UNIVERSITY OF CAPE COAST

CRUDE OIL PRODUCTION AND MACROECONOMIC PERFORMANCE IN GHANA

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature .... Date................................

Name: Delali Aku Tunyo

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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Name: Dr. Mark Armah

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ABSTRACT

This study investigated the impact of crude oil production on macroeconomic performance in Ghana. The study employed monthly data from January 2011 to December 2018. The structural vector autoregressive (SVAR) model was employed to analyse the impact of crude oil production on macroeconomic performance. The findings of the structural impulse response function revealed that crude oil production had no impact on the agricultural sector, manufacturing sector, services sector, real effective exchange rate and inflation. However, crude oil production had a positive impact on fiscal balance. The findings of the structural forecast error variance decomposition showed that crude oil production accounted for a small amount of variation in all the variables except fiscal balance for which it accounted for the largest portion of the variation. The study concluded that crude oil production had no significant impact on the non-oil sectors, real effective exchange rate and inflation. However, crude oil production had a positive impact on fiscal balance. The study recommended that the government through GNPC and major oil stakeholders such as Tullow Ghana Limited, Kosmos Energy Ghana and Anardako Petroleum Corporation should establish of oil refineries, petroleum industries and fertilizer plants domestically and also the development of the manufacturing and the services sector to provide the backward and forward linkages that needs to be shared between the oil sector and other sectors of the economy.

KEY WORDS

Agricultural sector

Crude oil production

Fiscal balance

Manufacturing sector

Services sector

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DEDICATION

To my family

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LIST OF ACRONYMS

ABFA	Annual Budget Funding Amount
BoG	Bank of Ghana
EC	Energy Commission of Ghana
FPSO	Floating Production Storage and Offloading
GDP	Gross Domestic Product
GHF	Ghana Heritage Fund
GNPC	Ghana National Petroleum Corporation
GSF	Ghana Stabilisation Fund
GSS	Ghana Statistical Services
IEA	International Energy Agency
IMF	International Monetary Fund
MoF	Ministry of Finance
PIAC	Public Interest Accountability Committee
PRMA	Petroleum Revenue Management Act
SDG	Sustainable Development Goal
SGN	Sankofa-Gye-Nyame
SVAR	Structural Vector Autoregressive
TEN	Tweneboa-Enyenra-Ntomme
VAR	Vector Autoregressive
WDI	World Development Indicators

CHAPTER ONE

INTRODUCTION

This chapter introduces the research area of the study. It provides background knowledge on crude oil production and macroeconomic performance. It presents the statement of the problem which highlights the motivation and the gaps, and spans on the purpose of the study, research hypotheses, significance, scope and limitations, and organisation of the study.

Background to the Study

The role of crude oil in the world economy cannot be underestimated because most aspects of human livelihoods depend directly or indirectly on energy (Jahangir & Dural, 2018). Crude oil serves as an essential input for most goods and services in almost every sector of most economies especially the manufacturing and the agricultural sectors. Oil production in the world has increased from 2,869 Million tonnes (Mtoe) in 1973 to 4,482 Mtoe in 2018 (International Energy Agency [IEA], 2019). This is due to the high demand and global economic expansion particularly in countries such as Germany, India, Japan, Korea and China who are major net importers of crude oil (IEA, 2018, 2019). At the regional levels, Middle East contributes 33.2% of the world crude oil production with the remaining production occurring in OECD countries (26.8%), Eurasia and Non-OECD Europe (15.8%), Africa (8.8%), Non-OECD Americas (7.6%), China (4.2%) and Non-OECD Asia (3.6%) (IEA, 2019).

According to Arezki *et al*. (2017), fluctuations in the global oil production have contributed to shocks in oil supply in the world market and conduced changes in the price of oil. For instance, Arab exporting countries placed embargo on the United States and some western countries for supporting

Israel in the Yom Kippur war in 1973. This led to a huge loss in the production of crude oil and caused an increase in the price of crude oil by 400 per cent for six months (Reisdorf, 2008). Other occurrences such as the Iraq-Iran war in 1978, the Gulf war in 1990, the Asian economic crisis in 1997 and the Iraq war in 2003 similarly reduced crude oil production and increased its price within those periods (Al-Shaikh, 2003; Juhasz, 2013). Changes in the price of crude oil have significant effects on the world economy due to its wide application in various economic activities (Lippi & Nobili, 2012; Peersman & Van Robays, 2012). Fluctuations in oil price affect inflation and economic growth of countries. Besides, oil price hikes can affect the cost of production, level of output as well as consumer prices through producer prices (Renou-Maissant, 2019).

High oil price increases the flow of revenue for oil-producing countries which enhances the ability of the countries to undertake huge capital projects to improve their economic growth and development (African Development Bank [ADB], 2009; Odupitan, 2017). According to the World Bank (2009), revenue generated from crude oil has boosted the growth of many oil-producing countries in the world. Besides, earnings from oil export are used in financing developmental projects. Countries such as Australia, Norway, Britain and Canada have used their oil wealth to transform their economies (Agbefu, 2011). Oil revenue has significantly contributed to the economic growth and development of Saudi Arabia and major oil-exporting Eurasian countries (Alkhathlan, 2013; Al Rasasi, Qualls, & Alghamdi, 2018; Bildirici & Kayıkç, 2013). The earnings from oil produced from the United Arab Emirates was used to transform Dubai which was a fishing community into a top-class tourist city, business centre and residential place in the world (Lahcen & Shifu, 2018; Sharpley, 2008). In Africa, major oil-producing countries such as Nigeria, Angola, Algeria and Egypt have experienced economic growth and development through revenues generated from oil production (Djelloul & Talbi, 2017; Mohammed, 2018; Olayungbo, 2019).

