

Before oil production, Ghana highly depended on proceeds from the sales of Cocoa, Gold, Timber and few non-traditional exports. Oil currently accounts for about 6% of GDP in Ghana (ISSER, 2014) and 1.2% of government revenue (MoF, 2015). Exports from the oil sector account for about 28.3% of total export revenue.

As a crude oil exporting country and a net oil-importer, crude oil prices play a vital role in the economy of Ghana. Ghana consumes high quantity of imported crude oil products and exports its produced crude oil. Whether as an

importer of crude oil products or an exporter, changes in crude oil prices affect Ghana. It must be mentioned that several developments have occurred over the years with regards to crude oil prices. Recent developments only indicate difficult times for oil exporting countries as crude oil prices have reached all time low. Currently, the price of a barrel of crude oil (Brent) stands at $33 in February, 2016 (NASDAQ, 2016).

Several reasons were given for this decline in crude oil prices. These include: weak demand in many countries due to slow economic growth for example in China and increased production from United States of America (USA). Other advanced reasons include increment in crude oil production from members of the Organization of Petroleum Exporting Countries (OPEC), an action taken by OPEC to maintain its market share. Another significant change was increased production from Non-OPEC members (see Hamilton, 2014; Baumeister and Kilian, 2015; Badel and McGillicuddy, 2015).

The production and export of crude oil brings several benefits and also great dangers for high oil dependent countries like Ghana. Oil exports have become an integral part of the Ghanaian economy and fluctuations in prices have significant impact on macroeconomic variables and government budgets. This assertion was noted in the works of Hamilton (Hamilton, 2003; 2008). Falling oil prices largely means falling revenue from oil proceeds. It could also mean falling cost of production for industries that use several crude oil products as inputs. For oil exporting countries like Ghana, rising oil prices leads to increased proceeds from oil exports. Thus improving the fiscal stance of government.

The impact of oil price fluctuations on economic activities varies with individual countries depending on several factors (World Bank, 2013; Rasmussen and Roitman, 2011). Studies in this area have over the years attracted several volumes of literature with contradictory results. Researchers such as Hamilton (2008) observed that oil price shocks were the main contributing factors to the recession in USA. Other authors in this field who argue that oil price shocks significantly affect economic activities, mainly economic growth include: Hamilton (2003; 2008); Chang and Wong (2003); Cunado and Gracia (2005); Kilian (2008); Lorde et al. (2009); Dogrul and Soytas (2010); Rasmussen and Roitman (2011).

Since 2011, Ghana has been receiving oil revenues which may continue for the next 20 years and beyond. Crude oil exports increased from US$2.8 billion in 2011 to US$3.9 billion in 2013 but dropped to US$3.7 billion in 2014. Correspondingly, total government oil revenues increased from US$444.1 million (16.0 percent of total oil exports receipts) to US$978.8 million (26.3 percent of total oil exports receipts) over the period. In 2011, when crude oil began to be exported, it added to cocoa and gold as Ghana's major export commodities, which together accounted for more than 80% of the country's total export revenue. Having trailed behind gold and cocoa in 2011, oil became the second biggest export revenue earner from 2012, when it contributed 22 percent of the country's total export revenue.

In 2013, Ghana exported US$3.9 billion worth of crude oil and importing US$3.4 billion of crude and refined oil products (IFS, 2015). It is important to point out that Ghana has increasingly relied on imports of refined oil products which cost a lot more than exported crude oil because of value addition. Not only that, but also the country has been importing crude oil at significantly higher prices than it exports in each year since 2011.

The first fundamental question that this dissertation seeks to answer is to investigate whether there is a stable relationship between oil prices and economic activities in Ghana. Economic activity in this regard is measured using GDP (Gross Domestic Product). The oil price-GDP relationship became a popular research topic in 1980s and has continued to attract attention due to the role crude oil price plays in the economic development of countries.

According to Hamilton (2003) cheap oil is crucial for the world's demand for energy but its availability is scarce, therefore volatility in supply of conventional oil will have substantial economic impact. O'Neill et al. (2008) noted that, significant increases in energy prices will lead to a considerable rise in production and transportation cost for many industries and hence drive wages and inflation upwards, which at the same time will dampen economic growth. This study therefore seeks to find out the relationship between the two variables in Ghana and to suggest measures to adopt to cushion the economy in the case of either positive or negative oil price shocks.

The second question this dissertation seeks to answer is whether the introduction of the new oil sector has had any significant changes in the structure of the Ghanaian economy. By the structure, the study seeks to assess the multiplier effect of the new sector on other sectors of the economy as well as intersectoral linkages and interdependence. Multiplier effects include output and income multipliers. Linkages include both backward and forward linkages. Generally, the oil sector is capital intensive and its overall impact in terms of employment generation and linkages with other sectors are limited. It also concentrates income, widening inequality by confining the benefits of exploitation to a narrow proportion of society. This study therefore seeks to assess the impact of the new oil sector in this regard and to propose alternative policies necessary to ensure improvement in the multiplier effect of the new oil sector and its linkages with other sectors in the economy.

The third objective the dissertation seeks to investigate is whether traditional sectors have been affected negatively due to the presence of the new sector and how the new sector has impacted on shadow economic activities. This aspect investigates what is commonly termed the Dutch Disease. The Dutch Disease basically refers to a decrease in the price competitiveness of a country's export as a result of currency appreciation stemming from a new booming resource sector. The presence of this phenomenon is indicated by a sustained appreciation of the real exchange rate, movement of resources from non-oil sectors to the new oil sector, decreased output or growth of non-oil sectors as well as declining export earnings of non-oil sectors.

This part of the study will also evaluate how underground economic activities also known as shadow economic activities have evolved with the introduction of the new sector. Underground economic activities are present in all economies of the world especially in developing countries. Though their presence may not necessarily be bad for the economies in which they prevail, they account for numerous economic and social problems such as environmental hazards, losses to state revenue, violation of labor regulations etc Nchor and Adamec (2015).

Their definition remains largely controversial but this study adopts the definition by Schneider et al. (2009) where underground economic activities are defined as market based production activities, which are deliberately hidden

from the official system. Such activities occur as a result of individuals and companies avoiding payment of taxes, social security contributions and compliance with labor market standards. The study therefore seeks to assess the development in shadow economic activities since the introduction of the new sector. This will facilitate the formulation and implementation of policies to curb any negative developments and to capture all oil related economic activities in the official system.

The dissertation is divided into several chapters. Chapter 1 describes the key features of oil discovery, its production, contribution and developments in the global oil industry. Chapter 2 describes the objective of the study. Chapter 3 draws on a wide variety of literature which exists on the topic under study. It seeks to find the gaps in which the information from this dissertation fills. Chapter 4 focuses on the key research methods employed to answer the research questions. It also describes the types of data used and transformation techniques. Chapter 5 expatiates on the results of the study and discusses them relative to findings of several other related research works. Chapter 6 summarizes the study and draws conclusions for all the various aspects of the study. Chapter 7 presents the conclusion of this study.

2 OBJECTIVE

The main objective of the dissertation is to assess the opportunities available to the Ghanaian economy with the introduction of the new oil sector and to investigate the challenges and threats that it brings. To achieve this objective, the study specified some research questions on certain key areas of the economy.

Research question 1

- What is the impact of oil price shocks on economic activities in Ghana?

Research question 2

- What are the multiplier and sectoral linkages effect of the new oil sector on other sectors of the economy?

Reasearch question 3

- Has the new oil sector impacted negatively on traditional sectors such as Agriculture and Manufacturing and has it affected shadow economic activities?

Research question 1 was chosen because oil prices play a major role in the economic development of countries whether as oil-importing or oil-exporting. Oil price developments are crucial to policy makers since it largely affects the fiscal stance of government. Such developments are also of importance to businesses and individuals since investment decisions are affected. With the role crude oil plays in production activities as an input, its price development means a lot to producers. The resource also contributes the second highest percentage of total export earnings after Gold and serves as a source of revenue to government in Ghana. It is therefore imperative to investigate how oil price developments affect overall economic activities in Ghana. Economic activities in this case was measured using the Gross Domestic Product (GDP).

Research question 2 was chosen so as to measure the impact of the oil sector on the performance of all sectors in the economy in terms of output and income multipliers. It will also help to bring out the impact of the new sector on intersectoral linkages and interdependence. In other words, the

study seeks to show whether there are improved income and output multipliers with the introduction of the new sector. It also seeks to assess how intersectoral linkages (backward and forward) have been affected.

Research question 3 helps to check for the negative effect of the oil sector on traditional agriculture and manufacturing. Though oil and gold contribute the largest share of export earnings, the economy of Ghana is still agrarian. A large portion of the labour force is employed in agriculture and any development that affects the agricultural sector negatively has grievous consequences for the long desired economic transformation and development.

This part of the study will also help to bring out the developments in underground economic activities. Several businesses mostly oil service companies came into being to take advantage of opportunities created by oil production. It is important to capture the activities of these companies in the official system in the calculation of national accounts but this will only depend on whether they are legally registered or not. The study thus sought to investigate whether there are signs of increased underground economic activities since the introduction of the new oil sector.

3 LITERATURE REVIEW

This section reviews literature on the global oil industry in relation to the Ghanaian context. It takes a look at the developments in crude oil prices over the years, the main factors driving it and the challenges and opportunities for Ghana as a new exporter of the commodity. This section also assesses the various methods employed by various researchers in the analysis of the oil industries. Observations are made about the results of such studies and conclusions are drawn for comparison with the findings of this study.

3.1 Crude Price Benchmarks and Price Developments

Crude oil producing and exporting countries have had to battle with low crude oil prices in the world market in 2014 and 2015. Prices hit a low level of $33.67 per barrel as at the end of February 2016 (NASDAQ, 2016) and that largely represents losses in terms of oil proceeds to oil producing and exporting countries given the fact that prices were three times higher than this price.

Crude oil extracted from different regions differ in several ways. Though they are often all classified as liquid petroleum, each is slightly different in its chemical make-up. This property affects its quality thus making it more or less preferable to others. The level of quality highly depends on many factors, one of which is the American Petroleum Institute (API) gravity. Higher API gravity is associated with light crude oil and vice versa.

The main crude oil grade, at Jubilee (the biggest oil field in Ghana), is light and sweet. It has an American Petroleum Institute (API) gravity of 36.4 degrees and sulphur content of 0.26% by weight, with no unusual characteristics. This study looks at three major types of crude pricing benchmarks: West Texas Intermediate (WTI), Brent Crude, Dubai Fateh and OPEC Reference Basket (ORB). WTI is probably the most famous of the benchmark oils. It is light, sweet crude with an API gravity of 39.6 degrees. It comes from the South Western part of the United States of America.

Brent crude comes from the North Sea. It is light, sweet crude with an API gravity of 38.06 and a specific gravity of 0.835, making it slightly heavier than West Texas Intermediate. The sulphur content is 0.37%. The price of Brent

crude is used to set prices for roughly two-third of the world's oil. It is mostly refined in North West Europe and is also called Brent blend, London Brent, and Brent petroleum. The Brent field is located in the East Shetland Basin, halfway between Scotland and Norway (petroleum.co.uk, 2016).

Dubai crude is light and sour with an API gravity of 31 degrees and a specific gravity of 0.871. Its sulphur content is high, making it sourer than Brent crude and even sourer than West Texas Intermediate. It is generally used for pricing oil that comes from the Persian Gulf (petroleum.co.uk, 2016).

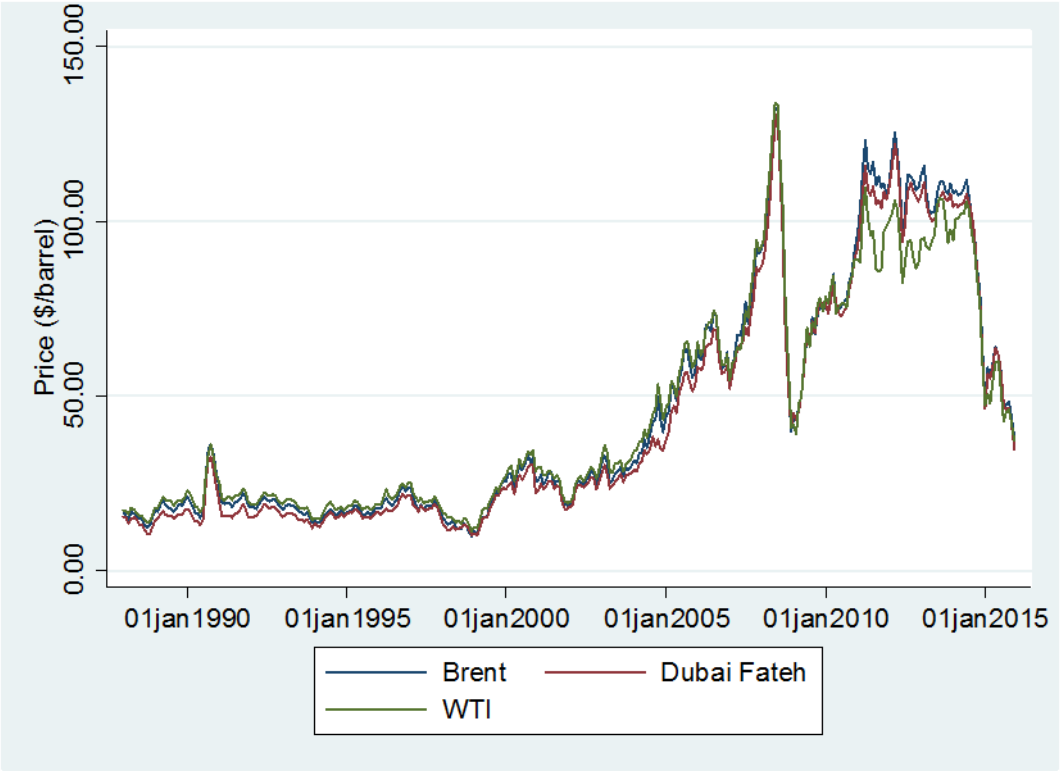
Dubai crude is also known as Fateh. Its importance comes not only from its quality but also from the fact that it was the only freely traded oil from the Middle East until recently.

The OPEC Reference Basket (ORB) is not a specific crude. It is rather a weighted average of petroleum that comes from OPEC countries. Different types of oils (11) are combined into the ORB (petroleum.co.uk, 2016). It averages API gravity with the present combination of 32.7 degrees and has a sulphur content of 1.77%. It was recently changed to reflect the average quality of crude oil in OPEC Member Countries. The change decreased the API and increased the sulphur content of the basket.

3.1.1 Falling global oil prices

Global oil prices have fallen sharply from the latter part of 2014 and the trend continued in 2015, leading to significant revenue shortfalls in many energy exporting nations, while consumers in many importing countries are likely to have to pay less for crude oil products. Prices of all the major crude oil benchmarks mentioned here have over the years moved together due to arbitrage (see Fig. 1).

Figure 1 Comparison of crude oil price benchmarks



Source: US. Energy Information Administration

There are about four reasons given to explain the oil price slump in 2014. The first is that, global demand is low because of weak economic activity. There is also increased efficiency and a growing movement from conventional crude oil to other non-conventional fuels. The second reason was attributed to the turmoil in Iraq and Libya. Thirdly, there was a significant increase in total production from USA. Crude oil importation in the USA also reduced drastically though its export of crude oil did not change significantly. The fourth reason given was about OPEC (Organization of Petroleum Exporting Countries) seeking to maintain their market shares by increasing production.

In support of these arguments, Arezki and Blanchard (2014) in their paper suggested that demand related factors contributed about 20-35 percent of the decline in oil prices. They concluded that, supply related factors and OPEC's decision not to cut supplies were more important in driving the decline in oil prices. According to Hamilton (2014), only two-fifths of the decline in oil prices in the second half of 2014 was due to weak global demand. Baumeister and Kilian (2015) report that more than half of the oil price decline reflects

the cumulative effects of oil supply and demand shocks and, among the remaining half, the most influential shock was associated with the weakening global economy.

The recent oil price drop has also been attributed to expected, rather than actual, demand and supply conditions. According to Badel and McGillicuddy (2015), oil prices declined mostly because of negative oil-specific demand shocks in anticipation of expected abundant oil supply. Baumeister and Kilian (2015) report that negative demand shocks associated with the global business cycle and shocks to the demand for oil inventories contributed to the recent oil price drop.

Another school of thought attributes the slump in oil prices to the U.S dollar's appreciation in 2014. Typically, a broad-based appreciation of the U.S. dollar raises the local currency cost of oil in countries using currencies not linked to the U.S. dollar. The effect of a stronger dollar is weaker oil demand in those countries and stronger supply from non-U.S. dollar producers (World Bank, 2015). Frankel (2014) argues that the role of U.S. dollar appreciation triggered by diverging monetary policies in the United States, Euro Area, and Japan was an important contributor to the decline in commodity prices.

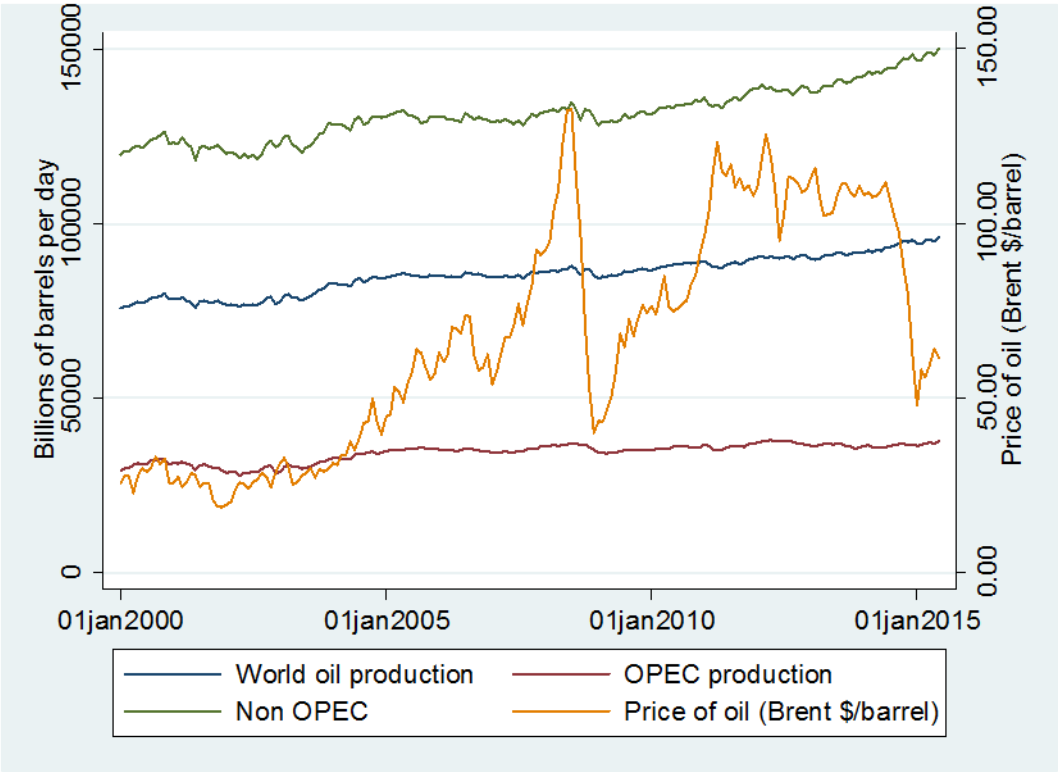
The crude oil price fall since July 2014 has serious negative implications for Ghana's economic growth, fiscal management and macroeconomic stability. Ghana's real GDP growth declined substantially as fiscal adjustment in response to the oil shock dampened economic activity. Real GDP growth declined to 3.5 percent in 2015 from 4.0 percent in 2014 and 7.3 percent in 2013 before recovering over the medium term (Institute for Fiscal Studies, 2015).

3.2 Crude Oil Price, Supply and Demand Relationship

The relationship between crude oil price and crude oil production is illustrated in Fig. 2. It clearly indicates that the price of crude is not solely determined by the supply of crude oil. Other factors play important major roles. The global economic crises in 2007 is observed with a sharp collapse in oil prices. Crude oil prices fell sharply later in 2014 due to strong non-OPEC production growth, weaker consumption growth relative to 2013 and OPEC's decision to defend market share (BP Global, 2015).

Considering the future of the oil industry, recent developments that led to the plunge in prices appear to affect the dynamics of oil markets in a lasting way. Unconventional oil supplies will likely continue to be a highly elastic source of oil supplies (Basu and Indrawati, 2015). The effect of this development is that, it could transform unconventional oil producers into the new swing producers in the oil markets. Less oil-intensive production technologies are being given priority and this will persist for a long time. Such developments will therefore exert continuing pressure on oil prices to decline or to remain at lower levels.

Figure 2 World crude oil production and crude oil price



Source: US. Energy Information Administration

3.2.1 Government of Ghana and oil companies adopting strategic measures to offset fluctuations in oil prices

The question as to how the oil companies operating in Ghana have reacted to falling oil prices is answered by observing production levels of the oil companies before and after the oil price fall. Oil companies have accordingly cut down production to cut cost of production. This was however not the case at the initial stages of the oil price fall in of 2014 where companies maintained production levels though prices were falling.

In preparation of the Ghanaian economy for the management of the new oil boom, government prepared and placed before Parliament a Petroleum Revenue Management Bill. This was done before the first oil production in commercial quantities came on stream in 2010. The Bill was passed into law on April 11, 2011. This led to the development of the Petroleum Revenue Management Act (PRMA), 2011 (Act 815).

Within the Act, a portion of the oil revenue is supposed to be used for budget support. This budgeted amount is called the Annual Budget Funding Amount (ABFA). A proportion of the oil revenue in Ghana was also to be set aside as Petroleum Funds, comprising the Stabilization Fund and a Heritage Fund.

Given the strain on public expenditure during periods of declining oil prices, the objective of the Ghana Stabilization Fund (GSF) is to cushion the impact on or sustain public expenditure capacity during periods of unanticipated oil revenue shortfalls. The Ghana Heritage Fund (GHF) is an endowment for the benefit of future generations.