Africa remains an important region in oil production and exportation globally (Carpenter, 2020; Graham & Ovadia, 2019). Nigeria, Angola, Algeria, Libya and Egypt are the leading producers of crude oil in Africa and accounts for 25%, 17%, 16%, 15% and 8% % of the production in the region respectively (Carpenter, 2020). In 2016, Africa produced 7.9 million barrels of crude oil per day, which accounted for about 8% of the world production (Auge, 2018). The production, however, increased to 8.8% of the world's total crude oil production in 2018 (IEA, 2019). The revenue generated from oil and gas production in Africa remains an important source of income and economic growth (IEA, 2014). An earlier study has shown that revenue received by Africa's oil exporters is used to provide infrastructure, fund investments, build foreign reserves and reduce budget deficit which stimulates economic growth (Leke, Lund, Roxburgh, & van Wamelen, 2010).

In Ghana, crude oil is relatively the largest source of energy for the industrial and commercial sectors, and provides almost all the energy needed for the agriculture and transportation sectors of the economy (Cantah, 2017; Energy Commission of Ghana [EC], 2019). This indicates the importance of crude oil to the other sectors of the Ghanaian economy. Since the production and exportation of crude oil in 2011, the contribution of crude oil to merchandise exports has increased from 21.73% in 2011 to about 30.7% in

2018, making crude oil the second-largest export earner after gold for the country (Bank of Ghana [BoG], 2019). The import of crude oil has reduced from 10.6 million barrels (Mbbls) in 2011 to 1.8 Mbbls in 2018 while the export of crude oil has increased from 24.7 Mbbls in 2011 to 62 Mbbls in 2018 (EC, 2019). This suggests that the production of crude oil has changed the status of the Ghanaian economy from a net importer to a net exporter.

The total revenue that Ghana received from the production of oil between 2011 and 2018 amounted to $5.013 billion (Public Interest and Accountability Committee [PIAC], 2019). This revenue was allocated to the Ghana National Petroleum Corporation (GNPC), Ghana Heritage Fund (GHF), Ghana Stabilisation Fund (GSF), and the Annual Budget Funding Amount (ABFA) to ensure effective management and use of the revenue (PIAC, 2019). The priority areas of ABFA aim to finance agriculture, education, health, road, rail and other critical infrastructure development according to the Petroleum Revenue Management Act (PRMA) 815 (Acquah-Sam, 2014; PIAC, 2019). The financing of agriculture improves nutrition, yield and production, ensures food security and contribute to achieving the Sustainable Development Goal (SDG1) (Yifu Lin, 2018). The improvement in infrastructure will increase productivity, boost the other sectors of the economy, increase foreign investment and ensure exclusive growth which will help alleviate poverty and reduce income inequality (Ayesha, n.d). The improvement in health and education will help boost human resources by improving primary health care, and provide strong human capital by reducing the rate of illiteracy in the country. These will facilitate growth and development of the economy.

The supply of gas from fields is anticipated to reduce the costs of power generation and enhance expansion in the supply of electricity. The oil and gas sector of Ghana has attracted huge investments and has created prospects for economic growth (Dah & Khadijah, 2010). The sector has provided jobs for more than 5,000 Ghanaians (Bonney, 2016). Despite this, the development of the oil and gas sector will highly impact the gross domestic product (GDP) than employment in the country (Fragkos, Fragkiadakis, & Paroussos, 2017). This is because the employment sector depends on knowledge and technology-intensive which limits employment opportunities for labour. The growth of the economy has declined from 14.1% to 6.3% between 2011 and 2018 despite the oil revenue that the country received between this period (BoG, 2013, 2014, 2017, 2019). The manufacturing sector had a negative growth between 2012 and 2015 after a massive growth in 2011. Moreover, the growth of the agricultural sector has relatively slowed amidst the production of crude oil.

There has been an increase in deficit on fiscal balance from 0.50% in 2011 to 6.83% in 2018 despite the oil revenue (BoG, 2013, 2014, 2017, 2019). Even though the Bank of Ghana devised inflation targeting framework, inflation increased from 8.7 to 12.4 between 2011 and 2017 (BoG, 2013, 2014, 2017, 2019). The real effective exchange rate has continued to fall (95.3 in 2011 to 73.8 in 2018), indicating a depreciation of the domestic currency against major foreign currencies. Despite these, knowledge on the role of oil revenue received from the production of oil in these economic indicators is limited. Therefore, it is important to assess the impact of crude oil production on the non-oil sectors and some macroeconomic variables in Ghana. An understanding of the impact of crude oil production will help identify suitable policies to inform decisionmakers and help control the adverse effect of crude oil production on non-oil sectors and macroeconomic variables of Ghana.

Statement of the Problem

The revenue allocation to the Annual Budget Funding Amount (ABFA) has increased from $166.96 billion (2011) to $235.1 billion (2018). This is likely to reduce the revenue-spending gap of the government and hence affect the fiscal balance of the country (Dagher, Gottschalk & Portillo, 2010; PIAC, 2019). However, the performance of fiscal balance has worsened despite the oil proceeds received. Empirical studies on crude oil production on fiscal balance, government revenue and expenditure have received varied responses (Adedoyin, Liu, Adeniyi & Kabir, 2017; Aregbeyen & Kolawole, 2015; Monjazeb, Choghayi, & Rezaee, 2014). Crude oil production often affects macroeconomic variables such as inflation and exchange rate of a country through crude oil prices since the country is exposed to the volatility in crude oil price (Dagher *et al*., 2010; Trang, Tho, & Hong, 2017). The domestic currency has continued to depreciate despite the exportation of crude which would accumulate foreign reserves for the country.

The contribution of the agricultural sector to GDP has continually declined and that of the services sector have received varied responses despite the revenue from the ABFA channelled for the improvement of these sectors. This underperformance of the agricultural sector has been attributed to the fact that oil revenue has replaced the budget allocation to the sector and the oil revenue investment allocated to the sector is inconsistent (Ackah, 2016). Even though the service sector is the leading sector of the Ghanaian economy, the sector has experienced varied contributions to GDP after the production with a decline in its contribution to GDP. The growth of the services sector recorded comes from the non-tradeable sector which provide little potential for productivity gains and technological diffusion (Ozyurt, 2019). The contribution of the manufacturing sector to GDP have received varied responses amidst the production of crude oil. According to Abdul-Mumuni (2016), the continuous depreciation of the domestic currency contributes to the slow growth of the manufacturing sector since this sector depends highly on imported raw materials to undertake production activities.

Due to the interdependency of the sectors, the underperformance of the agricultural sector hampers the performance of manufacturing sector because about 66.67% of the Ghanaian manufacturing sector rely on agricultural inputs (Breisinger, Diao, Thurlow, & Al-Hassan, 2008; Fiess & Verner, 2003). The country has experienced economic growth over these years but the challenge with the strong economic growth experienced is that, the agricultural sector and the manufacturing sector which have high labour absorption capacity continue to record slow growth whiles the growth of the mining (including oil) subsector, construction subsector and financial intermediaries which have a limited capacity to create employment due to the nature of activities in these sectors account for the growth of the economy (Aryeetey & Baah-Boateng, 2016; Baah-Boateng, 2013).

Knowledge of the benefits of crude oil production to the non-oil sectors of an economy is imperative since these sectors contribute to economic growth. This has been evident in the study by Ekperiware and Olomu (2015) who reported a positive impact of oil sector on agricultural sector which extended to economic growth. There is also a need to ascertain how oil production affects fiscal balance, real effective exchange rate and inflation since oil production could affect the other sectors through these macroeconomic variables. Earlier studies have emphasised largely on the impact of crude oil production on economic growth, and revealed varied responses (Djelloul & Talbi, 2017; Lucky & Nwosi, 2016; Mohammed, 2018; Tamba, 2017). In Ghana, similar observations have been made (Acquah-Andoh, Gyeyir, Aanye, & Ifelebuegu, 2018; Acquah-Sam, 2014; Dah & Khadijah, 2010; Fragkos *et al*., 2017). However, studies on the impact of crude oil production on the non-oil sectors and macroeconomic variables of the Ghanaian economy is limited.

The challenge with the existing studies on the Ghanaian economy is mainly associated with the unavailability of data related to oil production. Also, the work of Asafu-Adjaye (2010) was based on theoretical assumption with no time series data to test empirically. In addition, the study by Dagher *et al*. (2010) employed the dynamic stochastic general equilibrium (DSGE) model focused on the use of simulations that is not necessarily generated out of the character of the economy. This study employed the timeseries data from January 2011 to December 2018 using a structural vector autoregressive (SVAR) model to assess the dynamics as well as the transmission mechanism of crude oil production and macroeconomic performance in Ghana.

Purpose of the Study

The purpose of the study was to assess the impact of crude oil production on macroeconomic performance in Ghana.

Specifically, the study sought to:

1. Investigate the impact of crude oil production on the non-oil sectors.

2. Examine the impact of crude oil production on fiscal balance, inflation and real effective exchange rate.

Research Hypotheses

The study tested the following hypotheses:

1. H_0: Crude oil production has no impact on the non-oil sector.

   H_A: Crude oil production has an impact on the non-oil sector.

2. H_0: Crude oil production has no impact on fiscal balance, inflation and real effective exchange rate.

   H_A: Crude oil production has an impact on fiscal balance, inflation and real effective exchange rate.

Significance of the Study

Crude oil has contributed to economic growth and development of some oil-producing countries. However, the situation has been different for oil-producers in Africa who have experienced the resource curse syndrome. This study contributes to literature by assessing the impact of crude oil production on macroeconomic performance in Ghana. The study employs the SVAR model which provides the dynamic analysis and transmission mechanism of how crude oil production affects macroeconomic performance. It offers relevant policy recommendations and measures to help control the adverse effect of crude oil production on non-oil sectors, fiscal balance, real effective exchange rate and inflation in the economy. The outcome of the study will help the Ghana National Petroleum Corporation (GNPC), government and other major oil stakeholders to know the appropriate measure to undertake in ensuring that the non-oil sectors benefit from the production of oil and hence achieve macroeconomic stability.

Scope of the Study

The study examined the impact of crude oil production on macroeconomic performance (sectors of the economy, exchange rate, inflation, and fiscal balance) on Ghana's economy. The study used a monthly time series data set which spans from January 2011 to December 2018. The study limited itself to these periods because Ghana started producing crude oil in commercial quantities during these periods. The study employed the structural vector autoregressive (SVAR) model to achieve the stated objective.

Limitations of the Study

The main limitation of the study is the assumption underlying the structural vector autoregressive (SVAR) model. The SVAR model assumes that the structural shocks are orthogonal which is likely to be fairly restricted. Another limitation is that the non-availability of monthly data on some key variables such as fiscal balance and the non-oil sectors. The data on fiscal balance was an annual data and the data available on the non-oil sectors was quarterly data. The monthly series were generated through the Chow and Lin (1971) approach in E-Views 10 for estimation. The use of this approach does not pose risk to the reliability of the results because it can disaggregate data to any sub-period without being restricted.

Definition of Terms

Backward linkage – refers to reliance on the domestic economy for inputs in crude oil projects.

Forward linkage – refers to the value-addition to the crude oil extracted by the oil and gas industry.

Macroeconomic performance – considers how well the economy as a whole is doing in achieving some important objectives of government. It focuses on the aggregate changes in the economy such inflation, exchange rate, fiscal balance and national output (non-oil sectors).

Organisation of the Study

The study is organised into five chapters. Chapter one presents the background to the study, statement of the problem, purpose of the study, research hypotheses, significance, scope, limitations and organization of the study. Chapter two presents an overview of crude oil and macroeconomic performance, theoretical review and framework, and a critical examination of empirical literature related to the study. The methodological issues and techniques adopted in conducting the study are presented in chapter three. Chapter four focuses on the results and discussion of crude oil production and macroeconomic performance with regards to literature. Chapter five summarizes the findings of the study and provides conclusions and recommendations based on the outcome of the study.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews literature on crude oil production and macroeconomic performance. It spans on the overview of crude oil production and macroeconomic performance, the theoretical review and the conceptual framework which links crude oil production to macroeconomic performance. The empirical studies relevant to the study were reviewed.