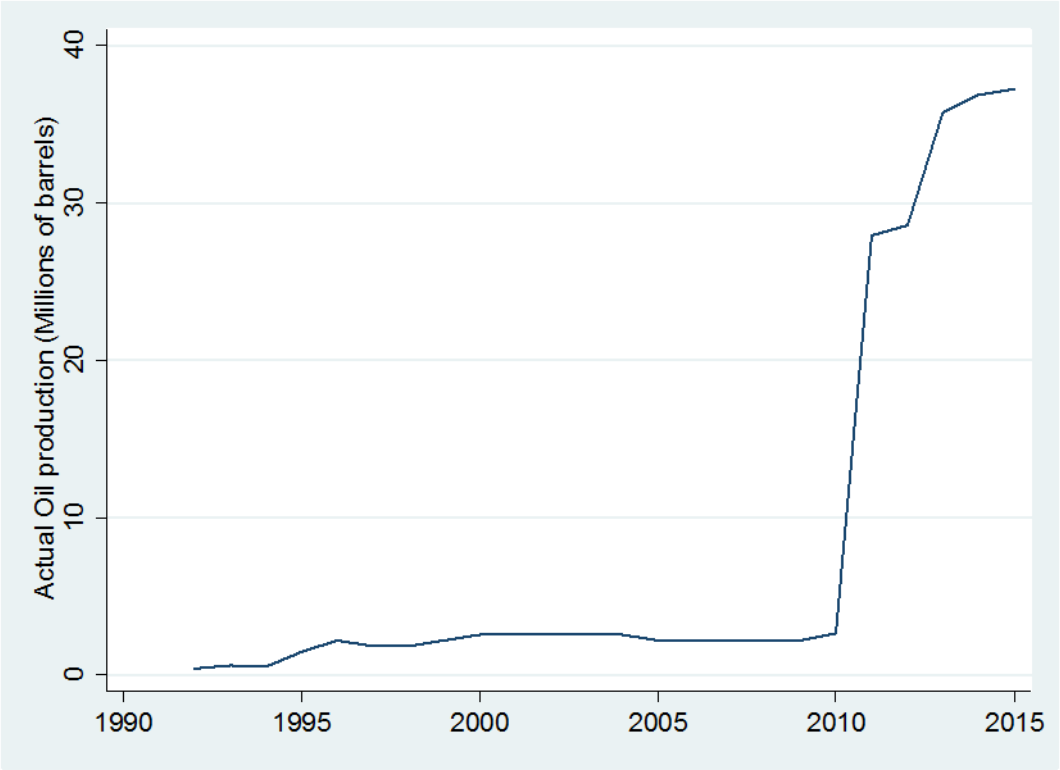
Will the drop in oil prices affect Ghana positively or negatively? The effect will depend on the share of net oil-exports or net oil-imports in GDP (World Bank, 2013; Rasmussen and Roitman, 2011). With regards to oil imports, Ghana's current accounts could also see substantial improvements (Kilian, Rebucci, and Spatafora, 2009) but the impact might vary depending on the underlying drivers of oil price developments (IMF, 2005; Buetzer et al. 2012).

With regards to oil exports, the drop in oil prices will have a significant fall in export earnings and government revenue. Unless Ghana government has ample buffers to safeguard spending, a significant loss of revenues might require a sharp fiscal consolidation. A decline in oil prices also deteriorates current account and precipitates currency depreciations. The Ghanaian currency (the Cedi) has however remained relatively stable from 2015 to 2016 in the face of the oil price slump.

3.3 Crude Oil Production in Ghana

The historical production of crude oil in Ghana is illustrated in Fig. 3. This covers the period of exploration and actual oil production. The exploratory period is marked by low level of production and was not classified as commercial. Actual oil production in commercial quantities commenced in 2010 but major discoveries were made in 2007. The difference is clearly seen with the sharp rise in production from the year 2010.

Figure 3 Crude oil production in Ghana



Source: US. Energy Information Administration

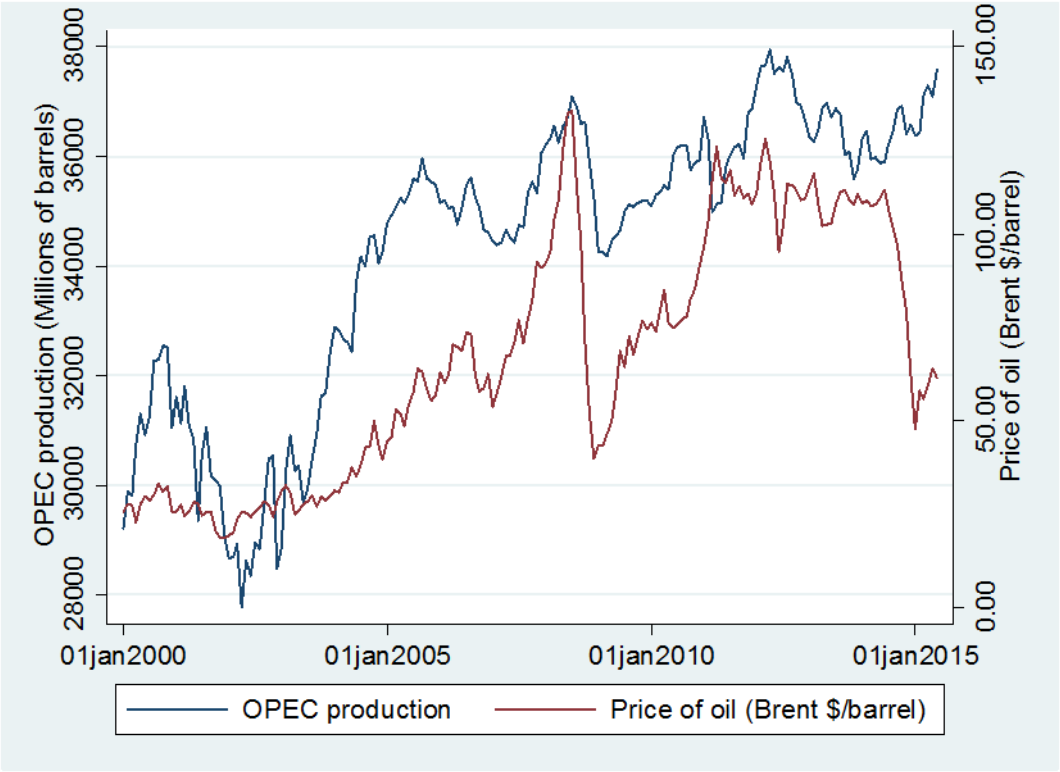
3.4 OPEC Production and Crude Oil Prices

The relationship between oil production by OPEC member countries and crude oil prices (Brent crude) is shown in Fig. 4. The figure demonstrates that rising oil price is accompanied by rising oil production by OPEC members. This is ideally explained by the concept of profit maximization by members. It should also be noted that OPEC member countries are able to influence oil prices either by producing more or less than is demanded in the market given the percentage of their market share.

In the case where OPEC member countries reduce supply given rising crude oil demand, oil prices tend to rise. OPEC is in control of about 43% of the world's oil production and furthermore stands for about 81% of the world's proven reserves (OPEC, 2014). OPEC states that 60% of the exported oil in the world comes from OPEC's member countries. This considerable market share means that they are able to influence the direction of international crude oil prices through the policies that they set (Kaufmann et al. 2004).

In November 2014, when total oil production by non-OPEC member countries increased, OPEC members responded by increasing supply in order to maintain their market share and this led to plummeting oil prices. World oil production significantly outpaced consumption in 2014, rising by 2.1 million barrels per day, all of the growth was in non-OPEC countries, which recorded a record increase.

Figure 4 The relationship between OPEC production and crude oil prices



Source: US. Energy Information Administration

3.5 Global Production and Consumption of Oil

The relationship between world production of crude oil and consumption is illustrated in Fig. 5. Rising demand is met with a rise in production. Values for

2016 and 2017 are projections. And a rise in production leads to falling oil prices which is indicated by a fall in production in subsequent years.

The diagram exhibits crude oil price war within the industry. It shows how some big producers in the industry such as OPEC are able to affect prices through their supplies. Production levels can be reduced during periods of price decrease and vice versa ceteris paribus. It is observed that from 2014, production outstripped consumption. This was due to increased supply from United States of America by several million barrels per day, increased production in Canada, Brazil and other non-OPEC member countries.

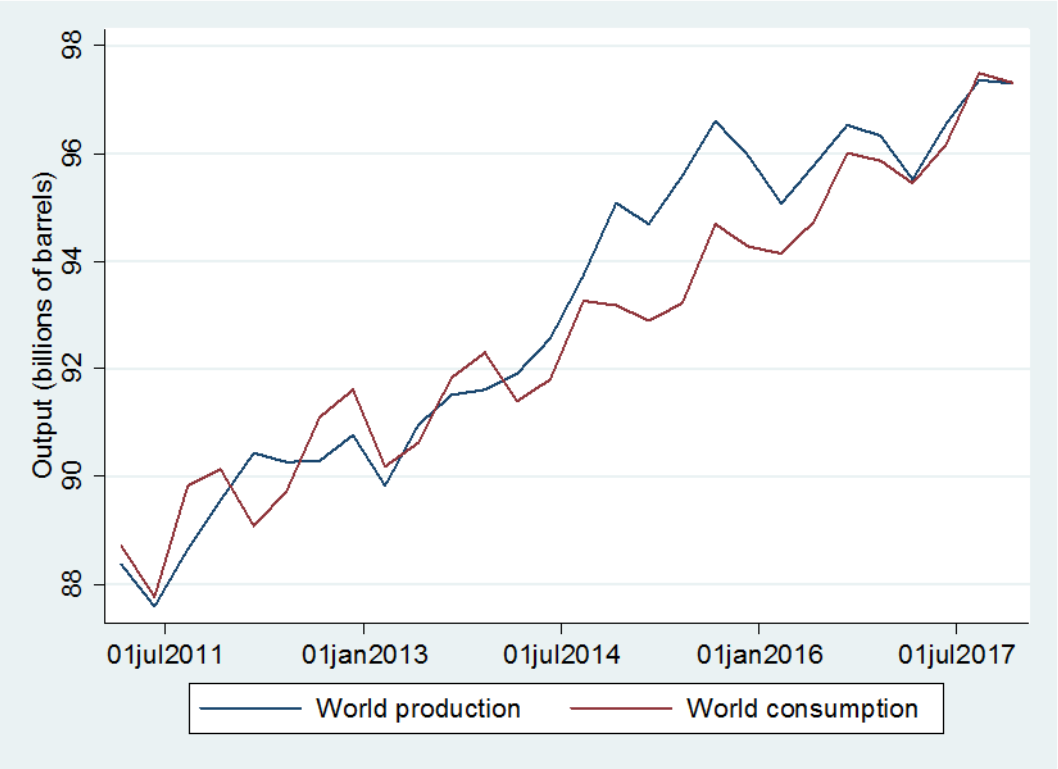
The cost of unconventional oil production is likely to decline over time as new technologies will reduce the cost of exploration and extraction (Benes et al. 2012). Marginal cost of unconventional oil production will lead to more unconventional oil being produced and used in place of conventional ones (Kaletsky, 2015; Basu and Indrawati, 2015). The overall effect is that oil supply will not be reducing soon to boost up prices.

Oil demand forecasts have been downgraded on several occasions as global growth repeatedly has not been impressive since 2012. It is a reflection of slowdowns in large emerging markets since their economic activities tend to be more oil-intensive than that in developed countries (Fournier et al. 2013). Although emerging economies continue to dominate the growth in global energy consumption, growth in these countries (2.4%) was well below its 10-year average of 4.2%. China (2.6%) and India (7.1%) recorded the largest national increments to global energy consumption (BP Global, 2015).

OECD consumption fell by 0.9%, which was a larger fall than the recent historical average. A second consecutive year of robust US growth (1.2%) was more than offset by declines in energy consumption in the EU (3.9%) and Japan (3.0%). The fall in EU energy consumption was the second-largest percentage decline on record (BP Global, 2015).

Global oil consumption grew by 0.8 million barrels per day, a little below its recent historical average and significantly weaker than the increase of 1.4 million barrels per day seen in 2013. Countries outside the OECD once again accounted for all of the net growth in global consumption. OECD consumption declined by 1.2%, the eighth decrease in the past nine years (BP Global, 2015).

Figure 5 Comparison of world oil production and consumption



Source: US. Energy Information Administration

3.5.1 Unplanned production outages

With the recent development in oil prices, one of the areas worth considering is production outages. In other words, how much of the fluctuations in oil prices can be attributed to unplanned production outages. Unplanned crude oil and liquid fuels supply disruptions may occur in many countries and for a variety of reasons such as technical difficulties, conflicts and natural disasters.

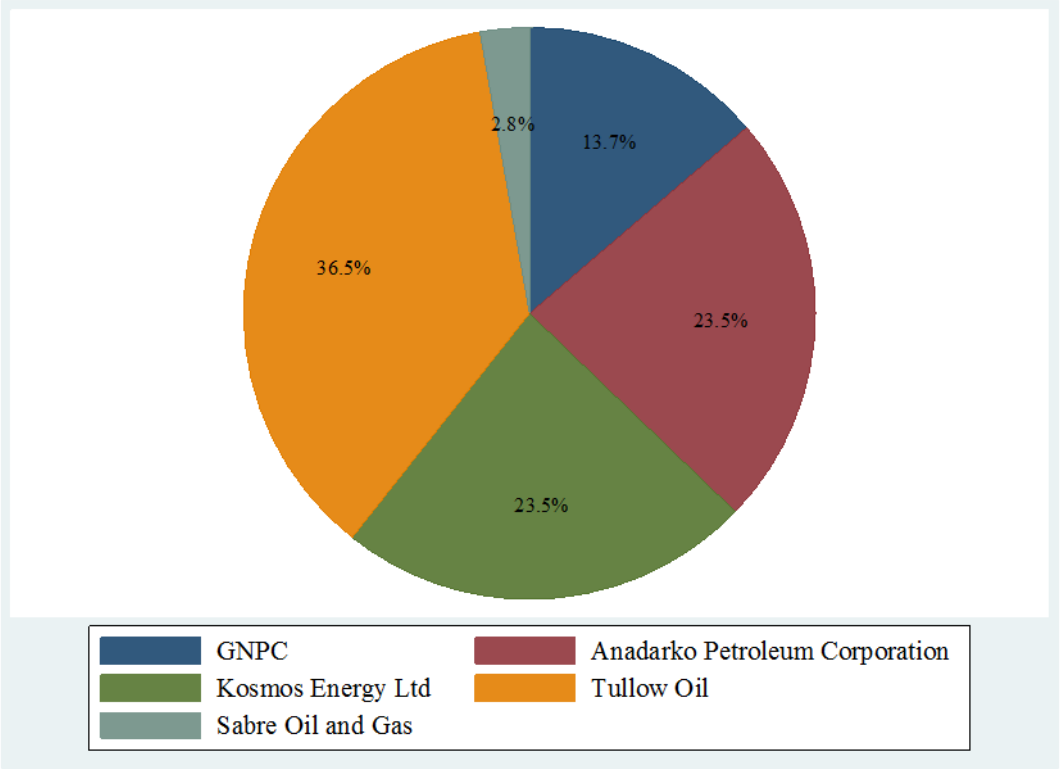
In recent times, total outages among the Organization of Petroleum Exporting Countries (OPEC) and non-OPEC producers rose to historical high levels. These outages, combined with relatively low surplus production capacity, have contributed to a tighter world oil market in recent times.

3.5.2 The Structure of Ghana's oil market

The oil and gas sector in Ghana is largely dominated by private players, primarily due to the large amount of investment required for exploring oil fields. These players are seeing significant growth and are planning for expansion in

Ghana. Fig. 6 shows the various operators in the oil fields in Ghana and their percentage share of the oil market in the country.

Figure 6 Structure of Ghana's Oil production sector



Source: Grail Research

3.5.3 Crude oil price and economic activities in Ghana

Berument and Ceylan (2004) state that the impact of oil price changes depends on the structure of the economy and whether the country is a net oil exporter or importer. Net exporters of oil should benefit from windfall profits and fiscal revenues created by oil price hikes, while net importers of oil will experience this situation as additional burdens on their economies and vice versa.

Studies on the role of crude oil prices on the economic activities of countries have over the years attracted several volumes of literature with contradictory results. Researchers such as Hamilton (2008) produced works which established the link between oil price shocks and the national economy of the United States of America. His paper observed that oil price shocks were the main contributing factors to the recession. This aroused interest from other researchers who sought to either confirm or otherwise. These include studies from both developed and developing countries' researchers such as (Hamilton, 2003, 2008; Chang and Wong, 2003; Cunado and Gracia, 2005; Kilian, 2008;

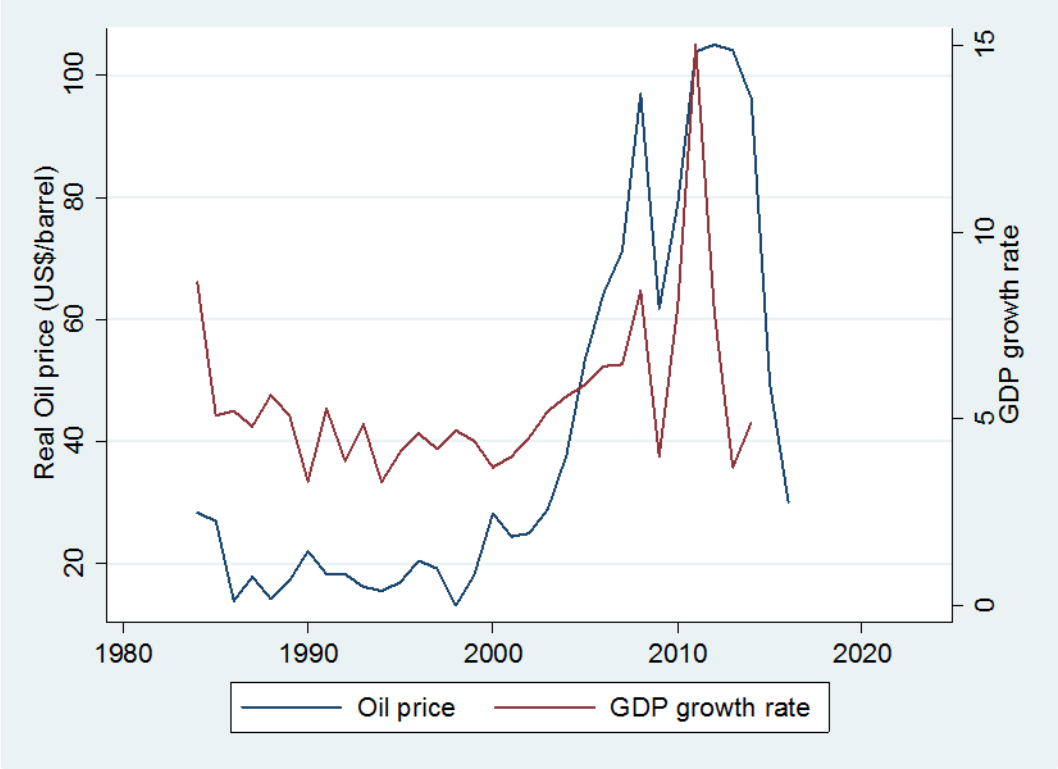
Lorde et al. 2009; Dogrul and Soytas, 2010; Rasmussen and Roitman, 2011) who argued that oil price shocks significantly affect economic activities, mainly economic growth.

Hamilton (1982) found a negative correlation between oil prices and GDP growth. He however argues that not all oil price changes have the same effect on the economy. He claims that a fall in the price of oil is unlikely to boost the economy in the same way that a price increase can depress it downwards.

O'Neill et al. (2008), suggests that significant increases in energy prices will lead to a considerable rise in production and transportation cost for many industries and hence drive wages and inflation upwards, which at the same time will dampen economic growth. It has been documented that rising oil prices appear to impede aggregate economic activity by more than falling oil prices stimulate it (Mork, 1989 and Lardic and Mignon, 2008)

Falling crude oil prices means declining incentive for higher production in Ghana and the vice versa ceteris paribus. Falling crude oil prices could also mean declining cost of imported crude oil products, hence declining cost of production. Fig. 7 shows the close relationship between GDP growth in Ghana and crude oil prices. It is observed that the relationship was strong when Ghana was only an importer of crude oil and now that Ghana is an exporter of the resource. Rising crude prices are accompanied by rising GDP growth and vice versa. There is no noticeable change in the relationship between the two variables before and after oil production. This is largely due to the fact that Ghana still maintains its status as a net crude oil importer even though the country is now exporting the commodity.

Figure 7 Oil price and GDP growth rate in Ghana



Source: US. Energy Information Administration, Ghana Statistical Service

The oil-price-economic activity relationship was examined by authors such as Papapetrou (2001), Berument and Tasci (2002), Lardic and Mignon (2006) and Zhang (2008). Evidence from their studies suggests that, there is a degree of negative correlation between oil prices and economic activity and it strengthens during periods of rapid oil price changes and high oil price change volatility. The question however remains whether there is a stable relationship between oil prices and economic growth over time. Studies such as De Gregorio et al. (2007) and Kapetanois and Tzavalis (2010) sought to answer this question. The general conclusion from these studies was that the negative effects of oil price spikes on most important economies have become relatively less important after 1980.

With regards to whether oil price fluctuations have a symmetric relationship with economic activities or not, several researchers (Mork, 1989; Cunado and Gracia, 2005) observed in their studies that economic activity exhibits asymmetric responds to oil price shocks. In other words, an increase in oil prices tend to depress aggregate economic activity by more than a decrease in oil price.

Hamilton (2008) argued that an increase in oil price will only matter if they are significantly larger in comparison to past experiences since most of the individual price increases are simply corrections to the earlier declines. Lee et al. (1995) also worked on the same non-linear measurement dilemma and they opine that variability in oil prices are likely to have greater impact on GDP in an environment of stable oil price movements than in an environment of frequent and erratic oil prices.

3.6 The Multiplier and Linkages Effect of the New Oil Sector

While providing a comprehensive set of channels, most of the empirical studies mainly look at the impact of the natural resource abundance on the overall and long-term economic growth and not directly at the interactions between the natural resource sector and the other sectors in the economy.

The idea of forward and backward inter-industry linkages as measures of structural interdependence was introduced by Rasmussen (1956). Its use in the identification of key sectors was subsequently suggested by Hirschman (1958), who postulated that economic development and structural change proceed predominantly along above-average linkages, so that a relatively small number of industries accelerate and amplify initially small changes, which eventually affect the whole economy. As a natural outcome of market forces, there will be: linkages from lead commodity producers in the commodities sector to input suppliers (backward linkages) and to commodity processors (forward linkages). These linkages will be a function of the age and the scale of the sector in the country in question. In the oil sector, backward linkages will be more prominent than forward linkages.

Among the few studies that look at the intersectoral linkages is the paper of Bhattacharya and Ghura (2006), which focuses exclusively on the Republic of Congo and finds that, while the oil sector does not have a direct impact on non-oil sector growth it may have indirect effects through political instability and real exchange rate movements. Fiess and Verner (2003) examined the intersectoral linkages in the Ecuadorian economy and found that the oil sector is co-integrated with the public sector and the transportation and communication sectors.

In light of available literature oil sector linkages can be divided into several categories (Fiscal, Environmental, Backward and Forward linkage). Fiscal linkages deal with resource management, revenue issues and social political and cultural incidences. Environmental linkages deal with environmental issues. Forward linkages deal with pricing and supplying of industrial output. Backward linkages deal with factor of production such as material, machinery, equipment and technology (Teka, 2011).

The available literature on backward linkage in the oil sector suggests that spillovers between the oil and gas and the aggregate economy arose in the manufacturing sector because the intermediate industry development process takes place in the manufacturing sector. The manufacturing sector supplies factors of production like machinery, equipment, material and other technical inputs (Teka, 2011).

Based on our input-output table, this dissertation quantifies the possible impact of the prospective oil sector development on other sectors of the Ghanaian economy. While the Leontief matrix of technical coefficients exposes the limited backward and forward linkages from the oil sector into the rest of the economy, the sheer magnitude of the domestic demand shock stemming from rising oil exports is likely to have major impact on overall output.

The policy challenge would be to secure that these complementarities between the oil and non-oil economy materialize so as to maximize the local benefits from the exploration of Ghana‘s expected oil riches. The commencement of oil production has the potential to boost some other economic activities. The reasons for such a potential are at least fourfold. First, some economic activities could provide inputs to the oil related industry itself which will be characterized by synergies to other local economic activities.

Second, the emergence of demand linkages can have sizeable effects in the economy. These demand linkages in particular may become relevant for some locally produced items.

Third, revenues from oil production can enable Ghana to carry out well targeted productivity enhancing investments that will make existing comparative advantages for activities more pronounced.

Tourism and related recreational activities have long been a priority issue on the development agenda for Ghana and the dissertation suggests that sizeable backward linkage materializes as a result of further developing the existing potential which remains largely untapped. Most importantly, the exact nature of a tourism strategy has yet to be defined (Potter, 2005), and integrated with the likely emergence of the oil sector.

Also, a number of activities that typically develop in tandem with the oil sector could create additional demand for hotel and other capacities. There are several industry related studies of the employment effects of upstream oil and gas development (Considine et al. 2009; Considine et al. 2010; Higginbotham et al., 2010; IHS Global Insight, 2011; Murray and Ooms, 2008; Scott, 2009; Swift, Moore and Sanchez, 2011).

Most of them use the Input-Output (IO) methodology and predict large increases, not only in employment but also in tax revenues and production. Kinnaman (2011) provides a peer-reviewed survey and a critique of a number of these. He points out that several assume, perhaps counter-factually, that nearly all windfall gains by households are spent locally and immediately, that most inputs are locally produced and that royalties are accrued locally.

Finally, Arora and Lieskovsky (2014) examine national economic impacts of the natural gas boom. They find evidence that lower real natural gas prices due to increased supply positively impact industrial production. Studies in the Angolan oil sector have mostly focused on fiscal linkages but limitedly on backward linkages.

The few studies that have looked at backward linkages in oil producing countries are limited to supply chain management (Wiig, 2006), localisation (Klueh et al., 2007) and human resources linkages. The current study pioneers work on the extent and nature of linkages in the manufacturing sector which literature posits as the main channel of transfer of capabilities and sustainable spillovers between the oil sector and the economy.

The idea of linkages was employed by Wang et al. (2013) in an attempt to measure the direct and indirect contribution made by the iron and steel industry in the economy of China and to assess the differences between China and other steel producing countries. This was done from the perspective of its

inter-relationship with other sectors of the economy in terms of multiplier effect and backward as well as forward linkages.

Given the public sector dominance in many of the selected oil exporters, an important channel through which the oil sector may affect the non-oil sector is the country's fiscal operations. In this regard, if the windfall of oil revenues are used in a prudential manner by directing public spending to investment in infrastructure and human capital in line with the economy's absorption capacity, oil revenues can have positive externalities on the non-oil sector.

On the other hand, inefficient use of oil revenues, which may lead to increased inflationary pressures if output is close to potential, sharp real exchange rate appreciation, a decline in the marginal efficiency of capital and a non-sustainable fiscal stance, is likely to have adverse effects on the economy as a whole, particularly as it increases the countries' vulnerability to external shocks, impairs external competitiveness and discourages foreign investment.

San Cristo'bala and Biezma (2006) focused on the inter-industry linkages of the mining industry of the European Union. Their study showed that only three sectors were key; the mining of coal and lignite and extraction of peat in Germany; mining of metal ores in Sweden; and other mining and quarrying in Austria, Denmark and Spain.

With oil resource endowment of the economy of Azerbaijan, Sabiroglu and Bashirli (2006) provided empirical research to identify the linkages between investment in the resource sector and productivity growth in the entire economy. They concluded that a marginal change in final demand in the oil sector has a significant impact on mining and quarrying of energy producing materials. The impact of this sector however on total output and total supply is relatively low. This can be explained by a limited capacity of this sector to directly generate wealth and employment opportunities on a large scale.

Ciarreta and Nasirov (2012) analyzed the development trends in the Azerbaijan oil and gas sector. Their study pointed out the limitations of the oil sector to effectively impact on the level of poverty and inequality. Rayner and Bishop (2013) quantified the links from demand for Australia's natural resources to activity in other domestic industries by using structural relationships embedded in input-output tables. They also estimated the size, growth rate and industry value added content of a broad measure of the resource economy,

which is defined to include all final demand related to resource extraction and investment.

The next section discusses literature on the impact of natural resource booming sectors (oil sector) on traditional sectors of the economy (agriculture and manufacturing).

3.7 The Oil Sector, the Dutch Disease and the Shadow Economy of Ghana

This part of the study reviews literature on the Dutch Disease phenomenon in various natural resource rich countries and compares the situation with Ghana. It also reviews literature on shadow economic activities in various countries especially developing oil producing ones. The conclusions from these reviewed works are noted and used for comparison with the results of this study.

3.7.1 The oil sector and the Dutch Disease

The Dutch Disease posits that a boom in the natural resource sector leads to a decline in the performance of the manufacturing sector through crowding out and an appreciation of the real exchange rate. Krugman (1987), Matsuyama (1992) and Torvik (2001) have argued that this could have harmful long-term economic consequences, arguing that growth is largely driven by learning by doing in the manufacturing and agricultural sectors. This mechanism has been cited as a possible culprit for the "resource curse" found by Sachs and Warner (1995) and several subsequent papers, although the existence of the curse has been called into question by a few recent papers including Brunnschweiler and Bulte (2008), Alexeev and Conrad (2009) and Smith (2013).

In simple models where labor is the only mobile factor, a resource boom unambiguously predicts a decrease in output of the non-booming traded sector, or "deindustrialization". However, making more than one factor mobile between sectors can produce ambiguous implications for manufacturing.

Further, Corden and Neary (1982) point out real-world factors beyond the core model that could lead to a resource boom being a blessing for manu-

facturing. Since the increase in income will presumably be taxed, the government may invest the extra revenue in other sectors or in infrastructure that raises productivity generally. If there is a non-booming traded sector besides manufacturing, for example agriculture, then that sector could suffer the brunt of the negative effects. Perhaps most pertinently, since manufacturing will contain both traded and non-traded sub-sectors, the spending effect may be a net positive for manufacturing as a whole.

However, a number of empirical Dutch Disease papers have been produced more recently. Caselli and Michaels (2009) exploit differences in oil endowment across Brazilian municipalities, finding little effect on non-oil GDP. Allcott and Keniston (2013) use an approach similar to this paper and Black et al. (2005) and finds that oil booms increase manufacturing output in oil-rich United States counties.

In a cross-country literature, Rajan and Subramanian (2011) considers aid rather than resources as the windfall and finds that aid-dependent countries experience slower growth in tradable manufacturing sectors relative to non-tradeable sectors during the 1980s and 1990s. Ismail (2010) and Harding and Venables (2013) both find a negative relationship between price movements and manufacturing value added and exports among oil-exporting countries.

3.7.2 The oil sector and the shadow economy of Ghana

Underground economic activities are present in all economies of the world especially in developing countries. Though their presence may not necessarily be bad for the economies in which they prevail, they account for numerous economic and social problems such as environmental hazards, losses to state revenue, violation of labor regulations etc. The positive aspect of such activities is that, they provide additional opportunities for employment and extra income to the impoverished population.

Shadow economic activities are also regarded in some quarters as hidden activities, black market activities to mention but a few. Their definition remains largely controversial but this study adopts the definition by Schneider et al. (2009) where underground economic activities are defined as market based production activities, which are deliberately hidden from the official system. Such activities occur as a result of individuals and companies avoiding payment

of taxes, social security contributions and compliance with labor market standards. In other words, such activities are in principal legal, however, remain unreported to the authorities with the purpose of tax evasion, noncompliance with regulations or avoidance of official bureaucracy.

Numerous definitions of the underground economy were previously formulated in the literature (Ogbuabor and Malaolu, 2013; Schneider et al. 2009). The relationship of the underground economy with the official economy still remains incomprehensively described, although some authors claim that rising official economy weakens underground economic activities, as both compete for the same resources (Ogbuabor and Malaolu, 2013).

4 MATERIALS AND METHODS

The dissertation sought to answer three research questions: the impact of oil price shocks on economic activities in Ghana, how the new oil sector has affected economic multipliers and sectoral linkages and to investigate whether traditional sectors have been affected negatively by the presence of the new oil sector as well as the evolution of shadow economic activities with the introduction of the new sector. Each of the questions was answered using a different research methodology.

4.1 Data Transformation

To answer all the three research questions posed in this study, different types of datasets were obtained from different sources. Various data transformation techniques were applied to the datasets used in this study. The techniques varied for each of the research methods applied to answer the respective research questions.

For the analysis of the impact of oil price shocks on economic activities in Ghana, the data was obtained from the US Energy Administration and covered the period from 1984-2015. For economic multipliers and sectoral linkages, the data was obtained from the Ghana Statistical Service' supply and use table. The data for the analysis on the Dutch Disease phenomenon and the shadow economy of Ghana were obtained from the World Bank's world development indicators. The subsequent subsections discuss the various data transformation techniques applied.

4.2 Method for Research Question 1: The Impact of Oil Price Shocks on Economic Growth in Ghana

In attempting to assess the impact of oil price shocks on economic activities in Ghana, the dissertation made use of two variables with yearly observations: real GDP and real oil price. Quarterly or monthly data were more preferable but accessing such kind of data for GDP in Ghana was a challenge. Oil price (Brent crude) was measured as the international price of a barrel of crude oil

(in US$) and was obtained from United States Energy Information Administration. It was transformed into logarithmic form. Data on real GDP was obtained from the Ghana Statistical Service and also transformed into logarithmic form.

4.2.1 Unit root test

Unit root testing was carried out using the Augmented Dickey-Fuller (1979) test to ascertain whether the variables of the model were stationary or otherwise. Beginning with the first Dickey-Fuller (DF) test, the simplest approach to test for a unit root begins with an autoregressive process, AR (1) model.

$$Y_t = \beta_0 + \phi Y_{t-1} + a_t \tag{1}$$

where $a_t \sim WN(0, \sigma_a^2)$ implying that a_t is a white noise (WN) error term distributed with a mean zero and variance, σ_a^2. β_0 and ϕ are the estimated intercept and slope coefficients. DF test actually does not consider β_0 in the model, but actually a model with β_0 and without β_0 gives different results. Consider the hypothesis,

$$\begin{aligned} H_0&: |\phi| = 1 \Rightarrow Y_t \sim I(1), \\ H_1&: |\phi| < 1 \Rightarrow Y_t \sim I(0). \end{aligned} \tag{2}$$

To simplify the computation, subtract Y_{t-1} from both sides of the AR (1) model implies,

$$Y_t - Y_{t-1} = \beta_0 + (\phi - 1)Y_{t-1} + a_t, \tag{3}$$

Thus

$$\Delta Y_t = \beta_0 + \delta Y_{t-1} + a_t, \tag{4}$$

Where $\delta = \phi - 1$, if $\delta = 0$, it implies that, the system has a unit root.

$$H_0: \delta = 0$$

$$H_1: \delta < 0.$$

According to Dickey and Fuller (1979)

$$\Delta Y_t = \delta Y_{t-1} + a_t, \tag{5}$$

implies a pure random walk (RW) and

$$\Delta Y_t = \beta_0 + \delta Y_{t-1} + a_t, \tag{6}$$

implies a pure random walk with a drift and

$$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + a_t, \tag{7}$$

indicates the addition of drift and linear time trend. Applying OLS method and finding the estimator for ϕ, the test statistic is given by,

$$t_{\phi-1} = \frac{\hat{\phi} - 1}{s.e.(\hat{\phi})} \tag{8}$$

The test is a one-sided left tailed test. If Y_t is stationary (i.e., $|\phi| < 1$) then it can be shown $\sqrt{n}(\hat{\phi} - \phi) \xrightarrow{d} N(0, (1 - \phi^2))$.

This means that under H_0, the limiting distribution of $t_{\phi=1}$ is normal N(0,1), (n is the sample size and *d* indicates distribution).

Augmented Dickey Fuller (ADF)

If serial correlation exists in the DF test equation, then AR(p) can be used to get rid of the serial correlation.

$$\phi_p(B) Y_t = a_t, \tag{9}$$

where $\{a_t\} \sim WN(0, \sigma_a^2)$ with $E(a_t^4) < \infty$ and $\phi_p(B) = 1 - \phi_1 B - \cdots - \phi_p B^p$ may contain a unit root. To test for unit roots, it is assumed that,

$$\phi_p(B) = (1 - B)\phi_{p-1}(B). \tag{10}$$

where $\phi_{p-1}(B) = 1 - \phi_1 B - \cdots - \phi_{p-1} B^{p-1}$ has roots lying outside the unit circle.

$$\phi_{p-1}(B)(1 - B) Y_t = a_t, \tag{11}$$

$$\phi_{p-1}(B) \Delta Y_t = a_t, \tag{12}$$

$$\Delta Y_t - \sum_{j=1}^{p-1} \phi_j \, \Delta Y_{t-j} = a_t. \tag{13}$$

Hence, testing for a unit root is equivalent to testing $\phi = 1$ in the following model. The ADF test equation is given as,

$$Y_t = \phi Y_{t-1} + \sum_{j=1}^{p-1} \phi_j \, \Delta Y_{t-j} + a_t, \tag{14}$$

or

$$\Delta Y_t = \underbrace{(\phi - 1) Y_{t-1}}_{\delta} + \sum_{j=1}^{p-1} \phi_j \, \Delta Y_{t-j} + a_t. \tag{15}$$

In this case the ADF test equation is given by,

$$\Delta Y_t = \delta Y_{t-1} + \sum_{j=1}^{p-1} \phi_j \, \Delta Y_{t-j} + a_t, \tag{16}$$

The null and alternative hypotheses are given as,

$$H_0: |\phi| = 1$$

$$H_1: |\phi| < 1.$$

Reject H_0 if $t_{\phi=1}$ is less than the critical value otherwise do not reject. The decision can also be taken based on the following null and alternative hypotheses,

$$H_0: \delta = 0$$

$$H_1: \delta < 0.$$

Reject H_0 if $t_{\delta=0}$ is less than the critical value otherwise do not reject.

An important practical issue for the implementation of the ADF test is the specification of the lag length p. If p is too small, then the remaining serial correlation in the errors will bias the test. If p is too large, then the power of the test will suffer. Ng and Perron (1995) suggest the following data dependent lag length selection procedure that results in stable size of the test and minimal power loss.

First, set an upper bound p_{max} for p. Next, estimate the ADF test regression with $p = p_{max}$. If the absolute value of the t-statistic for testing the significance of the last lagged difference is greater than 1.6, then set $p = p_{max}$ and perform the unit root test. Otherwise, reduce the lag length by one and repeat the process. A useful rule of thumb for determining p_{max}, suggested by Schwert (1989), is,

$$P_{max} = \left[12\left(\frac{n}{100}\right)^{1/4}\right]. \quad (14)$$

This choice allows p_{max} to grow with the sample so that the ADF test regressions are valid if the errors follow an ARMA process with unknown order. Determination of optimal lag length using the Loglikelihood ratio (LR tests),

$$LR = (T - m)(\ln|\Sigma_r| - \ln|\Sigma_u|) \sim \chi^2(q) \quad (15)$$

T is the number of observations (after accounting for lags), m is the number of parameters estimated in each equation of the unrestricted system, including the constant. $\ln|\Sigma_r|$ natural log of the determinant of the covariance matrix of residuals of the restricted system.

q is the total number of restrictions in the system (the number of lags multiplied by n^2) and n is the number of variables (or equations). If the LR statistics is less than the critical value, reject the null of the restricted system. If the LR statistics is less than the critical value, reject the null of k-1 lags over k lags.

4.2.2 VAR lag order selection criteria

An appropriate lag length was required to proceed with the test to ascertain whether variables were cointegrated or not. This was checked using the various information criteria: Akaike Information Criteria (AIC), Schwartz Information Criteria (BIC) and Hannan-Quinn Criteria (HQC), see (Hannan-Quinn, 1979; Akaike, 1974; Schwartz, 1978). The rank of cointegration or the number of cointegrating equations is then determined.

$$SIC(p) = \ln\left|\overline{\Sigma}(p)\right| + \frac{\ln N}{N}(K^2 p), \quad (16)$$

$$HQC(p) = \ln\left|\overline{\Sigma}(p)\right| + \frac{2\ln\ln N}{N}(K^2 p), \quad (20)$$

$$AIC(p) = \ln\left|\overline{\Sigma}(p)\right| + \frac{2}{N}(K^2 p). \quad (21)$$

where N is the effective sample size and $\overline{\Sigma}$ is the quasi-maximum likelihood estimate of the innovation covariance matrix Σ (see Sin and White (1996) for further discussion of the theoretical rationale for these criteria).

The lag order estimate $\hat{p}$ is chosen to minimize the value of the criterion function for $(p: 1 \leq p \leq \bar{p})$ where $\bar{p} \geq p_0$. As noted by Granger, King and White (1995), any one of these three information criteria may be interpreted as a sequence of Likelihood ratio (LR) tests with the critical value being implicitly determined by the penalty function. No one model is favored because it is chosen as the null hypothesis, and the order in which the criterion function is evaluated does not affect the lag order choice.

4.2.3 Cointegration test

In the case of two non-stationary I(1) variables y_t and X_t, if there are two non-zero values $(a \neq 0, b \neq 0)$ such that $ay_t + bX_t$ is stationary, or I(0), then the variables are said to be cointegrated. To identify the cointegrating vector, one of the values (a, b) is set to 1 and the other is estimated. As Granger and Engle (1987) showed, this can be done by a regression in levels. If the residuals from that 'Granger-Engle' regression are stationary, cointegration is established.

In the general case of K variables, there may be $1, 2, \ldots, (K-1)$ cointegrating vectors representing stationary linear combinations. That is, if y_t is a vector of I(1) variables and there exists a vector β such that βy_t is a vector of I(0) variables, then the variables in y_t are said to be cointegrated with cointegrating vector β. In that case the study needs to estimate the number of cointegrating relationships, not merely whether cointegration exists among these series. For a K-variable VAR with p lags,

$$y_t = v + A_1 y_{t-1} + \cdots + A_P y_{t-p} + \epsilon_t. \quad (22)$$

let ϵ_t be i.i.d: normal over time with covariance matrix $\sum$. Then the VAR may be rewritten as a VECM,

$$\Delta y_t = v + \prod y_{t-1} + \sum_{i=1}^{p-1} \phi_1 \Delta y_{t-1} + \epsilon_t. \quad (23)$$

where v is a vector of contants, $\Pi = \sum_{j=1}^{j=p} A_j - I_k$ and $\phi_1 = -\sum_{j=i+1}^{j=p} A_j$.

Rank $\Pi = 0$, then there are no cointegrating variables, all rows are linearly dependent, and the system is non-stationary. First-difference all the variables to remove non-stationarity, then standard inference applies (t, F and χ^2). The VECM can thus be written as a simple VAR in first differences,

$$\Delta y_t = \sum_{i=1}^{n-1} \Phi_i \, \Delta y_{t-i} + u_t. \quad (24)$$

If rank $\Pi = K$ (where K is the number of variables) it implies that, all variables are stationary, i.e., $y_t \sim \mathrm{I}(0)$, all roots are in the unit circle with modulus less than 1, and hence the system is stationary and the levels of variables have stationary means.

Rank $\Pi = r < K$, the system is non-stationary but there are r cointegrating relations among the variables (r rows are linearly independent, thus r linearly independent combinations of the y_t sequence are stationary). The cointegration relation is determined by,

$$\Pi = \alpha\beta'. \quad (25)$$

where α is a $(K \times r)$ matrix of weights, the loading matrix, which measures the average speed of convergence towards long-run equilibrium. β is also a $(K \times r)$ matrix of parameters determining the cointegrating vectors. $\beta' y_{t-1} \neq 0$ is the long-run equilibrium error.

4.2.3.1. The VECM model

The essence of the VECM lies in the implication that the series being studied are cointegrated, thus implying the existence of long-run relationship between the integrated time series. The presence of cointegration among relevant variables indicates that a linear combination of non-stationary time series exhibits a stationary series, thus avoiding the problem of spurious regression. An error correction mechanism is incorporated in the model to capture the variations associated with adjustment to a long term equilibrium.

Consider two series Y_t and X_t, that have the following equations,

$$Y_t + \beta X_t = \varepsilon_t, \varepsilon_t = \varepsilon_{t-1} + \omega_t, \tag{26}$$

$$Y_t + \alpha X_t = v_t, v_t = pv_{t-1} + \tau_t, |p| < 1, \tag{27}$$

Assume that ω_t and τ_t are i.i.d. disturbances, correlated with each other. The random-walk nature of ε_t, implies that both Y_t and X_t are also I(1), or non-stationary, as each side of the equation must have the same order of integration. By the same process, the stationary nature of the v_t process implies that the linear combination (Y_t + X_t) must also be stationary, or I(0).

Thus Y_t and αX_t cointegrate, with a cointegrating vector (1, α).

The system can therefore be rewritten as,

$$\Delta Y_t = \beta\delta Z_{t-1} + \pi_{1t} \tag{28}$$

where

$$\Delta X_t = -\delta Z_{t-1} + \pi_{2t} \tag{29}$$

where $\delta = \frac{1-p}{\alpha-\beta}$, $Z_t = Y_t + \alpha X_t$ and the errors (π_{1t}, π_{2t}) are stationary linear combinations of (ω_t, τ_t).

When Y_t and X_t are in equilibrium, $Z_t = 0$. The coefficients on Z_t indicate how the system responds to disequilibrium. A stable dynamic system must exhibit negative feedback.

STATA's implementation of VECM modelling is based on the maximum likelihood framework of Johansen (1988). In that framework, deterministic trends can appear in the means of the differenced series or in the mean of the cointegrating relationship. The constant term in the VECM implies a linear trend in the levels of the variables. Thus, a time trend in the equation implies quadratic trends in the level data. Writing the matrix of coefficients on the vector error correction term Y_{t-1} as $\Pi = \alpha\beta'$ trend can be incorporated in the cointegrating relationship and the equation itself as,

$$\Delta Y_t = \alpha(\beta' Y_{t-1} + \mu + \rho t) + \sum_{i=1}^{p-1} \phi_1 \Delta Y_{t-i} + \gamma + \tau t + \epsilon_t. \quad (30)$$

4.2.3.2. Diagnostic test in VECM model

In statistics, the Jarque-Bera (JB) test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The test is named after Carlos Jarque and Anil K. Bera. The test statistic JB is defined as,

$$JB = \frac{n-k+1}{6}[S^2 + \frac{1}{4}(C-3)^2]. \quad (31)$$

where *n* is the number of observations (or degrees of freedom in general); *S* is the sample skewness, *C* is the sample kurtosis, and *k* is the number of regressors,

$$S = \frac{\hat{\mu}_3}{\hat{\sigma}^3} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{\left[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right]^{3/2}} \quad (32)$$

$$C = \frac{\hat{\mu}_4}{\hat{\sigma}^4} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^4}{\left[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right]^{2}} \quad (33)$$

where $\hat{\mu}_3$ and $\hat{\mu}_4$ are the estimates of third and fourth central moments, respectively, $\bar{x}$ is the sample mean, and $\hat{\sigma}^2$ is the estimate of the variance of the second central moment. If the data comes from a normal distribution, the *JB* statistic asymptotically has a chi-squared distribution with two degrees of freedom, so the statistic can be used to test the hypothesis that, the data are from a normal distribution. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being zero. Samples from a normal distribution have an expected skewness of 0 and an expected excess kurtosis of 0 (which is the same as a kurtosis of 3).