Overview of Crude Oil Production and Macroeconomic Performance in Ghana

Ghana first discovered oil in 1970 off the coast of Saltpond. However, the amount of reserve was not enough for commercial production. In 2007, the Jubilee oil field was discovered at the Tano Basin of the Gulf of Guinea with the reserves sufficient for commercial production (Asafu-Adjaye, 2010). The production of crude oil commenced in the last quarter of 2010 with 1,267,700 barrels of crude oil produced. From Figure 1, there has been an increase in the total amount of crude oil produced between 2010 and 2015 from the Jubilee field (Energy Commission of Ghana [EC], 2019). The Tweneboa-Enyenra-Ntomme (TEN) fields discovered in 2010 begun production in August 2016, adding to Ghana's production asset. In this same year, there was a reduction in the production as a result of the damage of the turret bearing of the Floating Production Storage and Offloading (FPSO) Kwame Nkrumah from the Jubilee field in February (Public Interest and Accountability Committee [PIAC], 2017). In 2017, the Sankofa-Gye-Nyame (SGN) field also started commercial production with 5,455,511.54 barrels of crude oil (PIAC, 2018). The full operation of these three fields increased the amount of crude oil produced from 58,658,064 barrels in 2017 to 62,135,435 barrels in 2018 (Figure 1).

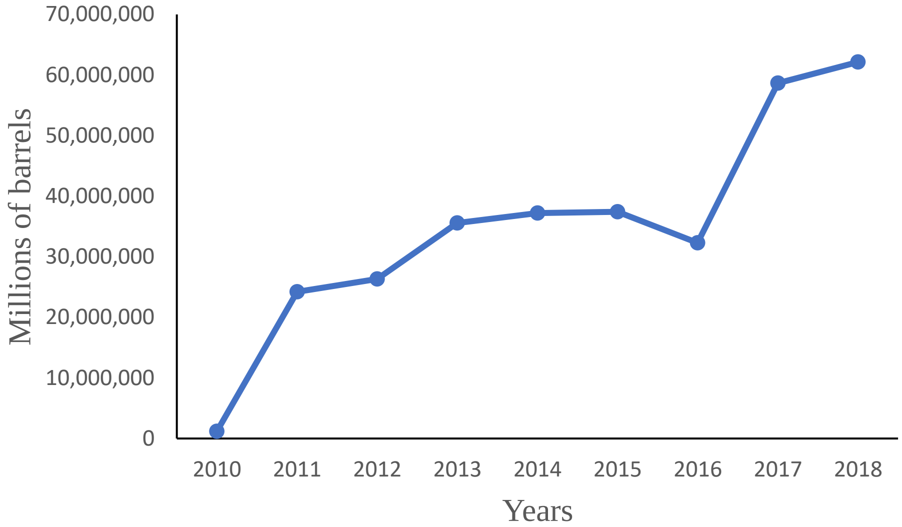

Figure 1: The trend in crude oil production in Ghana.
Source: PIAC (2020)

In 2018, the total crude oil produced was 62,135,434 barrels out of which 62,020,235 barrels (99.81%) was exported. Since the inception of exportation of crude oil in 2011, the total revenue the country has raked from the production of crude oil amounts to $5.013 billion (PIAC, 2019). A total amount of $1,931.70 billion was allocated to the government for annual budget funding (PIAC, 2019). The overall oil revenue proportion of GDP increased from 17.1% in 2011 to 17.7% in 2014 (International Monetary Fund [IMF], 2015). The fiscal balance showed a deficit, indicating that the total expenditure of government exceeds total revenue generated (Figure 2). The deficit after commercial crude oil production has worsened compared to the period where there was no oil revenue (Figure 2). The deficit was greater in 2016 (-12.97% of GDP) which could be due to the reduction in oil proceeds received on the account of the damage of the turret bearing of the FPSO Kwame Nkrumah and the election held in 2016. This deficit was attributed to a sharp downturn in commodity prices, higher interest payment on debt, shortfalls in revenues and grants and tight external financing conditions (Bank of Ghana [BoG], 2014, 2017). The oil revenue received was used to finance payment of the development and rehabilitation of irrigation projects in the Central region, Eastern region, Volta region and Upper West region. Other projects that were financed with the revenue from oil production were railway, road and health infrastructures, and the free SHS policy which commenced in 2017 (PIAC, 2018).

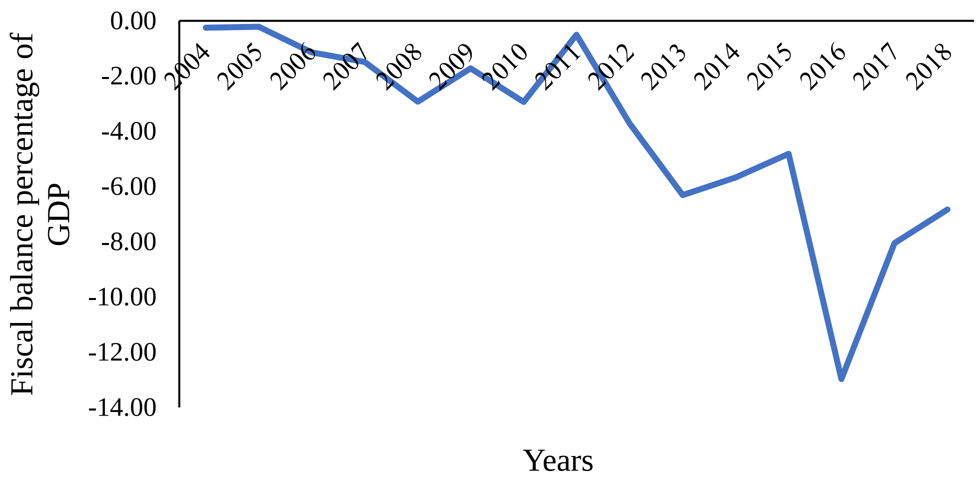

Figure 2: The trend in the performance of fiscal balance.
Source: Tunyo (2020)

Despite the production and exportation of crude oil, the real effective exchange rate has continuously fell, indicating a depreciation of the domestic currency (Ghanaian cedi) against major currencies (Figure 3). The deficit of the fiscal balance could also contribute to the depreciation of the domestic currency since the deficit is financed by external borrowing. The payment of the debt could have an effect on the real effective exchange rate. The trade balance of the country has been a deficit from 2011 to 2016 and a surplus from 2017 to

2018 (BoG, 2014, 2015, 2017, 2018). The deficit trade balance attributed to high imports of non-oil and oil products. However, after the production of natural gas to support the generation of electricity and other oil products, the imports of oil products have reduced which has contributed to the surplus on trade balance. The deficit on the balance on services and income has also accounted for the depreciation of the currency especially interest payment on public debt and outflow of services (BoG, 2014, 2015, 2017, 2018).