For small samples the chi-squared approximation is overly sensitive, often rejecting the null hypothesis when it is true. Furthermore, the distribution of *P*-values departs from a uniform distribution and becomes a right-skewed uni-modal distribution, especially for small *P*-values. This leads to a large Type I error rate.

Other diagnostic checks on the model include checks on autocorrelation between the residual terms of the model and model stability test. The study also proceeded to test for granger causality between the variables.

4.3 Method for Research Question 2: Economic Multipliers and Sectoral Linkages from the Oil Sector

The raw data for analysis was a supply and use national accounts table in the form of a matrix recording how supplies of different kinds of goods and services originate from domestic industries and imports. It was obtained from the Ghana Statistical Service. The table also shows how these supplies were allocated between various intermediate uses or final uses, including exports.

The input-output table which was developed from the Supply and Use Table (SUT) rearranges the data by expressing rows and columns in the same classification. It establishes direct links (sector by sector).

4.3.1 Fixed commodity sales structure

The input-output model used in this study assumes that each product has its own specific sales structure, irrespective of the sector where it is produced. There are no negative elements in the transactions table. It is organized in the form of sector by sector tables which are based on the fixed product sales structure. It does not involve any technology assumptions and does not require the application of any arbitrary methods to adjust for negatives.

Further readings on the formation of symmetric input-output models can be made using: Thage (2002; 2005) or Thage and Ten Raa (2006). In constructing sector by sector tables, assumptions are made based on the origins and destinations of products and not on the technology of production.

4.3.2 The choice of input-output model

There is a large literature discussing the merits and drawbacks of various models though some models minimize the limitations in the field of input-output modelling. Models are evaluated based on a set of four desirable properties:

material balance, financial balance, price invariance and scale invariance. Only the commodity technology model satisfies all four criteria.

4.3.3 Open models and closed models

Using an input-output model in this kind of study requires a decision on whether to regard household as one of the intermediate sectors of production or a final demand component. The basic kind of transactions that constitute the activity of the final demand sector, as have been seen, are consumption purchases by households, sales to government, gross private domestic investment, and shipments in foreign trade (either gross exports or net exports-exports from a sector less the value of imports of the same goods), Miller and Blair (2009).

Categorizing households as an exogenous sector is something of a strain on basic economic theory. Households (consumers) earn incomes (at least in part) as payment for their labor inputs to production processes and as consumers, they spend their income in rather well patterned ways. And in particular, a change in the amount of labor needed for production in one or more sectors for instance, an increase in labor inputs due to increased output will lead to a change (here an increase) in the amounts spent by households as a group for consumption.

Although households tend to purchase goods for final consumption, the amount of their purchases is related to their income, which depends on the outputs of each of the sectors. Thus one could move the household sector from the final demand column and labor input row and place it inside the technically intermediate consumption table, making it one of the endogenous sectors. This is known as closing the model with respect to households (see Miller and Blair, 2009).

Input-output models can be “closed” with respect to other exogenous sectors however, closure with respect to households is more usual. It requires a row and a column of transactions for the new household sector, the former showing the distribution of its output (labor services) among the various sectors and the latter showing the structure of its purchases (consumption) distributed among the sectors.

It is customary to add the household row and column at the bottom and to the right of the transactions and coefficients tables. Dollar flows to consumers, representing wages and salaries received by households from the *n* sectors in payment for their labor services.

4.3.4 Valuation and accounting for price changes

From the approach of Miller and Blair (2009), in comparing the input-output data used by this study with different years, it was important to distinguish changes attributable to prices from other sources of difference. This essentially involved converting the table originally valued at nominal prices for the year in which the data for the tables were collected (current prices) to corresponding tables valued at constant prices for some established base time period, specifically a base year.

The most common method used to achieve this is called double deflation, which refers to a two-step process when intermediate inputs, final demands, and total outputs valued at current prices in the accounting period are either deflated or inflated by using (multiplying by) commodity price indices for all intermediate inputs, final demand, and total output and then deriving a value added price index that balances the fundamental identity that the value of total outputs must always be equal to the value of total inputs.

All the output of a particular sector, i.e. deliveries to other sectors and to final demand, was adjusted by a price index for that sector's output. The price indices were calculated simply as ratios of the price of the commodities in the year for which valuation is sought to the corresponding price in the base year (2006). This study illustrates the process of double price indexing by recalling that intersectoral transactions in value terms refer to a physical transaction and a corresponding price.

4.3.5 Savings and investment

Miller and Blair (2009) refer to savings and investments as deliveries to final markets as final demand, deliveries of goods and services to other businesses as intermediate output, and purchases of goods and services by businesses that

are not resold as intermediate goods to other firms or consumers. In other words, they become long-term depreciable assets, as capital investments.

This study is interested in measuring the key economic flows in the Ghanaian economy, income, and expenditures, over a standardized period. Expenditures on capital, which this study can loosely define as the use of goods and services that extend beyond the standardized period, accumulate in the economy as a stock, only a portion of which gets "consumed" during the current period. This is why, in national income accounting, depreciation of a capital investment is often referred to as a capital consumption allowance.

4.3.6 The government sector

Finally, the major role of government in the economy suggests it should also be included explicitly as a major activity in the portfolio of national economic accounts, which this study labels as Government purchases. This involves highlighting government transactions, including taxes paid by consumers, government purchases of goods and services and government deficit spending.

4.3.7 Producers' and consumers' prices

The input-output transactions table presented by the Ghana Statistical Service was in producers' prices. This means that, the prices at which the seller completes the transaction. These are sometimes called free-on-board or FOB prices as seen in the works of Miller and Blair (2009). The purchaser incurs the producer's price plus trade and transportation margins as well as excise taxes.

This study assigned the margins on all interindustry transactions in a column to the industry responsible for the margin. That is, all wholesale and retail trade margins on all inputs to an industry are summed and recorded. Similarly, all transportation margins on inputs are summed and recorded as the input entry for transportation. Hence, the trade and transportation sectors are not really treated as producing and consuming sectors in the economy, but only as pass-through sectors (see Miller and Blair, 2009).

These conventions simply mean that the input-output table does not actually trace flows through the trade and transportation sectors, since this would depict an economy where industries and final customers would make most of

their purchases from and sales to these two industries alone. Instead, transactions are depicted as flowing directly from producer to consumer, bypassing trade and transportation. This is done to show the links between producers, consumers and final customers.

Since trade and transportation margins for all transactions into an industry are accumulated as single values for each industry, they in effect become service inputs to that industry. Hence, the sum of all inputs measured in producers' prices plus the value of all transportation and trade margins valued as service inputs (hence, valued in de facto producers' prices) is then the value of all inputs in consumers' prices (the column sums of the transactions matrix).

4.3.8 Accounting for imports and exports

As mentioned in the works of Miller and Blair (2009), imports in an input-output framework are usually divided into two basic groups: imports of commodities that are also domestically produced (competitive imports) and imports of commodities that are not domestically produced (non-competitive imports). The distinction, of course, is that competitive imports can be represented in a technical coefficients matrix, while non-competitive imports cannot.

Competitive imports are usually handled by adding transactions to the domestic transactions matrix (as in the case of transfers of secondary products) as if they were domestically produced. However, the "domestic port value" (in effect, value in producers' prices) of all imports of a particular commodity is included as a negative entry in final demand.

The purpose of this adjustment is to assure that the total output of a sector, computed as the row sum of the intersectoral transactions to other sectors and final demand allocation, is total domestic production, net of imports. Non-competitive imports are assigned to a new sector category, but the total value of all non-competitive imports is given a negative value in final demand so that, as in the case of competitive imports, the total output. That is, the row sum of transactions and final demand will be total domestic production, which in this case is zero. The negative final demand entries in both classes of imports ensure the total production and GNP of the economy are not incorrectly biased by imports.

4.3.9 Inventory changes

Inventories in the input-output model are not quite equivalent to the conventional definition of that term. In input-output models, inventory change is usually taken to mean the change in inventories of a sector's primary product, regardless of which sector(s) hold(s) the inventories. The traditional definition is usually restricted to the inventory actually held by the sector producing the product. This modified definition is adopted in input-output to ensure that the row total of the transactions and final demands is equal to total current output of the sector. If this study ignores inventory depletion or addition, then the row totals are total consumption, not output (see Miller and Blair, 2009).

International indicators were used in assessing a representative technique of production for the thirteen economic activities included in the I-O table developed for the Ghanaian economy. These activities follow the standard ISIC (International Standard Industrial Classification), System of National Accounts (2008), namely: Agriculture, Mining, Manufacturing, Energy and water, Construction, Distribution and Catering, Transport and Communication, Business and Finance, Public Sector Administration, Education and health, Other community services, Households and the Oil sector.

4.3.10 The input-output tables

The input-output table is developed from a combination of supply and use tables. Supply tables provide a detailed picture of the supply of goods and services by domestic production and imports. They also show the use of goods and services for intermediate consumption and final use (consumption, gross capital formation, exports). The "Use tables" show how the components of value added (compensation of employees, other net taxes on production, consumption of fixed capital, net operating surplus) are generated by industries in the domestic economy. Thus, Supply and Use Tables (SUT) give detailed information on the production processes, the interdependencies in production, the use of goods and services and generation of income in production. Balanced Supply and Use Tables provide coherent data linking industries, products and sectors.

The SUTs and input-output tables relate sectors to other sectors. It thus uses the industry by industry approach. The conversion of the supply and use tables into symmetric input-output table followed the method by, Soklis (2009).

This approach proposes straight forward treatment based on general joint-product models unlike the unrealistic assumption that single production, and not joint production, characterizes the economic structure of the real world.

Tab. 1 shows the structure of the combined SUT. It consists of the intermediate consumption component made of the thirteen sectors of the economy. The intermediate consumption by sector is a matrix of dimensions $(n \times n)$ matrix where n is equal to the 13 sectors in the economy. Final consumption by sectors is $(n \times 1)$ vector. Gross fixed capital formation by sectors is $(n \times 1)$ vector. Net export by sectors is $(n \times 1)$ vector. Value added is $(1 \times n)$ vector.

In the input-output model, the sectors are represented by numbers to ensure a simplified table. The representation was as follows; agriculture (1), mining (2), manufacturing (3), energy (4), construction (5), distribution and catering (6), transport, and communication (7), finance and business (8), public administration (9), education and health (10), other community social services (11). Households were represented by 12 or 13 depending on whether or not the table includes the oil sector. If the table includes the oil sector then households takes the number (13) otherwise (12).

Table 1 Structure of the supply and use table

Sectors		Producers and consumers								Final demand			
		Agriculture	Mining	Manufacturing	Electricity and water	Construction	Distribution and catering	Others	Total intermediate consumption	Gross private investment	Government Purchases	Net exports	Total demand
Producers	Agriculture	Interindustry transactions											
	Mining												
	Manufacturing												
	Electricity and water												
	Construction												
	Distribution and catering												
	Others												
	Total intermediate input												
Value added	Compensation of employees									Gross domestic product			
	Taxes on production												
	Subsidies												
	Consumption of fixed capital												
	Gross operating surplus												
	Total value added												
	Total output												

4.3.11 The input-output model equations

The structure of the input-output model is illustrated in Tab. 2. The model basically builds on the developments in input-output analysis and employs approaches developed by Miller and Blair (2009). X represents total output in Ghana cedis. Each small x represents quantities of products used by each industry.

The relationship between the inputs used by the industries and the total output produced is given by the input coefficients in equation (34).

$$A_{ij} = \frac{x_{ij}}{X_j}, \tag{34}$$

where X_j is the total output of sector j. Given the nature of the Ghanaian economy, technical coefficients are assumed to be stable and thus fixed. The economy is therefore represented by the following set of homogenous linear equations (35, 36, 37 and 38).

$$X_1 = A_{11}x_{n1} + A_{12}x_{n2} + A_{13}x_{n3} + \cdots + A_{1i}x_{ni} + \cdots + A_{1m}x_{nm} \tag{35}$$

$$X_2 = A_{21}x_{n1} + A_{22}x_{n2} + A_{23}x_{n3} + \cdots + A_{2i}x_{ni} + \cdots + A_{2m}x_{nm} \tag{36}$$

$$X_3 = A_{31}x_{n1} + A_{32}x_{n2} + A_{33}x_{n3} + \cdots + A_{3i}x_{ni} + \cdots + A_{3m}x_{nm} \tag{37}$$

$$X_m = A_{m1}x_{n1} + A_{m2}x_{n2} + A_{m3}x_{n3} + \cdots + A_{mi}x_{ni} + \cdots + A_{mm}x_{nm} \tag{38}$$

This shows how employment, output and income depend on final demand in an economy. The term $A_{12}x_{n2}$ represents the part of i^{th} sector's output that is dependent on the inputs x_{n2} of sector 2. The magnitude depends on the technical input coefficients of all sectors except households. Thus output of a sector is computed as,

$$x_{i1} + x_{i2} + \cdots + x_{ij} + y_i = X_i, \tag{39}$$

where x_{ij} represents purchases by the sector j of the output produced by sector i, y_i represents the sales from sector i, to final demand and X_i is the total output of sector i. Linear and algebraic equations for the output of the various sectors can be expressed as seen below.

Table 2 Structure of the input-output model

Sectors		Producers and Consumers								Final Demand			
		Agriculture	Mining	Manufacturing	Electricity and water	Construction	Distribution and catering	Others	Intermediate consumption	Gross private investment	Government purchases	Net exports	Total demand
Producers	Agriculture	$x_{1,1}$	$x_{1,2}$	...	...	...	...	$x_{1,13}$					
	Mining	$x_{2,1}$	$x_{2,2}$	...	...	...	...	$x_{2,13}$					
	Manufacturing	..	....	...	...	...	...	...					
	Electricity and water	...	...	...	...	...	...	...					
	Construction	...	...	...	...	...	...	...					
	Distribution and catering	...	...	...	...	...	...	...					
	Others	$x_{13,1}$	$x_{13,2}$	...	...	...	...	$x_{13,13}$					
	Total intermediate input												
Value added	Compensation of employees									Gross domestic product			
	Taxes on production												
	Subsidies												
	Consumption of fixed capital												
	Gross operating surplus												
	Total Value Added												
	Total output												

Economic multiplier effects of changes in final demand on each sector was calculated in terms of output and income multipliers. From Equation (34),

$$x_{ij} = A_{ij}X_j, \tag{40}$$

And from Equation (39),

$$A_{i1}X_1 + A_{i2}X_2 + \cdots + A_{in}X_n + y_i = X_i. \tag{41}$$

Using simple matrix notation, where A represents a matrix of technical coefficients, X is the vector of output, Y is the vector of final demand.

Therefore

$$AX + Y = X, \tag{42}$$

This can be rewritten as,

$$(I - A)X = Y. \tag{43}$$

Given I as the identity matrix, $(I - A)$ is the Leontief matrix.

Therefore Equation (43) can be written as,

$$X = (I - A)^{-1}Y, \tag{44}$$

The matrix $(1 - A)^{-1}$ is called the Leontief inverse matrix or the matrix of partial output multipliers.

The solution of the input-output model is therefore obtained from equation (44). Total output multipliers (OM) will be given by the column sums of B_{ij} and interpreted in Ghana cedis (GH¢).

where

$$B_{ij} = (I - A)^{-1}. \tag{45}$$

The output multipliers (OM) were therefore calculated as done in equation (46),

$$OM = \sum_i B_{ij}. \tag{46}$$

The total income multipliers (IM) also measured in Ghana cedis (GH¢) were given by,

$$IM = \sum_i \frac{v_i B_{ij}}{v_j}, \quad (47)$$

where $\boldsymbol{v}$ refers to the ratio of income from employment to total output of the industry. To the extent that the results of an input–output analysis with households exogenous tend to underestimate total effects, total or type II multipliers may be more useful than simple or type I multipliers in estimating potential impacts. However, if one is primarily interested in ranking or ordering the sectors, which sector has the largest multiplier, which has the next largest, and so on. If this study consider the input coefficients matrix closed with respect to households, this study captures in the model the additional induced effects of household income generation through payments for labor services and the associated consumer expenditures on goods produced by the various sectors.

4.3.12 Intersectoral linkages and interdependence

Intersectoral linkages describe the output and input relationships among the given sectors of production. These linkages were categorized into two: backward and forward linkages. Backward linkages describe how a given sector depends on other economic sectors for input supply. Forward linkages on the other hand refers to how a sector supplies its output to other sectors to be used as intermediate inputs of production. Linkages were calculate as follows,

Backward linkages,

$$\sum_i U_{wj} = \frac{\frac{1}{n}\sum_i w_i B_{ij}}{\frac{1}{n^2}\sum_{ij} w_i B_{ij}}. \quad (48)$$

Forward linkages,

$$\sum_i U_{wi} = \frac{\frac{1}{n}\sum_j w_j B_{ij}}{\frac{1}{n^2}\sum_{ij} w_j B_{ij}}. \quad (49)$$

with w being the chosen weight and B_{ij} being the elements of the Leontief inverse.

4.4 Method for Research Question 3: The Impact of the Oil Sector on Traditional Agriculture and Manufacturing as well as on the shadow economy of Ghana

The third research question which is also the last to be solved by this study seeks to assess the impact of the oil sector traditional agriculture and manufacturing. It investigates whether oil production and export has affected the performance of non-oil sectors negatively in terms of growth and export competitiveness. This aspect of the study also looks at how shadow economic activities have evolved over the years with emphasis on the period after oil production on commercial basis.

4.4.1 The Dutch Disease phenomenon

To assess the impact of the oil resource boom on traditional sectors such Agriculture and Manufacturing, the study sought to investigate the presence of the Dutch Disease phenomenon. The presence of the Dutch Disease is indicated by two effects: resource movement from non-oil sectors to the new oil sector and the spending effect which involves a sustained appreciation of the real effective exchange rate. The real effective exchange rate is the nominal effective exchange rate (a measure of the value of the Ghana cedi as against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

Growth performance, contributions to GDP and non-oil export earnings were also considered. The real effective exchange rate movement was assessed by using data from 1991 to 2013 to inspect whether there was a sustained increase over the years. The performance of traditional sectors was assessed using data from the Ghana Statistical Service.

4.4.2 The shadow economy of Ghana

With regards to the investigation of the impact of the new oil sector on the shadow economy of Ghana, the study employed the Multiple Indicators and Multiple Causes model (MIMIC). In the past, numerous approaches have been considered to estimate the underground economy. Out of many, the Currency

Demand approach (Ariyo and Bekoe, 2011; Faal, 2003) and the Multiple Indicators and Multiple Causes model (MIMIC) (Schneider and Enste, 2000; Schneider et al. 2009) were the most favoured.

4.4.2.1. The MIMIC model

The Multiple Indicators and Multiple Causes model (MIMIC) is a variant of the Simultaneous Equations Model (SEM). It has two parts: the structural equation model and the measurement model. The first component estimates the relationship between the causal variables and the latent variable, which represents the underground economy. The following equation (50) shows the relationship between individual causal variables and shadow economic activities in each specific country.

$$\eta_t = \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t} + \alpha_4 X_{4t} + \alpha_5 X_{5t} + \alpha_6 X_{6t} + \alpha_7 X_{7t} + \varepsilon_t. \qquad (50)$$

In the structural equation model (50), η_t is the latent variable (underground economy) and $\alpha_1, \alpha_2, \ldots, \alpha_7$ are the model coefficients. Symbols $X_1, X_2, \ldots, X_7$ denote exogenous causal regressors determining the size of the latent variable. The latent variable is directly unobserved, but estimated from the MIMIC model.

The measurement model on the other hand, estimates the impact of the underground economy on each indicator variable. It is given by equation (51).

$$y_t = \beta \eta_t + \varepsilon_t. \qquad (51)$$

where $y_t = (y_1, y_2 \ldots, y_n)$ is a $(1 \times n)$ vector of the indicator variables, β represents the regression coefficients and ε_t is a $(1 \times n)$ vector of errors satisfying white noise.

The MIMIC Index

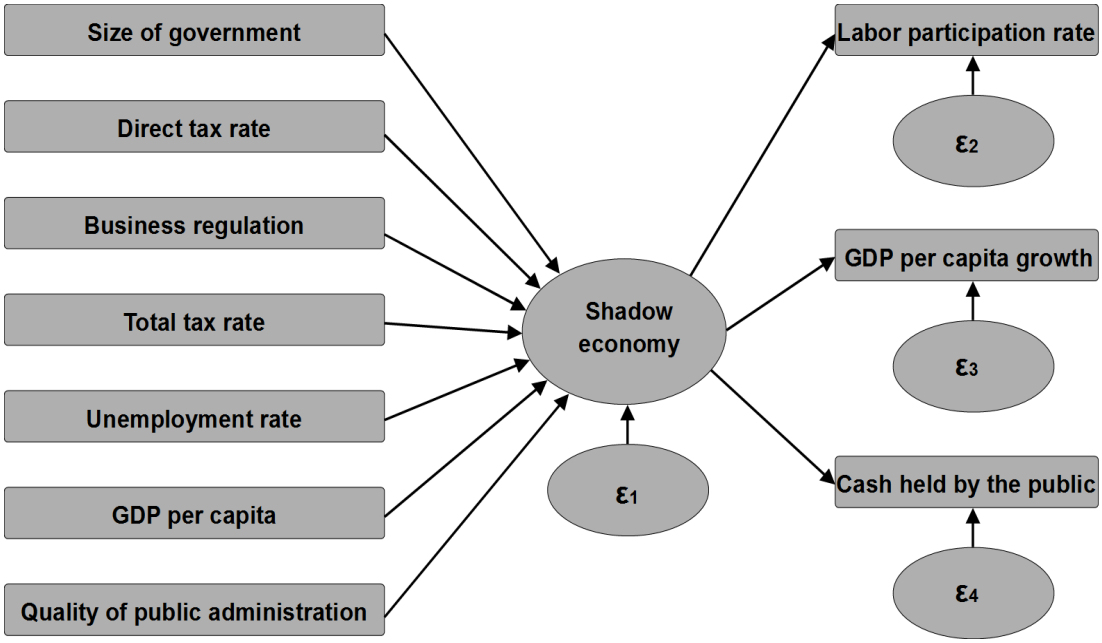
First, for each country, the MIMIC model is correctly specified and its parameters are subsequently estimated by the method of Maximum Likelihood (ML). The structure of the MIMIC model is illustrated in Fig. 8. The causal and indicator variables provided, may slightly differ among models for specific countries. During the diagnostic stage the analysts verified parameter significance ($\alpha = 0.10$) and ensured that the SEM model met the criteria of good fit (StataCorp, 2011). Later the parameter estimates were used to predict the latent

variable (underground economy) and to calculate the MIMIC index [%] from it (Schneider et al. 2009).

$$\hat{\eta}_t = 100 \frac{\tilde{\eta}_t}{\tilde{\eta}_{1990}} \eta^*_{1990} \tag{52}$$

In equation (52), $\hat{\eta}_t$ is the calculated MIMIC index at time *t*; it estimates the underground economy as a percentage of the official economy; $\tilde{\eta}_t$ is the estimated value of the latent variable at time *t;* $\tilde{\eta}_{1990}$ is the estimate of the underground economy in the base year 1990 and $\eta^*_{1990}$is the exogenous estimate of the underground economies in 1990. Exogenous underground economy is the exterior estimate, i.e. base value of the underground economies in 1990, derived for each country as the average size of the underground economy from several previous studies.

Figure 8 General structure of the MIMIC model



Source: Nchor and Adamec (2015)

5 RESULTS

This part of the study is divided into three sections based on the results obtained for the three research questions posed in the study. The first part discusses the results with regards to the impacts of oil price shocks on economic activities in Ghana taken from the research by Nchor et al. (2016). The second part discusses the results with regards to multiplier and linkages impact of the oil sector on other sectors of the economy taken from the work of Nchor and Konderla (2016). The third and last part discusses the results about the issue of the Dutch Disease phenomenon drawn from the works of Nchor et al. (2015) as well as Nchor et al. (2016) on the nature of the shadow economy of Ghana.

5.1 Oil Price Shocks and Economic Growth of Ghana

To assess the impact of oil price shocks on economic activities in Ghana, the study employed a Vector Error Correction Model after series of unit root and cointegration test. The model results were checked to make sure that they meet the necessary requirements for interpretation.

5.1.1 Unit root test

Stationarity test using the ADF test (Dickey and Fuller, 1979) was carried out for each variable, over the sample period 1984 to 2015. This sample period was considered because it had reliable data for both study variables: oil price and GDP. It has been evidenced from previous studies that majority of time series data are non-stationary at levels but stationary and integrated after first order differences (Engle and Granger, 1987). Stationarity in the data series therefore needed to be ascertained to avoid spurious results and to ensure that the variables fit into the estimation technique.

Both variables were transformed into logarithmic form to reduce the level of skewness in their distribution. It was also applied to make the patterns in the data more interpretable and for meeting the assumptions of inferential statistics. The results of the ADF test (see Tab.3) show that log of crude oil prices and log of GDP were both non-stationary at level but stationary after first order

differences. They were therefore integrated of order one, I(1) and a significance level, $\alpha = 0.05$ was used.

Table 3 Unit root test ADF

Variable	Level *P* value	FoD *P* value	Decision
Log oil price	0.58	<0.01	I(1)
Log GDP	0.63	<0.01	I(1)

MacKinnon approximate *P*-value for Z(t), FoD represents First Order Difference

5.1.2 Lag order selection criteria in VAR(*p*) model

Since both variables were integrated of order one, I(1), it was necessary to test whether they were cointegrated or not. An appropriate lag length was required to consistently carry out the cointegration test. Three criteria, Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC) and Hannan-Quinn Criterion (HQC) were applied in addition to the likelihood ratio (LR) test to determine the optimal lag length. From comparison of different criteria, lag of the order, 3 (see Tab. 4) was chosen. However, the lag length of a Vector Error Correction Model is one less than VAR hence lag of order, 2 was used in the VECM model in case the variables were found to be cointegrated.

Table 4 VAR lag length determination

Lag	LL	LR	df	*P* Value	FPE	AIC	HQIC	SBIC
0	-159.42				534.53	11.96	11.98	12.05*
1	-153.53	11.78	4	0.02	465.54	11.82	11.90	12.11
2	-147.62	11.81	4	0.02	406.97	11.67	11.82	12.16
3	-141.28	12.67*	4	0.01	347.71*	11.50*	11.70*	12.17
4	-138.89	4.80	4	0.31	402.91	11.62	11.88	12.49
5	-138.09	1.60	4	0.81	535.56	11.86	12.17	12.91

Where LL represents Log likelihood, LR represents Likelihood Ratio, *P* represents probability values, FPE represents Final Prediction Error. The asterisk (*) shows the chosen lag lengths based on the various criteria, df represents the degrees of freedom.

5.1.3 Johansen test of cointegration

Theoretical developments by Granger and Engle (1987) raised the possibility that two or more integrated, nonstationary time series might be cointegrated. In that case, a linear combination of these series could be stationary even though each series is not. If two series are both integrated of order one, I(1) their interrelationship could be modelled by taking first differences of each series and including the differences in a VAR. However, this approach would be suboptimal if it was determined that these series were indeed cointegrated. VAR would only express the short-run responses of these series to innovations in each series. This implies that the simple regression in first differences is misspecified.

A VAR in first differences, although properly specified in terms of covariance-stationary series, will not capture those long-run dynamics. See Tab.5 for results of the cointegration test. The null hypothesis of 0 cointegrating vectors was rejected in favor of $r > 0$ via the trace statistic. The null hypothesis of 1 cointegrating vector was not rejected. Thus, the study concluded that there was one cointegrating vector. See Tab. 5 for results of the test of cointegration and the number of cointegrating equations using Johansen test (1988). The results suggest the use of a VECM with one cointegrating vector and 2 lags of the first differences of the variables.

Table 5 Johansen tests for cointegration

Maximum rank	Parms	LL	Eigenvalue	Trace statistic	5% Critical value
0	14	-175.43		73.25	15.41
1	17	-140.29	0.91	2.97*	3.76
2	18	-138.81	0.09		

5.1.4 The estimated VECM output

The estimated parameters of the bivariate VECM with one cointegrating relationship are displayed in the tables below. The default output has three parts. Tab.6 provides information about the sample, the model fit and the identification of the parameters in the cointegrating equation.

Table 6 Model fit statistics

Equation	Parms	RMSE	R-square	χ^2	*P* value
Δ Log GDP	6	1.57	0.66	45.36	0.00
Δ Log oil price	6	11.19	0.65	42.38	0.00
Log likelihood	-152.13				
AIC	11.58				
HQIC	11.73				
BIC	12.06				

χ^2 is the Chi-square statistic, RMSE means Root Mean Square Error.

The main estimation results (see Tab.7) contains the estimates of the short-run and long-run parameters along with their standard errors and confidence intervals. In the Log GDP equation, the ECT_{t-1} term is the lagged error correction term in the model. It is significant and negative, representing the negative feedback necessary to restore equilibrium. It also confirms the existence of a long run relationship between GDP and oil prices. In the short-run, changes in oil prices affect GDP in this equation and short-run changes in GDP also affect GDP.

In the oil price equation, the lagged error correction term is negative and less than 1. In other words it adjusts to restore equilibrium within a year. Overall, the estimated output from the VECM model indicates that the model fits well. The coefficient of oil price in the cointegrating equation is statistically significant as are the adjustment parameters. The adjustment parameters which are the error correction terms in this bivariate VECM are easy to interpret and the estimates have the correct signs and imply rapid adjustment toward equilibrium. The estimate of the coefficient of the error term in the GDP equation is -0.38 (see Tab.7). Thus when GDP is out of equilibrium, 38% of this disequilibrium is restored yearly.

The coefficient of the error correction term in the oil price equation is negative and significant as it should be. This is necessary to correct for short run disequilibrium. It shows that 10% of the deviation from equilibrium is corrected annually.

Table 7 VECM output

Equation	Variable	Coefficient	z	*P* value
Δ Log GDP				
	ECT_{t-1}	-0.38(0.07)	-5.43	0.00***
	Δ Log GDP_{t-1}	0.63(0.20)	3.19	0.00***
	Δ Log GDP_{t-2}	0.25(0.19)	1.32	0.19
	Δ Log Oil $Price_{t-1}$	-0.14(0.03)	-4.67	0.00***
	Δ Log Oil $Price_{t-2}$	0.37(0.21)	1.81	0.07*
	Constant	-0.06(0.30)	-0.20	0.84
Δ Log Oil Price				
	ECT_{t-1}	-0.10(0.03)	-3.33	0.00***
	Δ Log GDP_{t-1}	0.01(2.16)	0.01	0.99
	Δ Log GDP_{t-2}	0.24(0.72)	0.34	0.74
	Δ Log Oil $Price_{t-1}$	0.14(0.06)	2.42	0.02**
	Δ Log Oil $Price_{t-2}$	0.17(0.03)	5.79	0.00***
	Constant	2.45(1.19)	2.06	0.04**

Standard errors in brackets, the index $t-1$ *and* $t-2$ show time lags, and (*), (**), (***) represent statistical significance at 10%, 5% and 1% levels respectively, Z is the Z statistic.

Tab. 8 reports the estimates of the parameters in the cointegrating equation, along with their standard errors. The results indicate strong support for a cointegrating equation. Identification of the parameters in the cointegrating equation is achieved by constraining the coefficient of the first differenced log GDP. It was normalized to 1.

Table 8 Johansen Normalization restriction imposed

Beta	Coefficient	Standard Error	z	*P* value
Δ Log GDP	1			
Δ Log oil price	0.54	0.11	5.15	0.00
Trend	-0.34	0.09	-3.81	0.00
Constant	-2.40			
		Cointegrating equation		
Equation	Parms	χ^2		*P* value
ECT	1	26.49		0.00

5.1.5 Granger causality test

The question that arose from the variables used in this model was whether or not crude oil prices could help to forecast GDP in Ghana and vice versa. From a realistic point of view, the study does not expect GDP in Ghana to granger-cause the international price of crude oil. Given *G* as log of GDP and *OP* for log oil prices, then Granger causality in the bivariate VECM model was given by,

$$\Delta G_t = \alpha_1 + \sum_{i=1}^{l} \beta_{1i}\, \Delta G_{t-1} + \sum_{i=1}^{m} \gamma_{1i}\, \Delta OP_{t-1} + \sum_{i=1}^{f} \theta_{1i} ECT_{f,t-1} + \varepsilon_{1t}, \qquad (53)$$

$$\Delta OP_t = \alpha_2 + \sum_{i=1}^{l} \beta_{2i}\, \Delta G_{t-1} + \sum_{i=1}^{m} \gamma_{2i}\, \Delta OP_{t-1} + \sum_{i=1}^{f} \theta_{2i}\, ECT_{f,t-1} + \varepsilon_{2t}. \qquad (54)$$

Δ is the first difference operator, ECT refers to the error correction terms derived from the long-run cointegrating relationship via the Johansen Maximum likelihood procedure and ε_{it} are serially uncorrelated random error terms with zero means. Granger causality (endogeneity of the dependent variable) can be tested either using the significance of θ estimates in the lagged ECT by jointly testing the significance of the sum of the coefficients of the lags of each explanatory variable (β and γ) or by a joint *F* or Wald Chi-square (χ^2) test. The non-significance of the above mentioned tests indicates the econometric exogeneity of the dependent variable in general.

Results for the test of granger causality can be seen in Tab. 9. The study tested for the significance of lags of log oil price on log of GDP in Ghana and the null hypothesis of no granger causality was rejected implying that oil price granger causes GDP in Ghana.

Coefficients of the lags of GDP were tested if they granger cause oil prices. The null hypothesis of no granger causality was not rejected. For the given time frame, a one-way causality is found. At a 5% level of significance, oil price shocks granger cause GDP in Ghana. At 5% significance level, GDP in Ghana does not granger cause oil price. This is understandable due to the fact that the international price of crude oil can influence GDP in Ghana but the vice versa is a highly unlikely situation.

Table 9 Granger causality test

Equation	Excluded	χ^2	*P* value
Δ Log GDP	Lags of Δ Log Oil Price	28.83	0.00
Δ Log oil price	Lags of Δ Log GDP	4.26	0.10

5.1.6 VECM diagnostic checks

Checks were carried out to investigate if the estimated model meets the conditions required for a standard VECM. These checks include: autocorrelation of residuals, normality in the distribution of residuals as well as the stability of the estimated VECM system. The results are shown below.

5.1.6.1. Autocorrelation

The test of autocorrelation of residuals in the VECM was carried out using Lagrange-multiplier test. The results showed that the model had no such problem. Both null and alternative hypothesis of the test are given below. The null hypothesis is rejected if the *P* value obtained from the test is less than 0.05. The *P* values from Tab. 10 show that the null hypothesis is not rejected.

H_0: There is no autocorrelation at the chosen lag orders

H_1: There is autocorrelation at the chosen lag orders

Table 10 Test for residual autocorrelation

Lag	χ^2	*P* value
1	3.80	0.43
2	4.91	0.30

5.1.6.2. Test for normality of residuals

The study carried output a test of normality of residuals of the estimated model using Jarque-Bera test. This test gives statistics for each equation and for all equations jointly against the null hypothesis of normality. For the individual equations, the null hypothesis is that the disturbance term in that equation has a univariate normal distribution. For both equations jointly, the null hypothesis is that the number of disturbances (*K)* come from a *K*-dimensional normal distribution. In case of the single equations, the null hypothesis of normally distributed residuals is not rejected. The joint test of both equations shows that the null hypothesis is also not rejected (see Tab. 11). Thus residuals are normally distributed.

$$H_0: \textit{Residuals are normally distributed}$$

$$H_1: \textit{Residuals are not normally distrubted}$$

Table 11 Normality test

Equation	χ^2	*P* value
Δ Log GDP	1.79	0.41
Δ Log oil price	2.15	0.34
All	5.37	0.25

5.1.6.3. VECM model stability

Interpretation of VECM requires that an even stricter stability condition be met. If the VECM is stable, impulse response functions (IRFs) and forecast-error variance decompositions have known interpretations. Lütkepohl (2005) and Hamilton (1994) both show that if the modulus of each eigenvalue is

strictly less than one, the estimated VECM is stable. The modulus of the Eigen values obtained show that the model is stable. See Tab. 12.

Table 12 VECM stability test

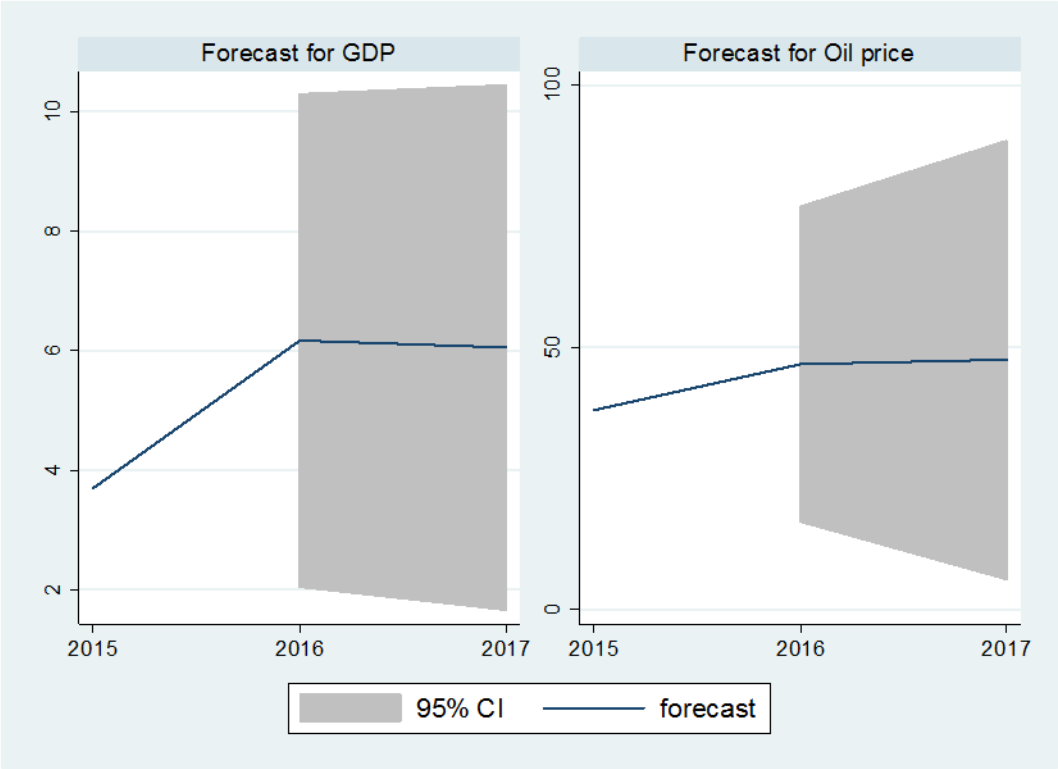
Eigenvalues			Modulus
1.00			1.00
-0.03	+	0.75i	0.75
-0.03	-	0.75i	0.75
-0.61			0.61

5.1.7 Forecast series of variables

Cointegrating VECMs are also used to produce forecasts of both the first-differenced variables and the levels of the variables (see Lütkepohl, 2005). Fig. 9 shows the results of the forecast from the VECM at a 95% confidence interval. The forecast is made for the next 2 years beyond 2015. Oil prices are slightly expected to rise from the slump in 2015 to about $47 per barrel by the end of 2016 and about $50 per barrel by the end of 2017. GDP is expected to grow by about 6% in 2016 and is expected to remain steady at this growth rate by 2017.

The projections on crude oil prices from this study were compared with forecasts by other institutions such as the World Bank, IMF and OECD. According to the World Bank (2016), oil price is projected to end 2016 at $41.0 per barrel and $50.0 per barrel at the end of 2017. According to IMF (2016), crude oil price is projected to end 2016 at $43.9 per barrel and $51.0 per barrel by the end of 2017. OECD (2016) forecasts oil price to end 2016 and 2017 at $50 per barrel. Since both supply and demand related factors underlying the recent decline in oil prices are expected to persist for some time, oil prices are likely to remain low but volatile, with a gradual recovery over the next decade.

Figure 9 Forecasting (VECM model, confidence interval 95%)



Source: Author's work

5.1.8 Impulse Response Functions (IRFs)

Impulse response functions (see Fig. 10) show the effects of shocks on the adjustment path of the variables used in the model (Crude oil prices and GDP). The graphs indicate that a one standard error shock to GDP in Ghana has no significant effect on the international price of crude oil. This is explained by the fact that, Ghana's oil-GDP forms a negligible part of the oil-GDP of the world hence fluctuations in GDP in Ghana has no determining influence on crude oil price. A shock to GDP in Ghana has a positive and transitory effect on GDP in Ghana. GDP reacts positively in the short-run and dies off subsequently. A shock to crude oil prices has no initial effect on GDP in Ghana. The effect is felt after the first year and it is transitory and negative. The negative effect is observed in the first two years and by the third year it turns positive as it tails off.

The effect of an increase in crude oil prices on economic activities can be looked at from two different perspectives. The first is the case where Ghana

is an exporter of crude oil. In this case, a price increase is a boost to the economy as export earnings increase leading to increased fiscal stance of government.

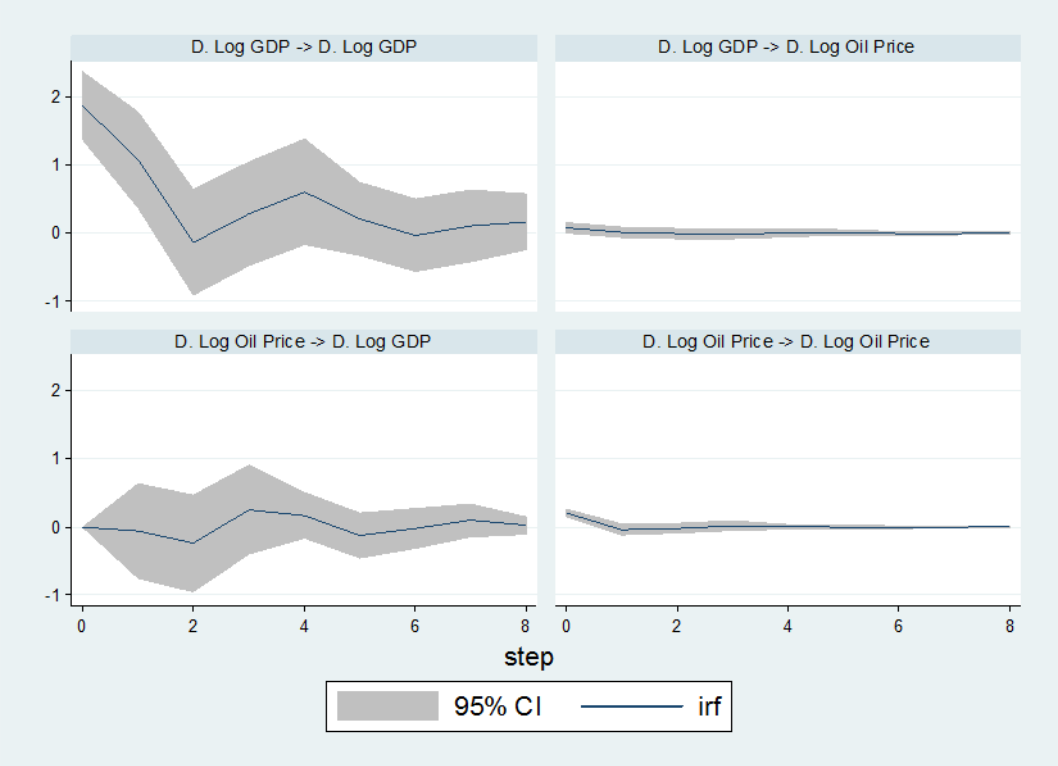
The effect can also be looked at from the perspective of a net oil importer of crude oil. It must be noted that though Ghana exports crude oil, the country imports huge quantities of crude oil products. In this case an increase in the price of crude oil means more expenditure on oil imports. The net effect on the country will therefore be predictably negative.

Ghana was a net crude oil importer before oil discovery and production and still remains a net importer even after oil production. In this case, the effect of crude oil price developments are expected to follow a similar pattern except for the role of export earnings and oil revenue management which will help reduce the negative effect of crude oil price increments.

In line with the results of this study, several studies have also established a negative relationship between crude oil price shocks and economic activities. For example, Jiménez-Rodríguez and Sánchez (2005) in their study found the relationship between crude oil price shocks and GDP growth to be negative in France, Italy, Norway and Canada. Studies by Papapetrou (2001), Berument and Tasci (2002), Lardic and Mignon (2006) and Zhang (2008) also showed that, there is a degree of negative correlation between oil prices and economic activity.

Contrary to the results of this study, Berument, Ceylan and Dogan (2010) examined how oil price shocks affect output growth in some net-exporting and net-importing countries in the Middle Eastern and North African (MENA) region. They suggest that oil price shocks have a significantly positive effect on the GDP of Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria and United Arab Emirates.