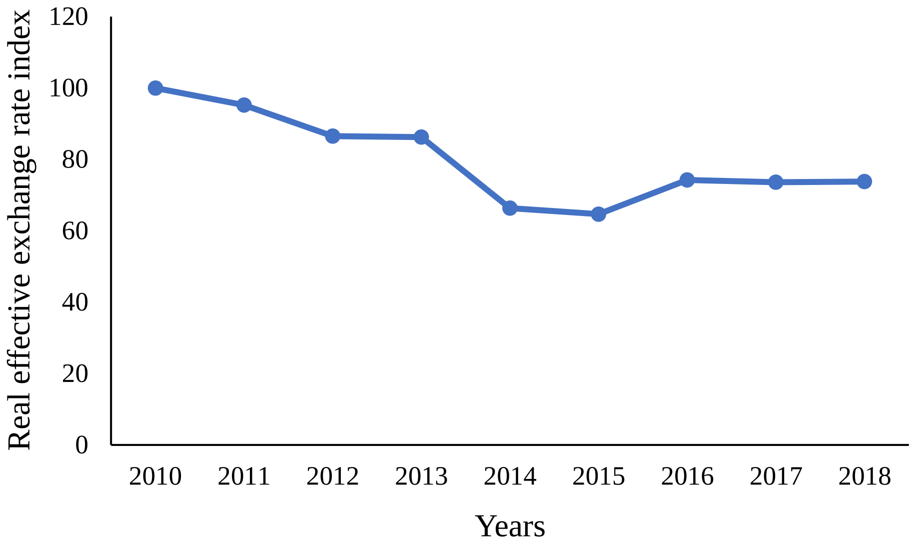

Figure 3: The trend in the performance of real effective exchange rate.
Source: Tunyo (2020)

The performance of consumer prices experienced a rise and a fall between 2011 and 2018 (Figure 4). Inflation witnessed a double-digit from 2013 to 2017. This high inflation within these periods has been attributed to the depreciation of the currency, increase in energy cost and the pass-through effect of upward adjustment in petroleum product prices, utility tariffs and transport fares (BoG, 2014, 2015, 2017). The deficit on the fiscal balance could account for the high inflation because excessive spending by government will increase the money supply in the country which could increase aggregate demand and a rise in the prices of goods and services.

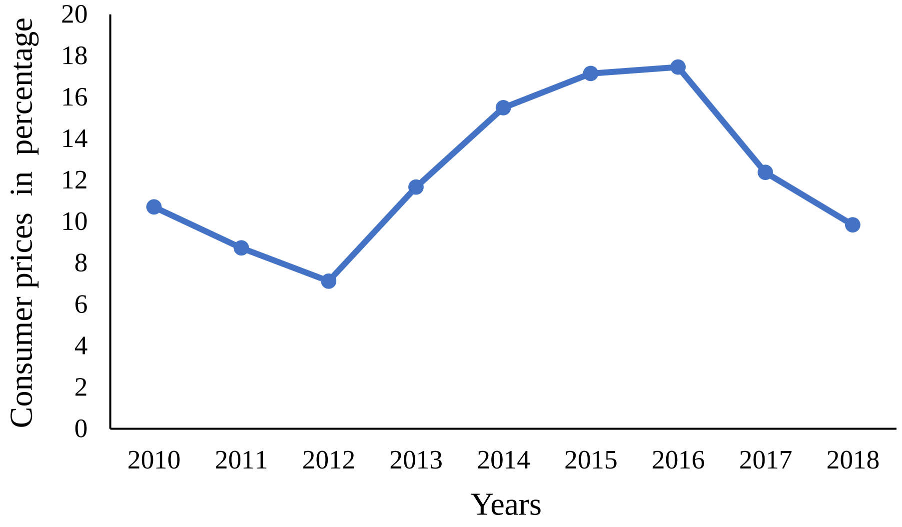

Figure 4: The trend in the performance of inflation.
Source: Tunyo (2020)

The ABFA that was channelled to the agricultural sector was used in financing rehabilitation and development of irrigation infrastructure, fertilizer subsidy programme, sea defence projects, rehabilitation of greenhouse capacity building training centres, supply and installation of solar water pump, fisheries and aquatic inputs and infrastructure, and planting for food and jobs which commenced in 2018 (PIAC, 2012, 2013, 2015, 2018, 2019). Despite the use of proceeds from crude oil production to finance the agricultural sector, the share of the agriculture sector to GDP witnessed a further decline after losing its position to the services sector (Figure 5). The production of oil affected the crops subsector as it experienced negative growth in 2015 (Ministry of Finance [MoF], 2015). The reduction in the contribution of the agricultural sector was attributed to the inconsistencies of the oil revenue investment in the sector, the misapplication of agricultural receipts to other sectors such as the use of 69%

of the revenue to fund sea defence projects and the fall in international commodity prices coupled with energy crises (Ackah, 2016; BoG, 2014, 2015, 2019).