Figure 10 Impulse Response Functions (95% confidence interval)



Source: Author's work

5.2 Economic Multipliers and Sectoral Linkages

This section discusses the results of the impact of the new oil sector on output and income multipliers as well as forward and backward linkages in the economy. The content of the output displayed in both tables represent the partial output multipliers which are defined as the amount of output required from other sectors or industries for every given unit change in production.

The numbers from 1 to 12 or from 1 to 13 represent the respective sectors of production: Agriculture (1), Mining (2), Manufacturing (3), Electricity and water (4), Construction (5), Distribution and catering (6), Transport and communication (7), Business and finance (8), Public administration (9), Education and health (10), Other services (11). The household sector is represented by 12 or 13 depending on the number of sectors in each table. In a 12 sector table such as Tab. 13, household is represented by 12. In a 13 sector table such as Tab. 14, household is represented by 13 and the oil sector is represented by the number, 12.

5.2.1 Leontief Inverse Matrix

The Leontief inverse matrix shows the estimated values of the partial output multipliers. Partial output multipliers (see Tab. 13 and 14) measure the amount of output required of each sector to produce the goods and services of another sector due to a change in final demand. These were derived from equation (44) and represent the matrix $(I - A)^{-1}$.

Table 13 Leontief inverse matrix before oil production

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.87	0.12	0.48	0.07	0.11	0.23	0.13	0.08	0.11	0.20	0.11	0.58
2	0.02	1.64	0.17	0.06	0.05	0.03	0.03	0.01	0.02	0.03	0.02	0.07
3	0.20	0.43	2.19	0.27	0.46	0.32	0.41	0.17	0.19	0.36	0.21	0.89
4	0.01	0.05	0.03	1.61	0.01	0.02	0.01	0.02	0.03	0.03	0.03	0.06
5	0.00	0.01	0.01	0.08	1.58	0.00	0.01	0.01	0.02	0.01	0.01	0.03
6	0.02	0.08	0.05	0.03	0.02	1.77	0.06	0.06	0.09	0.10	0.05	0.27
7	0.02	0.05	0.03	0.02	0.01	0.08	1.57	0.07	0.08	0.10	0.06	0.27
8	0.01	0.25	0.06	0.03	0.02	0.05	0.07	1.50	0.05	0.04	0.04	0.08
9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	1.38	0.02	0.01	0.06
10	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.03	1.30	0.28	0.08
11	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	1.01	0.09
12	0.02	0.07	0.05	0.04	0.03	0.05	0.11	0.11	0.19	0.34	0.16	1.08

Tab. 13 shows the results without the oil sector and Tab. 14 shows the results with the inclusion of the oil sector. The values in each table represent the partial output multipliers. A decline in values is observed from Tab. 13 to Tab. 14. The drop in partial output multipliers is in line with the findings of Rayner and Bishop (2013) who concluded that spillover effect of natural resource sectors is large and negative on other sectors.

Table 14 Leontief inverse matrix after oil production

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.74	0.02	0.22	0.02	0.02	0.11	0.03	0.02	0.03	0.06	0.04	0.07	0.23
2	0.01	1.26	0.07	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.01
3	0.12	0.13	1.59	0.12	0.16	0.13	0.15	0.05	0.05	0.11	0.09	0.36	0.31
4	0.01	0.02	0.02	1.32	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.15	0.02
5	0.00	0.04	0.04	0.12	1.29	0.01	0.01	0.01	0.01	0.01	0.01	0.85	0.02
6	0.01	0.02	0.01	0.01	0.00	1.46	0.02	0.02	0.03	0.03	0.02	0.01	0.11
7	0.01	0.01	0.01	0.01	0.00	0.04	1.30	0.03	0.03	0.03	0.03	0.01	0.11
8	0.01	0.09	0.02	0.01	0.00	0.02	0.03	1.30	0.02	0.01	0.03	0.01	0.03
9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.23	0.01	0.00	0.00	0.03
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.20	0.25	0.00	0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.01	0.00	0.04
12	0.00	0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.01
13	0.01	0.03	0.03	0.03	0.01	0.02	0.05	0.07	0.11	0.22	0.13	0.10	1.03

5.2.2 Income and Output Multipliers

The total output and income multipliers were then calculated from equations (46) and (47) respectively. Output multipliers for a particular sector are defined as the total of all outputs from each domestic sector required in order to produce one additional Ghana cedi of output. The income multipliers show the increase in income from employment or compensation of employees that result from a change of one Ghana cedi of income from employment in each sector. These were derived in equation (9). The results were compared for the two scenarios; before and after the new oil sector. See Tab. 15 and Tab. 16.

Table 15 Output and Income Multipliers before oil production

Sector	Output multipliers	Income multipliers
Agriculture	2.17	4.02
Mining	2.71	3.27
Manufacturing	3.08	3.11
Electricity and water	2.22	2.40
Construction	2.31	2.68
Distribution and catering	2.57	2.86
Transport and communication	2.43	1.90
Business and finance	2.08	1.69
Public administration	2.20	1.57
Education, health and social works	2.56	1.39
Other community services	1.99	1.74
Households	3.55	0.82

The results from Tab. 15 show that households had the highest output multipliers. Manufacturing has the second highest. The sector with the least output multiplier before oil production is the other community social services. It must be mentioned that the economy of Ghana is agrarian and thus expected to have a high output multiplier for Agriculture. Most households are employed in agriculture. The multiplier value of agriculture is affected by the households' participation as a sector of production.

It can however be observed that with regards to income, the agricultural sector has the highest multiplier effect. Households have the least income multiplier which applies in the explanation provided above. Mining and manufacturing also have high income multipliers.

Tab. 16 shows the results for both income and output multipliers after oil production. The oil sector is seen to have the highest output multiplier of 2.67. It is followed by manufacturing before households and agriculture.

The agriculture sector however still maintains its highest income multiplier effect though the value is lower than the period without oil production.

The income multipliers of most sectors also declined. Such declining performance in non-oil related sectors are typical of countries that fail to ensure balanced sectoral development. This trend was observed by Ciarreta and Nasirov (2012) in their study of the oil sector of Azerbaijan.

Table 16 Output and Income multipliers after oil production

Sectors	Output multipliers	Income multipliers
Agriculture	1.93	3.00
Mining	1.68	1.80
Manufacturing	2.06	1.95
Electricity and water	1.78	1.71
Construction	1.52	1.62
Distribution and catering	1.82	1.92
Transport and communication	1.61	1.42
Business and finance	1.52	1.37
Public administration	1.53	1.30
Education, health and social works	1.70	1.23
Other community services	1.64	1.62
Oil and gas	2.67	1.68
Households	1.98	0.35

5.2.3 Backward and forward linkages

The results of linkages (see Tab. 17 and 18) calculated from equations (48) and (49) show that the manufacturing sector had the highest forward linkages excluding the oil sector, followed by agriculture and distribution and catering. It is also observed that agriculture sector had a very weak backward linkage, which is explained by its low requirement of inputs from other sectors for production. All other sectors within the economy had higher backward linkages than forward linkages.

There is however the need for higher backward linkages among the sectors to expand production in each sector. The development of agro-industries will have many beneficial feedback effects on agriculture. Though mining has a high contribution to GDP in Ghana, its forward linkage with other sectors in the economy is very low. This conclusion is in line with the findings of Stilwel et al. (2000) in the South African economy.

Table 17 Linkages before oil production

Sectors	Backward Linkage	Forward Linkage
Agriculture	0.87	1.64
Mining	1.09	0.86
Manufacturing	1.24	2.46
Electricity and water	0.89	0.77
Construction	0.93	0.71
Distribution and catering	1.03	1.04
Transport and communication	0.98	0.95
Business and finance	0.83	0.89
Public administration	0.88	0.61
Education, health and social works	1.03	0.69
Other community services	0.80	0.47
Households	1.43	0.91

It is also observed that the construction, distribution and catering as well as transport and communication sectors had changes in both backward and forward linkages after the commercial production of oil. The construction sector had more oil sector inclusive forward linkages than backward linkages. Distribution and catering had more backward linkages with the inclusion of the new sector. The forward linkages of transport and communication improved and were higher than its backward linkages. Though the mining sector has high total output in the economy, its linkage with other sectors is very low and this is

similar to the results from Sabiroglu and Bashirli (2012). See Tab. 17 and Tab. 18.

The results of most input-output models are similar and reflect similar assumptions. Results based on general joint-product models as was inspired by Miller and Blair (2009) of the Supply and Use tables is recommended as the way out of any inconsistencies.

Table 18 Linkages after oil production

Sectors	Backward Linkage	Forward Linkage
Agriculture	1.07	1.44
Mining	0.93	0.82
Manufacturing	1.14	1.87
Electricity and water	0.99	0.89
Construction	0.85	1.34
Distribution and catering	1.01	0.99
Transport and communication	0.89	0.90
Business and finance	0.84	0.88
Public administration	0.85	0.71
Education, health and social works	0.94	0.84
Other community services	0.91	0.60
Oil and gas	1.48	0.70
Households	1.10	1.02

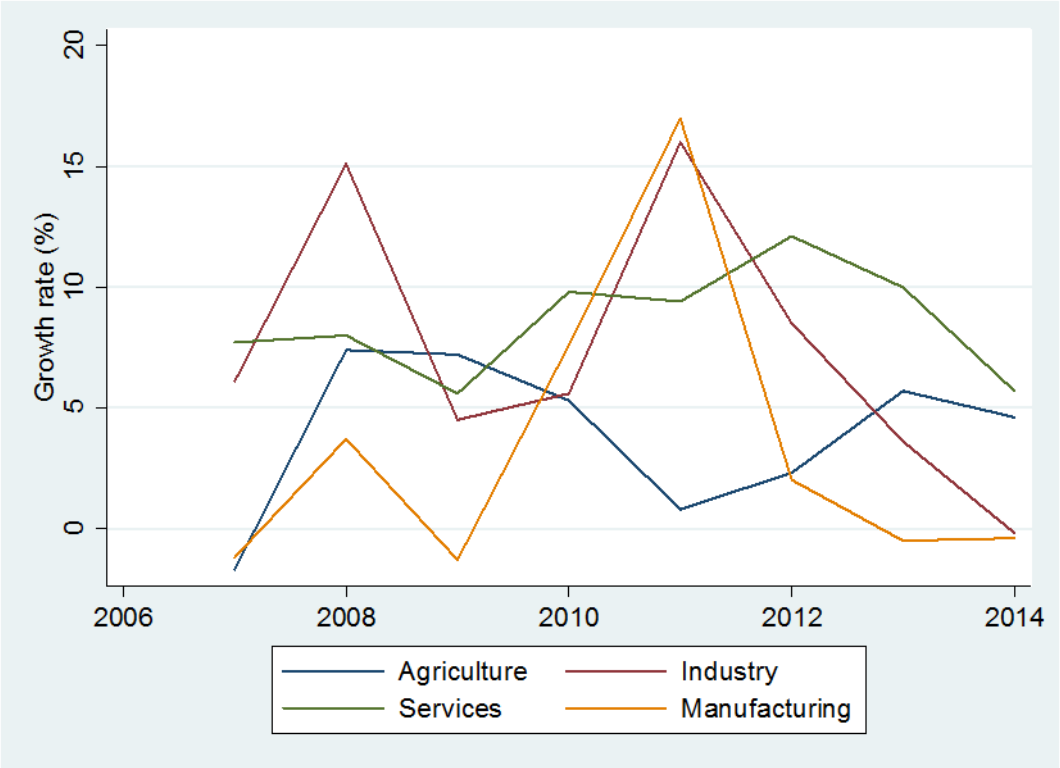
5.3 The Oil sector, the Dutch Disease and the Shadow Economy of Ghana

This part of the study shows the results of the impact of the new oil sector on other sectors of production. It also looks at the development in shadow economic activities before and after the production of crude oil.

5.3.1 Sectoral growth performance

The growth performance of Agriculture, Industry, Services and Manufacturing sectors before and after oil production are illustrated in Fig. 11.

Figure 11 Growth rate of sectors



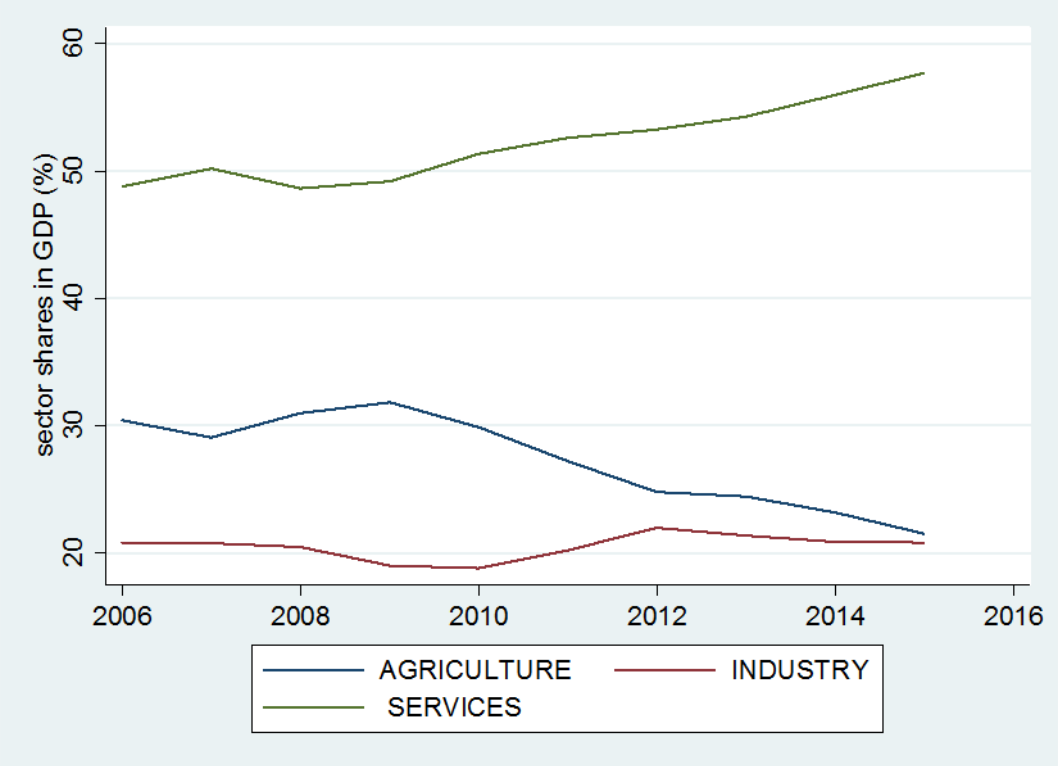
Source: Ghana Statistical Service

It shows the performance of those three areas in the economy before and after commercial production of crude oil. It covers the period from 2006 to 2014. The industrial and manufacturing sectors reacted significantly to the new oil sector with increased output growth in 2011. The shock increase in output growth however drastically declined and has since been reducing. The movements in Agriculture and Services are random and fluctuate. There is no clear indication of a dip or a continuous increase as a result of the new oil sector. Ghana underwent three years of chronic energy crises. This affected the production activities of most sectors since constant, reliable and affordable energy could not be guaranteed for production. It will therefore be challenging to associate any decline in sectoral performance to the introduction of the new oil sector.

5.3.2 Sectoral contribution to GDP in Ghana

The contributions of the traditional sectors to GDP were observed over a period. The results (see Fig.12 and 13) show that the services sector contributes the highest to GDP even before the oil production and still maintains that position after oil production. Fig. 12 shows contributions of non-oil GDP and Fig. 13 shows the share of each sector to oil-GDP. For non-oil GDP, the contributions of the industrial sector and the services sectors were rising. That implies that when the effect of the oil sector is excluded, the shares of both services and the industrial sectors were rising. Agriculture was however declining.

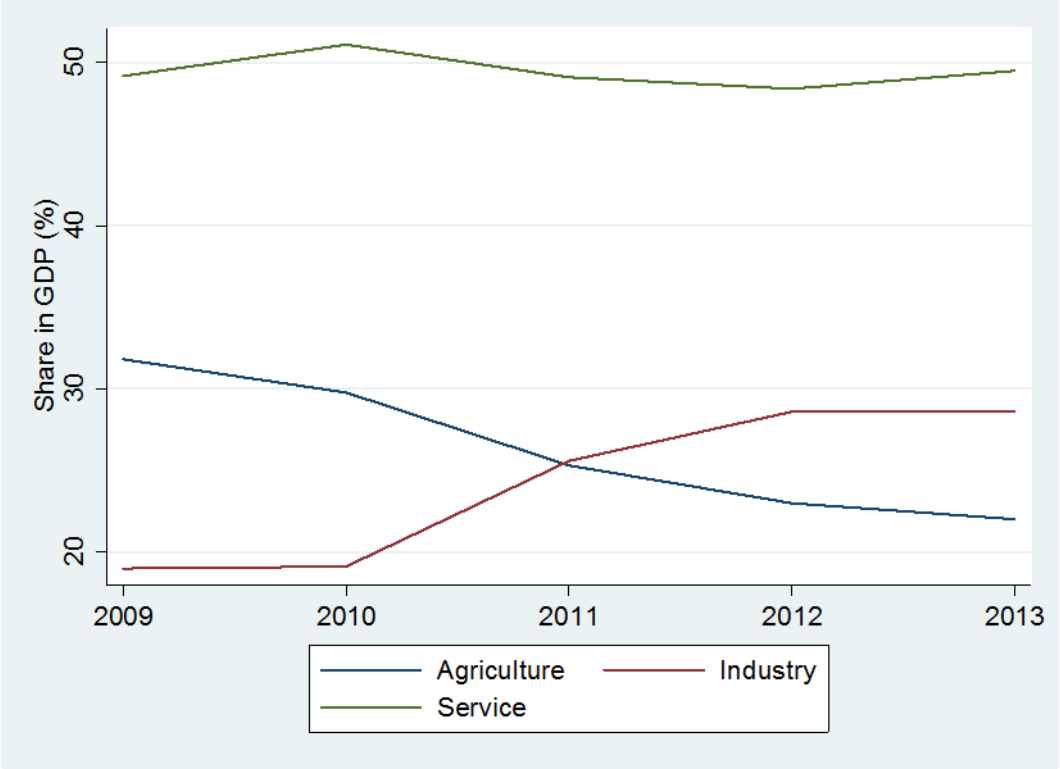
Figure 12 Contribution to Gross Domestic Product (Non-Oil Output)



Source: Ghana Statistical Service

Fig. 13 shows the effect of the oil sector in the overall contribution of sectors to GDP. It is observed that the inclusion of the oil sector leads to a rise in the share of the industrial sector above that of agriculture. The agricultural sector witnessed a decline in its share starting from 2010. At the same period, the industrial sector where the new oil sector is categorized experienced a rise in its share as it now overtakes the agricultural sector

Figure 13 Sector shares in GDP (including the Oil sector) in Ghana

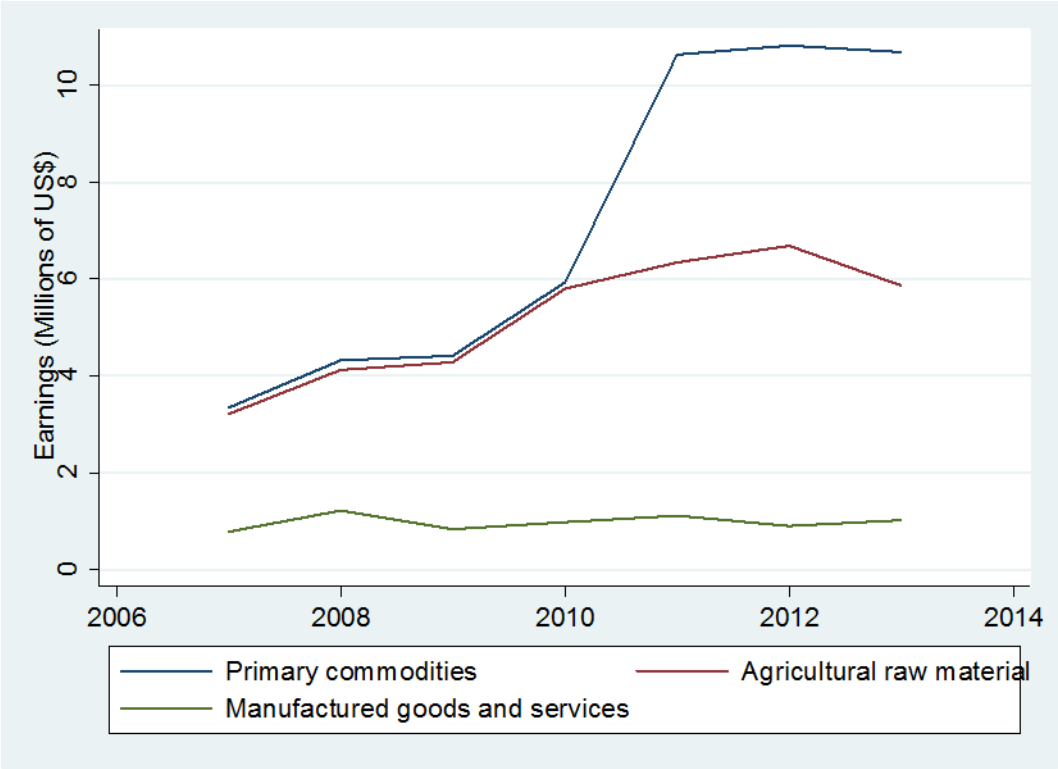


Source: Ghana Statistical Service

5.3.3 Non-oil export earning

Given the idea of a possible appreciation of the real exchange rate due to increased oil exports and the spending effect, it was imperative to find out the effect of oil exports on the earnings of non-oil sectors. Declining non-oil sector export earnings was an indication that the Dutch Disease phenomenon is operational. The study thus attempted to illustrate graphically non-oil export earnings over the years (See Fig. 14). It represents yearly earnings in millions of dollars of Agricultural raw materials, manufactured items as well as primary commodities. There is no clear case of declining export earnings for all the cases mentioned except a slight dip in Agricultural raw materials.