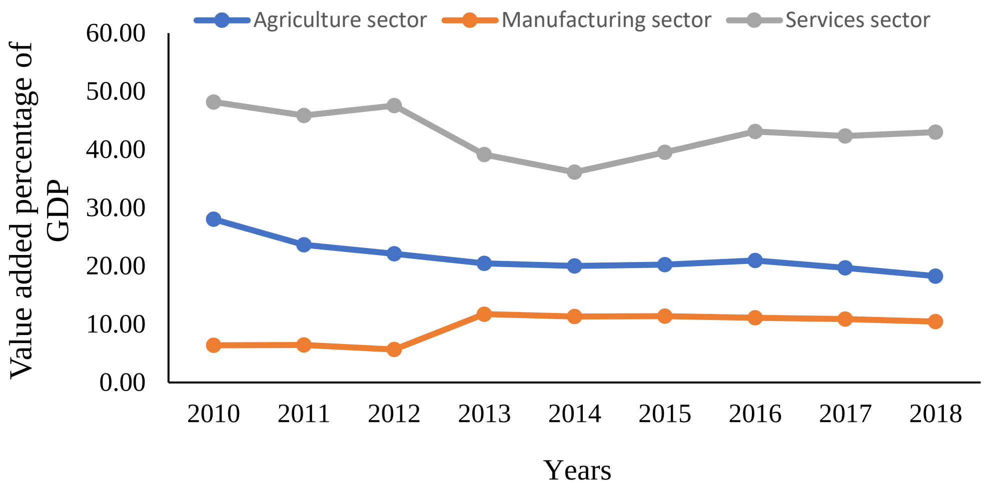

Figure 5: Value-added percentage of GDP for manufacturing sector, agricultural sector and services sector.
Source: Tunyo (2020)

The services sector has experienced varied contributions to GDP but remains the leading sector of the economy after 2006 (Figure 5). The ABFA that was channelled to the service sector was used in financing railway infrastructure, road infrastructure (construction and rehabilitation of roads, bridges and compensation to persons affected by the project), educational infrastructure (construction of 6-unit and 3-unit classroom blocks in various regions, reconstruction of dilapidated basic schools across the country and free SHS policy) and health infrastructure (construction of CHPS compound, remodelling and expansion of health centres and payment for the water sector improvement programme) (PIAC, 2012, 2015, 2018, 2019). The performance of the service sector is attributed to the growth of the information and communication technology subsector, education subsector, health and social works subsector, improvement in transportation subsector, tourism and provision of infrastructure in the sector (MoF, 2015, 2017a, 2017b; Powell, 2015). The oil rents investment (ABFA) allocated to certain subsectors has improved the performance of this sector.

The contribution of the manufacturing sector to GDP is fairly stable after the production of crude oil (Figure 5). The slow and negative growth experienced by the manufacturing sector between 2013 and 2015 was attributed to power shortages on account of adverse energy supply constraint (MOF, 2015, 2017a). However, the production of crude oil has helped the sector to get a stable energy supply after the operation of the Atuabo gas which has also contributed to the stable performance of the sector after 2015. The continuous depreciation of the domestic currency also contributes to the slow growth of the manufacturing sector since this sector depends highly on imported raw materials to undertake production activities (Abdul-Mumuni, 2016).

Besides the sectors and the macroeconomic variables of the economy, the financial sector has also benefited from crude oil production through the Ghana Oil and Gas Insurance Pool (GOGIP) and the Ghana Stock Exchange (GSE) market. The insurance company provides insurance cover to the three oil fields against risk for foreign companies since the risk cannot be retained locally. For example, when the Jubilee field had a major setback in 2016, the insurance company paid an insurance which covered loss of production and revenue for Tullow Oil (Acheampong, 2017). The listing of Tullow Oil on the GSE in 2011 provides an opportunity to make its shares available to other investors to share in the future performance of their operations in Ghana.

Theoretical Review

Exhaustible Resource Theory

Exhaustible resources are resources such as land and minerals of which when a unit is consumed today it cannot be consumed again. The theory of exhaustible resource developed by John Hartwick in 1977 was known as the "Hartwick rule". The Hartwick rule requires a nation to invest all the proceeds or rent received from oil which is currently extracted in a reproducible capital (Asheim, 2013). The rent is the maximum returns that the owners of oil will receive. The investment of the oil proceeds affects the fiscal balance since the government is the beneficiary of the oil proceeds and are used to meet budgetary needs of the government. The investment of reproducible capital considers the investment of the proceeds into the non-oil sectors since these sectors are likely to achieve development of the economy which will benefit future generations as well. The rule determines the amount of investment in produced capital such as roads, buildings, machines and human capital that is required to offset the decline in the stock of oil without harming future generations. The efficiency of oil extraction requires that the rate of return from owning a unit of oil deposit equal the rate of return from a unit of reproducible capital (Hartwick, 1977, 1978).

Dutch Disease Theory

Dutch disease refers to the situation where countries with no or little natural resource experience high economic growth than countries with natural resource (Sachs & Warner, 1995). Barder (2006) and Chen (2019) considered Dutch disease as the negative consequences from the exploitation of oil and gas on an economy due to appreciation of the domestic currency. This could cause the country's export to be less competitive on the market whilst it encourages importation since it has become cheaper compared to the locally produced products which could result in the deindustrialisation of an economy thereby lowering the growth of the economy (Humphreys, Sachs, & Stiglitz, 2007). This could hinder the macroeconomic stability and the competitiveness of the agricultural and manufacturing sectors and external sustainability of a country. The effect of a natural resource discovery can affect the macroeconomic performance of an economy in two channels. These channels are the spending effect and the resource movement effect (Corden & Neary, 1982).

The resource movement effect refers to a situation where there is a shift in labour from other sectors to the oil and gas sector due to an increase in demand for labour in the booming sector (Corden, 1984; Fardmanesh, 1991; Pegg, 2010). The migration of labour mostly involves the skilled leaving unskilled labour in the other sectors especially the manufacturing and agricultural sectors. The movement of labour will increase the wages of labour because of higher marginal productivity in the oil and gas sector. This suggests that the productivity of the traditional and non-traditional exports will reduce as a result of a reduction in the factors of production. Because of the higher wages, the labour in the other sectors will bargain for an increment in wage which does not correspond to their level of productivity, hence leading to inflation.

The prices of the tradable sector will not be affected since it is determined by the international market. The movement of the factor of production will trigger an increase in the demand for non-tradable goods resulting in an increase in its price since its price is determined domestically and lead to the appreciation of the real exchange (Arezki & Ismail, 2010; Corden &

Neary, 1982; Sala-i-Martin & Subramanian, 2003). This creates the problem of deindustrialization in the economy (Acheampong & Baah-Kumi, 2011). This movement in labour can only be possible if the skilled labour has the required skills needed in the oil and gas sector.

The spending effect occurs from a rise in domestic incomes as a result of a rise in revenue from the discovery of oil (Neary & Van Wijnbergen, 1986). The production of oil will increase revenues accrued to the government through tariffs, royalties and direct engagement in the production of oil. The revenue from oil will affect the fiscal balance and public debt level of government since part of the proceed will be used to financing the budget of the government and reduce the level of borrowing by government (Dartey-Baah, Amponsah-Tawiah, & Aratuo, 2012). The revenue received would be invested in the non-oil sectors especially the agricultural sector since the production of oil is likely to harm these sectors. The spending by government increase the income of households which would cause an increase in aggregate demand of traded and non-traded goods leading to inflation (Aryee, Ahor-Adawu, Effah, Asare, & Coffie, 2011).

Theoretical Framework

The current study constructed a theoretical framework that links crude oil production to macroeconomic performance based on the Dutch disease theory and economic intuition. The framework is depicted in Figure 6 and shows the various channels through which oil production affects macroeconomic performance using the currency appreciation effect and spending effect of Dutch disease. When crude oil is produced not all of the oil is exported (Figure 6). Some portion of the oil is allocated to the energy sector to account for the transmission of gas to power plants in the country. The exportation of crude oil could cause the real effective exchange rate to rise (an appreciation of the domestic currency) through trade. The appreciation of the domestic currency will make tradable goods (agricultural and manufacturing sectors) uncompetitive in the international market, hence hindering the performance of these sectors (Rudd, 1996).

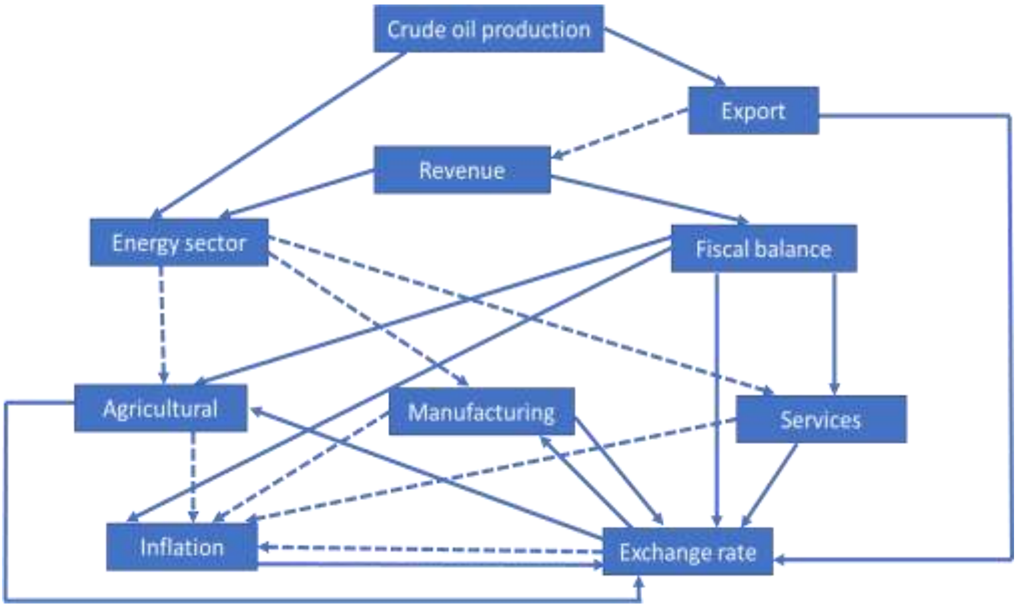

Figure 6: Transmission channel of oil production to macroeconomic variables.
Source: Tunyo, 2020

Exportation of crude oil generates revenue of which part goes directly to the energy sector and the government. The spending effect of the oil revenue is initiated by the government since the government receives royalties, trade tariffs from international trading, tax on private oil companies' earnings and its share from the revenue of crude oil produced (PIAC, 2012; Rudd 1996). This revenue accrued to the government is used to finance its expenditure which could affect the fiscal balance position of the government. The revenue is used to finance the agricultural sector and the service sector (health, education and infrastructure) which will improve the performance of these sectors (PIAC, 2012).

The spending effect of the oil revenue accrued to the government could affect inflation and exchange rate due to increase in the demand for goods and services (Arezki & Ismail, 2010; Sala-i-Martin & Subramanian, 2003). The pressures from aggregate demand will cause the prices of non-tradable goods and services to increase since the prices of these goods and services are determined domestically leading to inflation. The increase in aggregate demand will lead to an increase in import since the supply of goods and services cannot meet demand. This will cause a fall in real effective exchange rate, implying a depreciation of the domestic currency (Arezki & Ismail, 2010; Sala-i-Martin & Subramanian, 2003).

The energy sector provides energy to the agricultural sector, manufacturing sector and services sector. These sectors benefit from energy through the provision of electricity and fuel. The agricultural sector, manufacturing sector and services sector affect the exchange rate position through exportation and importation of goods and services. These sectors also affect inflation through the cost of production which is transmitted into the price of goods and services. When the cost of production is high (low), the price of goods and services increases (decreases). When the goods and services available is in abundance (scarce) on the market, the price of the goods and services falls (rises) since the supply of goods and services is greater (less) than the demand for the goods and services.

Finally, inflation affects exchange rate. Similarly, exchange rate affects inflation (Dzupire, 2020). When the prices of goods and services are high (low) relative to foreign prices, it leads to an increase (decrease) in the demand for imported products which require a high (low) demand for foreign currency to purchase and contributes to a rise (fall) in the exchange rate (Antwi, Boadi, & Koranteng, 2014). Similarly, a fall (rise) in the exchange rate could cause the cost of production to reduce (increase) since the price of imported inputs would reduce (increase), hence transmitting to a fall (rise) in the general price level (Agénor & Montiel, 1996; Dornbusch,1976; Monfared & Akın, 2017; Svensson, 2000).

Empirical Review

There have been numerous studies conducted on crude oil production for oil producing or oil-exporting countries. Majority of this research focused on the economic growth of oil-producing with few studies focusing on non-oil sectors and macroeconomic variables. In undertaking the review, the study first examined works in other parts of the world, followed by literature from Africa and finally related literature in Ghana.