Figure 14 Non-oil export earnings

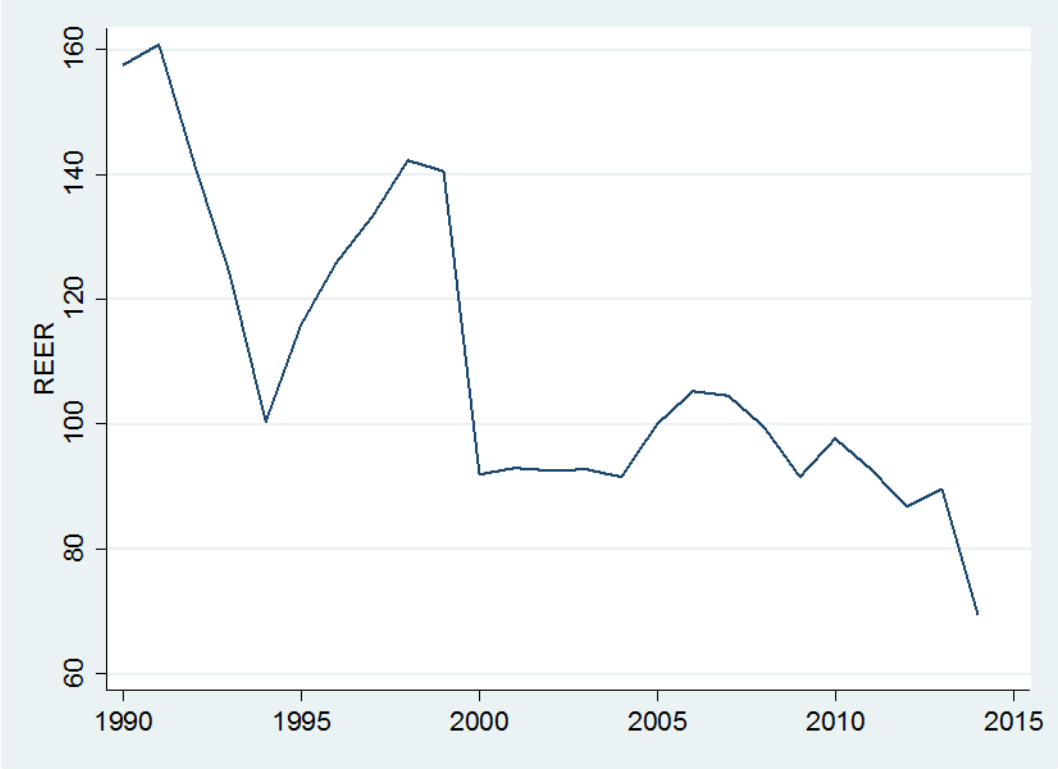


Source: UNCTAD

5.3.4 The real effective exchange rate in Ghana

As mentioned in the previous text, the presence of the Dutch Disease phenomenon is indicated by a sustained appreciation of the real effective exchange rate which in turn affects the earnings of non-oil sector exports. The results (See Fig. 15) show that the real effective exchange rate in Ghana has been depreciating over the years which is contrary to what is required to cause the Dutch Disease phenomenon.

Figure 15 The real effective exchange rate



Source: World Development Indicators

5.3.5 The prolonged energy crises: a genuine reason for declines in sectoral performances.

Ghana has experienced years of severe energy crises which comprise deplorable state of electricity provision to both homes and industries. The situation was so bad to the extent that businesses had to resort to the use of alternative means which were more expensive. Several of such businesses also laid off staff in a bid to reduce the cost of production while others experienced drastic declines in their output levels.

The major challenges confronting the Energy sector can be summed up in the growing demand and supply inadequacy and unreliability. The dependence on gas supply from Nigeria, low water levels at the Akosombo Dam and others serve to only emphasize the situation. According to the Ghana Statistical Service, real GDP growth rate for 2014 was 4.2%, compared to 7.3 percent recorded in 2013. The decrease in the rate of growth in 2014 was broadly attributed to energy supply constraints and rising input costs that reduced economic activity.

Inadequate power supply makes Ghana lose an estimated 2-6% of GDP annually. Inadequate and unreliable power supply increases the cost of doing business as businesses including those in the SME sector such as welders, tailors and seamstresses, restaurants and chop bars, and guest houses and motels are forced to use expensive alternative fuel options such as buying diesel and petrol to run and service generators sets.

It will therefore be ambiguous to associate any declines in the performance of sectors of production to the introduction of the new oil sector. The symptoms of the Dutch Disease phenomenon and the observed declines in sectoral output and income multipliers can also be attributed to the prolonged energy crises which even worsened over the last three years.

5.3.6 The impact of the oil sector on the shadow economy of Ghana

A summary of the detailed Structural Equation model results for Ghana and Nigeria are seen in Tab. 19. The results show only the model's significant coefficients and *z* statistics. Though some of the causal factors of shadow economic activities are common to both countries, others differ. Ghana's underground economy is caused by the size of government, the unemployment rate, direct taxes and total taxes. In Nigeria, it is caused by the size of government, unemployment, quality of public services, business regulation and total taxes.

A percentage point increase in the size of government causes an increase in the underground economies in Nigeria by 0.05% but decreases the underground economies in Ghana by 0.31%. A percentage point increase in the rate of unemployment causes underground economic activities in Ghana to increase by 0.17% and Nigeria by 0.04%. A dollar increase in GDP per capita only increases underground economic activities.

The quality of public sector services and business regulation are only statistically significant in Nigeria. A unit improvement in the quality of public services leads to 0.81% decrease in underground economic activities and a unit intensification of the business regulatory environment leads to more underground economic activities by 0.39%.

Table 19 MIMIC model equations, estimate, z-statistics in parenthesis

STRUCTURAL PART	Ghana	Nigeria
Underground economy		
Size of government	-0.31(-2.41)	0.05(2.82)
Unemployment rate	0.17(3.38)	0.04(4.40)
Direct tax rate	0.21(3.22)	
GDP per capita		
Deposit Interest rate		
Quality of public service		-0.81(-4.14)
Business regulation		0.39(2.12)
Total Taxes	0.40(3.34)	0.20(2.33)
MEASUREMENT PART		
Labor force participation		
Underground economy	1(constrained)	1 (constrained)
Constant	64.33(14.49)	49.03(15.81)
Size of government		
Unemployment	-0.10(-2.57)	
Money ratio		
Underground economy		
Constant		
Deposit interest rate		
GDP per capita growth		
Underground economy		-16.96 (-2.34)
Constant		129.8 (1.76)
Unemployment rate		

Only results for significant coefficients are displayed in Tab. 19.

Total taxes affect shadow economic activities in both Ghana and Nigeria. A percentage point increase in the total tax rate leads to growth in underground economic activities by 0.40% in Ghana and 0.20% in Nigeria. Direct taxes are only statistically significant as a cause of shadow economic activities in Ghana. Underground economic activities increase by 0.21% for every percentage point increase in direct tax rate (see Tab.19 for the results).

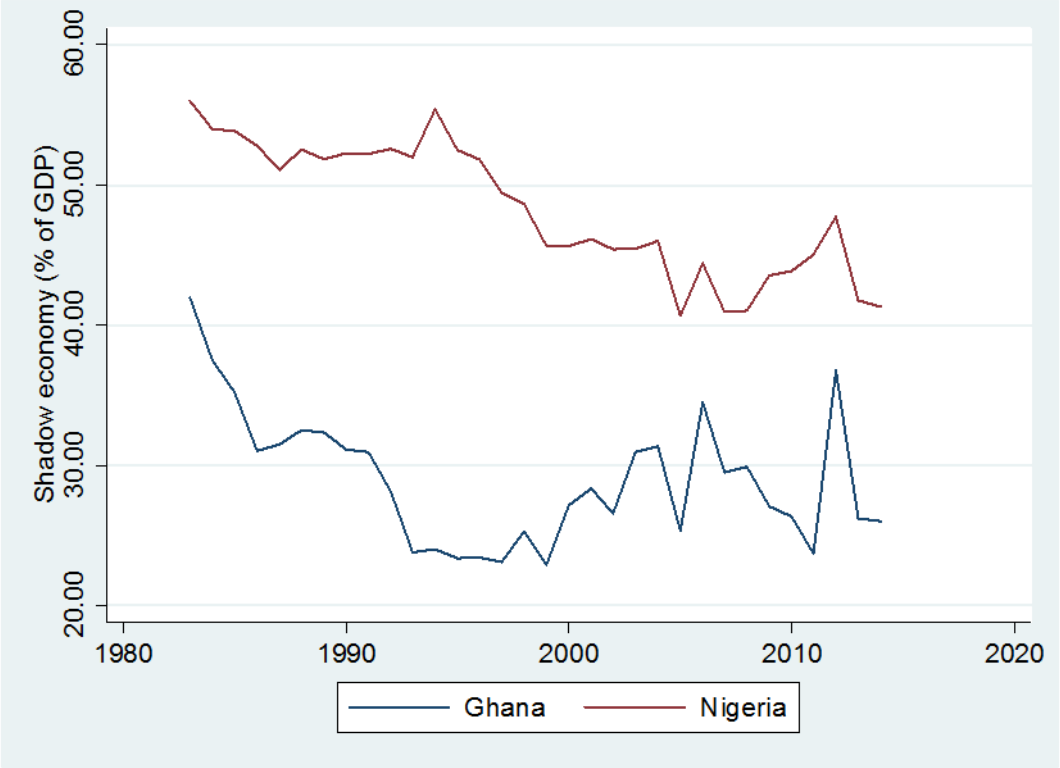
The study carried out model quality checks using the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR) and the Coefficient of Determination or the overall R-square. Pclose indicator provides the probability that, RMSEA ≤ 0.05. The results (see Tab.20) show that, the model satisfies the goodness of fit statistics. See Hu and Bentler (1999), Kenny, Kaniskan and McCoach (2014), MacCallum, Browne and Sugawara (1996) for further readings on simultaneous equation model fit indices.

Table 20 Quality of fit indicators for the estimated MIMIC models

Country	RMSEA	Pclose	CFI	SRMR	Overall R^2
Ghana	<0.01	0.55	1.00	0.02	0.88
Nigeria	<0.01	0.75	1.00	0.03	0.90

The study finds that the underground economy in Ghana shows a steady decline from 1990 to 2000 (see Fig. 16). The period beyond 2011 saw an increase in underground economic activities which could largely be attributed to the new oil sector activities. By 2012, underground economic activities in Ghana were about 37% of official GDP. Nigeria has a relatively high percentage of underground economic activities but generally declining over the last decades. Their economy reacted to the global economic crises in 2007 with a rise in such activities. As at the end of 2012, Nigeria's underground economy stood at 48% of official GDP.

Figure 16 Trend in the shadow economy of Ghana in comparison with Nigeria



Source: Author's work

6 DISCUSSION

This segment of the dissertation compares the results generated for the different research questions with the results from existing literature. This is done in three stages: the first part discusses the impact of oil price shocks on economic growth in Ghana. The second part compares the results of this study on sectoral multipliers and linkages with literature on natural resource sectors and the linkages effects on their respective economies. The last but not the least part compares the analysis on the Dutch Disease situation in Ghana with several other oil producing countries. It also compares the impact of the new oil sector on underground economic activities in Ghana with similar situations in other natural resource rich countries.

6.1 Do Shocks in Oil Prices Affect Economic Activities in Ghana?

Ghana was a net crude oil importer before oil discovery and production and still remains a net importer even after oil production. In this case, the effect of crude oil price developments are expected to follow a similar pattern except for the role of export earnings and oil revenue management which will help reduce the negative effect of crude oil price developments.

The findings from this study (see Fig. 10) show that shocks to crude oil prices affect GDP growth in Ghana. A one standard error shock to GDP in Ghana has no significant effect on the international price of crude oil. This is explained by the fact that, Ghana's oil-GDP forms a negligible part of the oil-GDP of the world hence fluctuations in GDP in Ghana has no determining influence on crude oil price. A shock to GDP in Ghana has a positive and transitory effect on GDP in Ghana. GDP reacts positively in the short-run and dies off subsequently. A shock to crude oil prices has no initial effect on GDP in Ghana. The impact is seen after one year. It is transitory and negative but becomes positive by the third year as it tails off.

Several reasons account for the initial negative relationship between crude oil prices and oil price shocks in Ghana. The first reason is that, Ghana is a net crude oil importer hence the impact of rising oil prices will be negative

though mitigated by export proceeds from the commodity. An exogenous increase in the real price of imported crude oil from the point of view of Ghana being an oil-importing economy is a terms-of-trade shock. Such terms-of-trade shocks matter through their effects on production decisions (see, e.g., Backus and Crucini, 2000). Crude oil and its related products serve as intermediate inputs in the production of goods and services of industries in Ghana. Thus rising crude oil prices means rising input cost of production which dampens economic activity.

The second reason for the negative relationship is that, some firms perceive crude oil price shocks as shocks to the demand for their products rather than shocks to the cost of producing their products hence tend to reduce production accordingly (see Lee and Ni, 2002).

The third reason is through discretionary income effect on crude oil consumers. In cases of oil price increases, there is a disruption in consumers' and firms' spending on goods and services other than energy products. This affects aggregate demand and dampens economic activity.

The fourth reason why changing oil prices also affect economic activity negatively in Ghana is through the uncertainty that it creates about future crude oil prices. Consumers of irreversible purchases of energy using consumer durables tend to postpone spending. Even when decisions are reversible, consumption might fall in response to crude oil price shocks, as consumers increase precautionary savings. This is because they foresee a greater likelihood of future income losses. Crude oil price increases could also negatively affect the economy due to the fact that, consumption of durables that are complementary in use with crude oil products will tend to decline even more.

The fifth reason why rising oil prices affect the Ghanaian economy negatively is that, after oil discovery and commercial production, banks discovered Ghana as a likely prospect for making loans. This is because high oil prices made the country credit-worthy. These loans if not used in productive ventures rather than financing higher imports and higher domestic consumption could lead to overall negative developments in the economy.

It is worth mentioning that, though this study establishes an impact of crude oil price shocks on economic activity, the size of the impact is small and

could possibly be indirect. This is because imported crude oil enters the production process of domestic gross output but not the production function of value added (see, e.g. Rotemberg and Woodford, 1996). Thus oil price shocks affect value added but indirectly by changing domestic capital and labor inputs. Viewing oil price shocks from the perspective of cost shocks for an oil importing country like Ghana therefore means that their effect cannot be very large such as observed in this study (See Fig. 10).

The small impact of oil price shocks could however be in the short-run and could be attributed to the presence of the Ghana Stabilization Fund. This Fund consists of savings from windfall profits coming from oil price increases. Thus in the case of low crude oil prices such as seen in 2014 and 2015, the country can rely on such windfall savings and investments to reduce the impact on her fiscal stance.

The negative impact of crude oil price shocks on economic activities in Ghana can also be minimized through improved monetary policies, diversification of energy sources etc. According to Blanchard and Gali (2008) the dynamic effect of oil shocks has decreased considerably over time and this is attributed to a combination of factors such as improvements in monetary policy, more flexible labor markets and smaller share of oil in production (see also Bernanke et al. 1997; Balke et al. 2002; Hamilton and Herrera, 2004; Kilian and Lewis, 2011).

The study employed a linear approach to establish the relationship between oil price shocks and GDP because while asymmetric models of oil price shocks have become common over the last few decades as seen in the studies of Kilian and Vigfusson (2011), Herrera, Lagalo and Wada (2011), these studies were unable to prove statistically significant asymmetry in the response of U.S. real output to oil price shocks.

The results from this study were compared with that of other researchers who also established a negative relationship between crude oil price shocks and economic activities. For example, Jiménez-Rodríguez and Sánchez (2005) found the relationship between positive crude oil price shocks and GDP growth to be negative in France, Italy, Norway and Canada.

Studies by Papapetrou (2001), Berument and Tasci (2002), Lardic and Mignon (2006) and Zhang (2008) also showed that, there is a degree of negative correlation between positive oil price shocks and economic activity. Cologni and Manera (2009) using a Markov-switching analysis for the G-7 countries show that positive oil price changes tend to have a greater impact on output growth.

Rentschler (2013) examined the significance of oil price volatility in a number of countries, including developed, developing, importing and exporting countries and concludes that an increase in oil price volatility can have negative consequences for the economies of both oil exporting and importing countries.

Peersman and Van Robays (2012) distinguishing between different sources of oil price shocks, find in their study that a 25 percent decrease in oil prices due to increased oil supply will reduce GDP in Norway by 0.8 percent. They emphasized that the decrease in oil price must however be persistent. The result here is highly dependent on whether the country is a net crude oil importer like Ghana or a net oil-exporter.

This study proceeded to make forecasts of future crude oil prices (Brent) and GDP growth in Ghana and made comparisons with forecasts figures of prominent institutions such as the World Bank and the International Monetary Fund. This study forecasts (see Fig. 9) a rise in oil price slightly from the slump in 2015 to about $47 per barrel by the end of 2016 and about $50 per barrel by the end of 2017. Due to the expected improvement in the prices of crude oil, this study also predicts an expected growth in GDP by about 6% in 2016. This growth rate is expected to remain steady till the end of 2017.

The projections on crude oil prices from this study were compared with forecasts by other institutions such as the World Bank, IMF and OECD. According to the World Bank (2016), oil price is projected to end the year 2016 at $41.0 per barrel and $50.0 per barrel at the end of the year 2017. According to IMF (2016), crude oil price is projected to end 2016 at $43.9 per barrel and $51.0 per barrel by the end of 2017. OECD (2016) forecasts oil price to end both 2016 and 2017 at $50 per barrel.

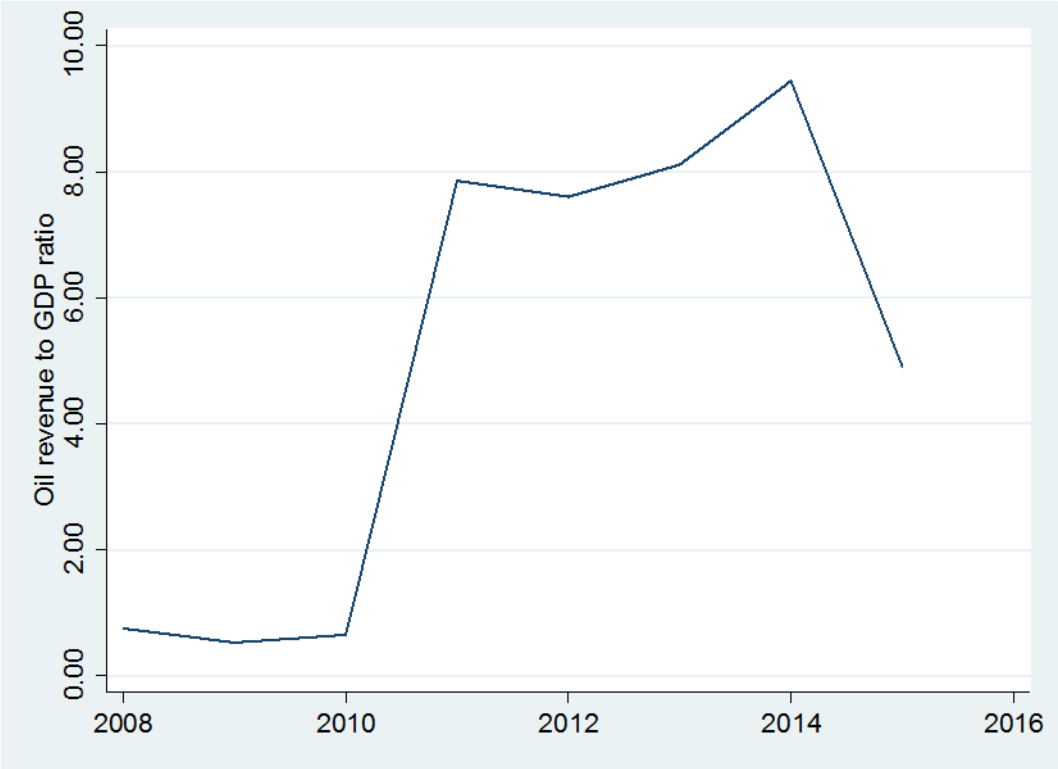
Looking at the future of the oil industry, recent developments that caused the plunge in crude oil prices appear to affect the dynamics of oil markets in a lasting way. Unconventional oil supplies will likely continue to be a highly

elastic source of oil supplies (Basu and Indrawati, 2015). The effect of this development is that, it could make unconventional oil producers the new swing producers in the oil markets. Currently, less oil-intensive production technologies are being given priority and this will also persist for a long time. Such developments will therefore exert continuing pressure on oil prices to decline or to remain at lower levels.

6.1.1 How vulnerable is Ghana to crude oil price shocks?

The vulnerability of a country to oil price shocks depends on the percentage of GDP used to purchase oil or the percentage of GDP that is accounted for by the oil sector, Kojima (2011). Guillaumont (2010) suggests that the vulnerability of developing countries to external shocks depends on factors such as population size, remoteness, export concentration and share taken up by the primary sector. From the year 2010, the dependence of Ghana on the oil sector has more than tripled (see Fig. 16). Though the ratio decreased after 2014, the dependence is still high (4.4% of GDP). Given the narrow range of exports and high concentration of Ghana's export earnings on crude oil and gold, the country is highly vulnerable to shocks from crude oil prices.

Figure 17 Oil revenue to GDP ratio



Source: Author generated from oil revenues and GDP data

6.2 Did the New Oil Sector Influence Sectoral Multipliers and Linkages?

The study sought to answer the research question concerning the impact of the new oil sector on sectors in the economy in terms of the multiplier effect of final demand changes on output and income as well as backward and forward linkages. Evidence from literature shows that, though the oil sector generates high income, the income is often concentrated within a segment of society and thus requires distributive policies of government to correct the anomalies of income gaps. Input-output techniques were employed to investigate the changes in multipliers and linkages.

6.2.1 Sectoral multipliers

Multipliers are seen as a summary of predicted effects of changes in final demand (Armstrong and Taylor, 2000). The results show that before oil production (see Tab. 15), the agricultural sector had an output multiplier of 2.17 and an income multiplier of 4.02. The mining sector had an output multiplier of 2.17 and an income multiplier of 3.27 while the manufacturing sector had 3.08 and 3.11 for output and income respectively. Households had 3.55 as output multiplier and 0.82 as income multiplier.

The period after oil production (see Tab. 16) witnessed a decline in multipliers for most sectors. The output and income multipliers of agriculture dropped to 1.93 and 3.00 respectively. Mining also experienced similar development with a drop in both multipliers to 1.68 and 1.80 respectively. The manufacturing sector which depends largely on energy inputs witnessed a decline in both multipliers to 2.06 and 1.95. The household sector also witnessed a decline in output multipliers to 1.98 and income multipliers of 0.35. This study also estimated the oil sector's output multiplier to be 2.67 and income multiplier to be 1.68. It is worth emphasizing in this study that, the introduction of the new oil sector coincided with extreme energy crises in Ghana. During this period businesses could not secure reliable electricity supply for their operations. This in the view of this study is therefore the main cause of the declines in the performance of the various sectors in the economy.

Input-output multipliers derived for sectors of production vary among countries (Corsetti et al. 2012). Comparing the results of this study with several others, Gim and Koonchan (2011) in their analysis of the South Korean economy using input-output techniques observed agriculture to have output and income multipliers of 1.2 and 1.5 respectively. Mining from their study had 1.4 and 1.9 respectively. The petro-chemical sector had 2.3 and 3.10. The range of values obtained by their study is in sync with the values obtained by this study.

The African Development Bank (2000) estimated oil sector multipliers for Chile to be 2.41, Australia to be 1.65 and U.S.A to be 1.47. Burney and Davis (2015) in their study of the importance of agriculture to the economy of Kentucky estimate both output and income multipliers of the sector to be 1.44 and 2.11 respectively. The values obtained are similar to those derived by this study.

Samarajeewa et al. (2006) estimated the output multipliers for cattle and beef production in different areas in Canada to be 3.01 and 2.44, in Alberta 2.54 and 2.11, in Ontario 2.66 and 2.00 in Quebec as well as 2.68 and 2.18 in Saskatchewan. Similar results were obtained by the Scottish government (2011) in their attempt to produce an input-output model guide of their economy.

Hristov et al. (2012) used input-output analysis to assess the impact of water consumption on the economy of Macedonia. Their results show that the water multiplier effects were 1.41 and 1.02 on agriculture and mining respectively. The water sector also had a backward linkage of 1.97 and a forward linkage of 5.59.

Stilwell et al. (2000) constructed an input-output model to assess the impact of mining on the economy of South Africa. For output multipliers, they estimated values of 2.54 for Agriculture and 2.06 for Gold mining. The range of values obtained are in tandem with the results obtained in the study by Nchor and Konderla (2016).

It will be too early to associate the declines in multipliers to the introduction of the new oil sector. Ghana has for the last couple of years been hit with a prolonged energy crises which affected basically productivity in every sector of the economy. Firms and companies could not access constant supply of electricity and had to resort to alternative and expensive means. According

to CEPA (2007), the Ghanaian economy continues to experience very severe energy crisis that hit the entire country from the start of the second half of the year 2006.

In February 2015, the Bank of Ghana announced that the country's GDP growth had slowed from 7.3% in 2013 to 4.2% in 2014 due largely to energy supply constraints and rising input costs (WANEP, 2015). These assertions were supported by Tuffour and Asamoah (2015).

6.2.2 Sectoral linkages

The study looked at intersectoral linkages (backward and forward linkages) and inter-dependence of all the sectors in the Ghanaian economy before and after oil production. Backward linkage indicates the interconnection of a particular sector to sectors from which it purchases its inputs (Miller and Blair, 1985). The larger the backward linkage of a sector, the greater the sector's dependence on other sectors in the economy for its inputs. It will be easier to stimulate an economy through an increase in the output of a sector with high backward linkage than a sector with low backward linkage (Aroca, 2001; Miller and Blair, 1985).

Forward linkage indicates the interconnection of a particular sector to those sectors to which it sells its output (Miller and Blair, 1985). It means the direct and indirect effect on the production of other sectors which use output of a specific sector as intermediate inputs. The larger a sector's forward linkage, the more its output is used as inputs of production by other sectors. Increased economic size and development in technology tend to increase forward linkages of sectors (Aroca, 2001).

According to Al-Moneef (2006), the term forward linkages refer to the actual physical output from the oil sector which feeds into the rest of the economy as intermediate inputs. Forward linkages in the oil and gas sector include the following: crude oil input into the refining industry; the input of gas and its liquid feed into the petro-chemical industry; and the input of oil and gas fuels into electricity production and energy intensive industries.

The results from this study show mixed results for backward and forward linkages before and after oil production. Some sectors witnessed improved link-

ages, others experienced declines. Before oil production (see Tab. 17), the agricultural sector had a backward linkage of 0.87 and a forward linkage of 1.64. Mining had 1.09 and 0.86 respectively, Manufacturing 1.24 and 2.46 and households 1.43 and 0.91. Similar results were obtained by Burrow and Botha (2013) on the South African economy. They estimated the GDP multiplier of the Agricultural sector to be 3.26. Bekhet and Abdullah (2010) estimate the backward linkage for agriculture in Malaysia to be 1.41, the oil sector to be 1.09 and mining to be 1.45.

After oil production (see Tab. 18), the backward linkage of agriculture increased to 1.07 and its forward linkage decreased to 1.44. The mining sector witnessed a decline in both backward and forward linkages to 0.93 and 0.82 respectively. Both backward and forward linkages declined for the manufacturing sector. The new oil sector has a backward linkage of 1.10 and a forward linkage of 1.02. This implies that the sector uses the inputs of domestic sectors for its production activities and also supplies its output to some sectors locally.

The agricultural sector is the backbone of the Ghanaian economy. It supplies basic raw materials to the industries, contributes significantly to GDP and employment. It thus serves as a source of livelihood for the people. The drop in its forward linkage as observed in the results of this study might be an indication of a drop in performance. Similar results were obtained by Apata (2010) who examined the linkages between crude oil exploration and agricultural development in Nigeria and concluded that crude oil exploration has led to environmental problems in the producing communities thus adversely affecting livelihood activities in agriculture leading to low income.

Considering the values (greater than one) obtained by this study on backward and forward linkages of the oil sector, one can conclude that the new oil sector is performing creditably well with regards to its linkage with the local economy. The relatively high performance points to the initial shock in the economy from the introduction of the new sector. It also shows that Ghana has made several improvements with regards to its local content policies. Local content policies are crucial if the country is to ensure efficient linkage of the oil sector with the rest of the economy.

The participation of GNPC in direct oil production activities is a good representation of national interest. As a developing country and a new oil producer both backward and forward linkages of the oil sector are still affected by: limited capacity and high costs of local companies, insufficient financial support, inadequate standards of certification and inability of contractors to meet high industry standards.

Steven (2008) sees forward linkages from oil and gas projects as the provision of energy inputs to other sectors of the economy. Bhattacharya and Ghura (2006) who focused exclusively on the intersectoral linkages in the Republic of Congo, finds that while the oil sector does not have a direct impact on non-oil sector growth it had indirect effects through political instability and real exchange rate movements.

The question therefore is how to ensure that the benefits of the oil sector are linked with the development of all other sectors. Given the public sector dominance in Ghana, an important channel through which the oil sector may affect the non-oil sector is Ghana's fiscal operations. In this regard, if the windfall of oil revenues have been directed into investment in infrastructure and human capital in line with the economy's absorption capacity, oil revenues will have positive externalities on the non-oil sector.

The Annual Budget Funding Amount of the government of Ghana will help to spread the benefits of the oil sector across all sectors (Revenue Management Bill, 2011). The use of the Annual Budget Funding Amount is to: maximise the rate of economic development, promote equality of economic opportunity with a view to ensure the well-being of citizens, to undertake even and balanced development of the regions, Revenue Management Bill (2011). In support of this view point, Fiess and Verner (2003) examined the intersectoral linkages in the Ecuadorian economy and found that the oil sector is co-integrated with the public sector, and the transportation and communication sectors.

Local content policy has become a key enabler of development of backward linkages. This is because it can be used to improve the participation of local companies in oil production activities. A major leverage of local content policy is national ownership of resources (Klueh et al. 2007). Generally, the participation of firms without such industrial background has been limited to

the supply of basic goods and services unrelated to oil production processes (Cappelen and Mjøset, 2009; Lange, 1977). This is observed in the operations of the oil industry in Ghana where domestic firms are reduced to providing services.

A project by the Columbia Center on Sustainable Investment (CCSI) in 2014 revealed that specifically as part of Ghana's local content policy, an indigenous Ghanaian company must have 5% equity participation in the production of crude oil. Contractors and sub-contractors are required to provide plans in the areas of employment and training, succession, research and development, technology transfer and use of legal and financial services.

There must be preference to a qualified indigenous Ghanaian company if within 10% of the lowest bid and a non-indigenous company must incorporate a local joint venture (Petroleum Commission Ghana, 2016). Such policies will help develop the relationship between the oil sector and the rest of the economy. The ability of the rest of the economy to develop a service sector depends upon the speed at which oil or gas resources are developed, which is determined by an important factor such as an enabling environment.

It has been argued that local content policies create distortions, inefficiency and in some cases even corruption. However, this cannot be generalized. Economic histories of a number of developed and developing countries show that linkages between the primary resource sector and other sectors were facilitated by local content policies.

It is necessary not to concentrate production in the resource sector that has little contact with the rest of the economy. The occurrence of this situation is termed the staple trap. Studies of many resource abundant countries show that the staple trap theory, while useful, has limited explanatory power since it does not take into account the role of macroeconomic and political economy variables (Findlay and Lütkepohl, 2001; Abidin, 2001; Gylfason, 2001).

6.3 Is the Dutch Disease Present and has the New Oil Sector Affected the Size of the Shadow Economy in Ghana?

This section discusses the results of this study with respect to the presence of the Dutch disease phenomenon and the impact of the oil sector on the shadow economy of Ghana.

6.3.1 The Dutch Disease and the Ghanaian economy

The study shows mixed results with regards to the presence of the Dutch Disease phenomenon. Though there are symptoms of such an occurrence, there are varied observations from the different indicators used. The Dutch Disease phenomenon is indicated by certain events. First, sustained real exchange rate appreciation. This was however not observed in the case of Ghana. The real effective exchange rate of Ghana has been declining though with intermittent peaks before and even after the country began commercial production of crude oil (see Fig. 15). This aspect can therefore not be mentioned as a symptom of the Dutch disease phenomenon in Ghana.

Second, there is an unambiguous decline in manufacturing output and employment, reflecting both direct and indirect de-industrialization. Looking at it from sector performance in terms of growth rate, there is a clear indication of a decline in manufacturing activities. There is also a clear decline in activities of the industrial sector in which category manufacturing is located. Agriculture after the initial setback in 2011, witnessed improved performance in the subsequent years 2012, 2013 but declined slightly in 2014 (see Fig. 11). It will be difficult to attribute such declining performances to only the presence of the new oil sector since over the years, growth rates have maintained similar patterns even before oil production began and Ghana underwent series of chronic energy crises.

Third, the combined effects on output and employment in the oil sector and the service sector are ambiguous because the spending and resource movement effects pull in opposite directions here. However, if the oil sector employs relatively few workers or if labor mobility is low, it is expected that the spending effect will dominate the resource movement effect, in which case this study would also expect to see an increase in service sector output and employment.

After 2012, the services sector experienced declines in its performance between 2013 and 2014 (see Fig 11). Though there are very few statistics on the employment levels of the sector, it has increased the level of employment which is largely attributed to the proliferation of several banks and developments within the telecommunications sectors and not necessarily service companies within the oil sector.

The study also notes that, earnings of non-oil exports have not been affected negatively since Ghana commenced commercial production of crude oil (see Fig. 14). Thus on the basis of the results discussed, this study concludes that the economy of Ghana though has symptoms of the Dutch Disease phenomenon the observations made cannot be largely attributed to the new oil sector. The country has undergone three years of energy crises where there was no constant supply of electricity for the industries. The underperformance of the manufacturing and industrial sector can therefore be attributed to this scenario. Though the crises have somehow been reduced, the cost of electricity supplied to industries has increased more than 100% and that will certainly affect the operations of firms and businesses.

The results of this study were compared with diverse literature on oil-producing and oil-exporting countries. It must be acknowledged that similar mixed results were derived for various countries. Though some researches produced works which supported the idea of the Dutch Disease in the various countries of their studies, others failed to prove it and concluded that it was not present.

Researchers who support the idea of the Dutch Disease such as Isham et al (2004) attributed the phenomenon to several factors and predicted that it leads to lower growth. Collier and Hoeffler (2004) indicate that countries with abundance of natural resources are more prone to violent conflicts. This has been observed frequently in oil producing developing countries such as Nigeria, Cameroon to mention but a few.

Government policies in the various countries even in the case of Ghana might also be mitigating the negative impact of the oil sector on the economy. One of these is the Annual Budget Funding Amount which receives a percentage of the oil revenue and is used for the development of other sectors such as

Agriculture, Health, Education, Transport and Communication, Energy to mention but a few.

Auty (1997) argues that the type of the natural resource is what matters for growth. In his view, there is a greater chance of a vicious cycle of mismanagement, rent-seeking and conflict in countries in which resources are concentrated and hence can be more easily expropriated such as oil and minerals and unlike agriculture.

Kareem (2010) obtained results for the Dutch disease analysis in oil exporting countries and concludes that oil booms affect the output of the manufacturing sectors in these countries negatively. Gelb (1988) concludes that Ecuador, Iran, Nigeria and Trinidad and Tobago experienced the Dutch disease where there were declines in the output of agriculture while Algeria, Indonesia and Venezuela witnessed improved development of their non-oil tradable sectors.

This study maintains that, Ghana could at any point in time experience the Dutch Disease but the results obtained now do not give any clear indication. This stance does not deviate from works by Westin (2004), based on data through 2003, who concluded that, despite the existence of some Dutch Disease symptoms, Russia had not contracted the full-blown disease by end of 2003.

In a similar study on the economy of Nigeria, Sala-i-Martin and Subramanian (2003) argue that waste and poor institutional quality stemming from oil rather than Dutch Disease, appear to have been primarily responsible for Nigeria's poor long-run economic performance.

6.3.2 The oil sector and underground economic activities in Ghana

One other area worth noting is how the introduction of the new oil sector has impacted on underground economic activities in Ghana. This was looked at in the study by Nchor and Adamec (2015) as well as Nchor et al. (2016). The oil sector led to several small service companies springing up but as to whether all services and jobs related to the oil sector are registered in the official system should be a matter of concern. The study results showed that the oil sector led to an increase in underground activities in Ghana.

The study finds (see Fig. 16) that the underground economy in Ghana shows a steady decline from 1990 to 2000. The period beyond 2011 saw an increase in underground economic activities which could largely be attributed to the new oil sector activities. By 2012, underground economic activities in Ghana were about 37% of official GDP.

This study found (see Fig. 16) the average level of underground economies in Ghana and Nigeria as 36% and 47% respectively. This is compared with the averages derived by Schneider et al. (2009) for the year 2006 as 42.3% and 56.2%, respectively. The size of government, the level of unemployment and total tax rates are unique causes in both countries. Direct taxes are only statistically significant in the case of Ghana. Business regulation and the quality of public sector services are unique causes in Nigeria.

The study by Schneider et al. (2009) showed that the rate of unemployment and the level of GDP per capita were influential in the size of underground economies of developing and transition countries. In their analysis of 88 developing countries, the size of government, direct taxes, fiscal freedom and the level of GDP per capita proved to be the main causes of shadow economic activities. Labor force participation rate, growth in GDP per capita and currency held by the public were statistically significant indicators for both countries studied (see Tab. 19).

Shadow economic activities are not always bad for the economies in which they prevail, Nchor and Adamec (2015). Their presence could boost the entire official system if such activities are well covered through registration. This view point is supported by Adam and Ginsburgh (1985) who focused on the implications of the shadow economy on official GDP growth in Belgium. They find a positive relationship between the growth of the shadow economy and the official system. In line with this stance, Schneider (1999) show clearly that over 66 % of the earnings in the shadow economy are spent in the official sector in Germany and Austria and provide a considerable boost for the official economy.

Increased shadow economic activities in the Ghanaian economy as a result of the new oil sector services is therefore not a negative development but has several positive benefits. It helps to provide a source of livelihood to a

section of the population and also provides avenue for employment. As also observed incomes earned from these activities are spent in the official system. It will therefore be necessary to capture such activities in the official system.

7 CONCLUSION

The study sought to look at the opportunities and challenges in the Ghanaian economy with the commencement of oil production on commercial basis. This was achieved by answering three research questions regarding the impact of the new oil sector on the economy of Ghana. The areas covered by these questions included oil price developments and their impact on the macroeconomy of Ghana, the overall productive impact of the oil sector on output and income multipliers of other sectors of the economy as well as the impact of the sector on traditional agriculture and manufacturing.

The first research question was chosen due to the fact that the impact of the oil sector on economic activities can be viewed either from the perspective of opportunities or challenges. This study measured economic activities by the level of GDP. Oil as a commodity for export or import and developments in its prices can pose either challenges or present opportunities to any economy. It is necessary to know such opportunities to take advantage of them and also to know the threats or challenges so as to minimize or mitigate against them. The most crucial element that the study looked at was crude oil price developments and its impact on economic activities in Ghana.

The study employed a Vector Error Correction model for the analysis. This model was used due to the fact that the study variables, GDP and crude oil prices were both integrated of order one, I(1) after the application of the Augmented Dickey Fuller test for unit roots. The variables were also cointegrated when Johansen test of cointegration was carried out. The VECM also helped to assess the impact of crude price shocks on GDP in Ghana and to make forecast of crude oil prices for the next two years.

The results show that Ghana as a net oil-importing country is affected by shocks to crude oil prices. A one standard error shock to GDP in Ghana has no significant effect on the international price of crude oil. This is explained by the fact that, Ghana's oil-GDP forms a negligible part of the oil-GDP of the world hence fluctuations in GDP in Ghana has no determining influence on crude oil price. A shock to crude oil prices has no initial effect on GDP in

Ghana. The impact is seen after one year. It is transitory and negative but becomes positive by the third year as it tails off. The negative effect after one year is explained by the fact that Ghana is a net oil-importer and thus spends more importing crude oil products than exporting. An increase in crude oil prices implies an increase in the cost of crude products which are used by the industries as inputs and that affects production negatively.

This study proceeded to make forecasts for future crude oil prices (Brent) and GDP growth in Ghana. The forecast figures by this study expects oil prices to slightly rise from the slump in 2015 to about $47 per barrel by the end of 2016 and about $50 per barrel by the end of 2017. GDP is expected to grow by about 6% in 2016 and is expected to remain steady at this growth rate by 2017. The results from this study were in sync with findings of other researchers who proved the existence of a negative relationship between crude oil price shocks and economic activities.

The second research question was about the impact of the oil sector on economic multipliers and linkages of the rest of the sectors of the economy. Oil production and the enormous revenue and export earnings it generates can be used to transform the economy by investing in the development of other less privileged sectors of the economy such as agriculture. This view can be seen as an opportunity therefore to ensure balanced sectoral development. The new oil sector however also poses threat if the country over concentrates its economic activities in this area. It might lead to the demise of crucial traditional sectors which are the backbone of the economy. This study therefore sought to also assess how the new oil sector has helped to improve or worsen the multipliers and linkages of the rest of the sectors of the economy.

Input-output techniques were employed to answer this second research question. The approach followed the extensions and modifications made by Miller and Blair (2009). They used this approach because it corrected for most of the limitations placed on input-output techniques from basic Leontief input-output assumptions. It was observed clearly that most sectors experienced declines in their output and income multipliers as well as their backward and forward linkages. While some sectors performed better in terms of their linkages with other sectors, others were weakened within the period of oil discovery and production.

This study however notes emphatically that, the oil sector was introduced at a time that Ghana slumped into a period of chronic electricity crises. Within this period, businesses and companies struggled to get reliable electricity or power supply for their operations. This in the view of this study, is the main reason for the decline of the performance of sectors and not necessarily the introduction of the new oil sector.

The third and last research question this study considered is about the impact of the new oil sector on traditional agriculture and manufacturing as well as on the shadow economy of Ghana. Crude oil production brings enormous benefits and can affect non-oil tradable sectors negatively. This is termed as the Dutch Disease. Oil production also provides several opportunities to businesses. This can however be a challenge or threat if the activities of these new businesses are not effectively monitored and regulated. To provide an insight into the situation, the study employed analysis of historical data of the performance of agriculture and manufacturing. The study also in this direction looked at the performance of non-oil export earnings before and after oil production. This will help to produce policies either to strengthen (positive impact) or to prevent any negative developments from the oil sector.

The Dutch Disease arguments basically talk about whether the new sector has caused non-oil exports to be uncompetitive. Ghana's exports have been practically uncompetitive due to the fact that they are exported in their unprocessed state. Quality level of some non-traditional exports also remains suspect. The Dutch Disease idea was however looking at the impact of the oil sector from two directions: the appreciation of the real exchange rate and the resource movement effect. The study could only conclude that the Dutch Disease phenomenon was present if there was a sustained appreciation in the real exchange rate. This was however not seen given analysis of data on the real effective exchange rate.

The other aspect is the resource movement effect. Though it is challenging obtaining data on how much labour has been lost from other sectors to the oil sector, it can be unequivocally stated that, the oil sector requires special skills and is therefore employment unfriendly to the available labour resource. This thus meant that the movement could be negligible. The second aspect is

capital movement. The new oil sector will not necessarily divert attention of investors from other sectors. It is capital intensive and might therefore be limiting the capacity of local investors.

The other aspect of the third research question is about the booming effect of oil sector activities on underground economic activities in Ghana. New oil related businesses sprang up to take advantage of the opportunities as a result of the commercial oil activities. These were mostly indigenous service oriented oil companies within the production value chain. These businesses certainly contribute to employment, income and output but as to whether they are legally registered remains a puzzle. The study observed that within the period of the new oil sector boom in Ghana, underground activities increased.

7.1 General Views on the Challenges of the Oil Sector in Ghana

The presence of the oil sector and its revenues are expected to create important fiscal space for Ghana to meet its objective of accelerated growth and poverty reduction. However, more often than not, oil resource endowed nations have failed to transform the huge proceeds from the resource into the needed economic development. Conflicts and mismanagement have affected development in most developing oil producing countries.

It should be the goal of the Ghana to switch from expensive crude oil product consumption to cheap alternatives to ensure conservation. One of the long run goals of Ghana should also be processing the extracted oil resource into refined products. This will largely bring about a reduction in the total amount of imported crude oil products and will also increase earnings from exports.

For all of Africa's oil resources, refining capacity on the continent remains limited and as a result, countries like Angola, Ghana and Nigeria export crude oil, only to import refined oil again later at an additional cost.

Conflict in oil producing countries have become common and at times also interrupt production. Subsidies have also contributed to low capacity utilisation at refineries. In Ghana, for example, current subsidy schemes lead producers to sell crude overseas rather than to local refineries and therefore add to increasing volumes of refined product imports which represent an enormous cost to the economy.

The oil sector in Ghana is facing severe lack of skilled labour. As a young oil producer, Ghana lacks the adequate number of qualified drillers, engineers, managers, production and operation workers to support the industry. This thus calls for the need to train more local labour force to fit into the operations of the oil industry.

Deregulating the oil sector is necessary in order to prevent smuggling and other malpractices. Due to high unemployment, thousands of people in Ghana engage in a practice known locally as 'oil bunkering', which involves hacking into pipelines to steal crude, refining it and selling it abroad for higher profit margins.

Utilising the revenues generated from the oil and gas industry could be a major challenge for Ghana. Countries such as Chad have seen the so-called 'resource curse' in the past, wherein countries that are rich in natural resources tend to grow less than those with relatively fewer resources. The primary reasons for the 'resource curse' could be a decline in the competitiveness of other economic sectors, mismanagement of the resources or weak, ineffective, unstable and corrupt regulatory bodies.

Another challenge is that in most African countries, the oil sector has minimal links to other sectors of the economy, with the sector providing very little employment. Furthermore, some of the countries in Africa with the highest income inequality are oil producing states, such as Gabon, Nigeria, Angola, and Equatorial Guinea.

Ghana certainly needs policies to be put in place to take care of booms and bust cycles from oil price developments. Allowing developments in oil prices to directly affect the economy could lead to volatility or macroeconomic instability within the economy. While the country is enjoying the enormous proceeds from the sector, one important thing worth noting is that oil resource is exhaustible and for that matter can be depleted. There is therefore the need for policies to be put in place to cater for future generations when the resource is depleted.

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