Torres, Afonso and Soares (2012) examined the impact of oil abundance on the economic growth of crude oil producers using an original approach. The study employed a panel factor-efficiency growth accounting model using annual data from 1980 to 2003 for 48 oil-producing countries. They found that oil abundance did not contribute to economic growth. However, when there was a fiscal responsibility and good institution, oil concentration contributed to economic growth. In consonance with their findings, Cotet and Tsui (2013) employed data on worldwide discoveries and observed a positive relationship between oil abundance and economic growth in the long run. For the panel estimation, the study adopted the pooled ordinary least square, fixed, Anderson-

Hsiao IV, and Arellano-Bond GMM estimation technique. Similar study by Bildirici and Kayıkç (2013) using major oil-exporting Eurasian countries on annual data from 1993 to 2010. The study reported same findings as Cotet and Tsui (2013). The panel ARDL, Granger causality and fully modified ordinary least square (FMOLS) were employed in the study.

Also, Djelloul and Talbi (2017) employed the same estimation techniques as Bildirici and Kayıkç (2013) from 1994 to 2013 for Organization of the Petroleum Exporting Countries (OPEC) and revealed the same findings as earlier studies. These latter studies contradict the study by Torres, Afonso and Soares (2012). The differences in their findings may be warranted by the differences in the strengths and weaknesses that are associated with their methodologies including the data span and econometric techniques applied and also, different economic conditions for these countries. The result from a cross-country analysis suffers from a high level of aggregation which may be different when an individual country is considered.

Crude oil revenue could contribute to economic growth since these revenues are used for developmental projects. A within-country analysis by Alkhathlan (2013) using data spanning from 1971 to 2010 revealed that oil revenue had a positive impact on real GDP in the short run and long run in Saudi Arabia when autoregressive distributed lag (ARDL) model approach was adopted. Al Rasasi, Qualls and Alghamdi (2018) extended the analysis from 1970 to 2017 using the error correction model (ECM) and Granger causality and reported same findings as Alkhathlan (2013). In agreement with the findings from earlier studies, Masan (2019) using data from the period of 1980 to 2013 revealed same findings for Oman. The Johansen cointegration technique and the vector autoregressive (VAR) model were employed for the study. The study employed a VAR model which is not based on economic theory for imposition of restrictions and the estimated shocks in the model are not pure shocks. Moreover, these countries have different economic conditions from Ghana which implies that results and recommendations obtained from the study may not be applicable to Ghana.

Measuring crude oil using exports and income to find its impact on economic growth. Maalel and Mahmood (2018) employed the non-linear ARDL cointegration using annual data from 1980 to 2016 and estimated the impact of oil dependence on economic growth in all Gulf Cooperation Council (GCC) countries. They reported that oil dependency on economic growth was pleasant for countries with higher income-dependence than those with lower income dependence. In terms of exports, countries that had higher exports-dependence experienced an adverse effect on economic growth than countries with lower exports-dependence. In contrast, Khayati (2019) revealed a positive impact for Bahrain. The study employed the cointegration analysis using annual data from 1997 to 2015. GCC countries and Bahrain have different economic conditions from Ghana, hence results and recommendations may not be applicable to Ghana.

Crude oil production and its impact on non-oil sectors. A cross-country analysis conducted by Klein (2010) using a panel VAR approach and an annual data from 1985 to 2008 for 23 developing countries including African countries. Natural resource curse effect was found to have a large effect in countries with high oil-intensity. The oil sector was found to have a positive effect on the non-oil sector for countries with low oil-intensity and vice-versa for countries with high oil intensity. However, the non-oil sector contributed more to the oil sector than what the oil sector contributed to the non-oil sector. The study did not disaggregate the non-oil sectors to identify the sectors that are benefiting or lagging from the spill overs of the oil sector. Also, the study employed a cross-country analysis. Therefore, the result and policy recommendation could be different when an individual country is considered. Similar study was investigated by Al-Mawali, Hasim and Al-Busaidi (2016) using the boxplot method over the period 1980 to 2012. They reported same findings as Klein (2010) Oman. However, they reported that the least influence of the oil sector was on the agricultural sector of the economy. Oman has a different economic condition from Ghana which implies that the results from their study may not be applicable to Ghana given the time span of oil production in Oman.

Evidence to support crude oil production on government expenditure by Farzanegan (2011) using the unrestricted vector autoregressive (VAR) in Iran over the period 1959 to 2007. The study disaggregated government expenditure into military and security expenditures and other social spending components. The author found that military and security expenditures responded positively to shocks in oil revenue while other social spending components showed no response to oil revenue shocks. The VAR model employed in the study is not based on economic theory for imposition of restrictions. Moreover, the estimated shocks in the model were not pure shocks. Similarly, Ali and Harvie (2013) employed the deterministic dynamic general equilibrium macroeconomic model in Libya and found that an increase in oil revenue increased government revenue and spending in the domestic economy. In contrast to earlier findings, Monjazeb, Choghayi and Rezaee (2014) found a negative impact for selected oil-exporting countries when OLS method was employed using annual data from 1995 to 2011.

When Monjazeb, Choghayi and Rezaee (2014) singled out Iran and Kuwait who are OPEC members, this effect was found to be insignificant for Iran and Kuwait. A similar cross-country analysis by Adedoyin, Liu, Adeniyi and Kabir (2017) for 20 oil-dependent economies and 61 net oil exporting countries including Ghana. They employed the general method of moment (GMM) in comparison with estimations from pooled OLS, least-square dummy variable (LSDV) fixed effects, and two-stage least square (2SLS) technique on data from 2000 to 2005. For countries who adopted fiscal rules, they found oil rent shocks to have no impact on fiscal balance. This finding conforms with the study by Monjazeb, Choghayi and Rezaee (2014). The differences in their findings may be warranted by the differences in the strengths and weaknesses associated with their methodologies including the data span and econometric techniques applied and also, different economic conditions for the countries. Also, the result from a cross-country analysis suffers from a high level of aggregation which may be different when an individual country is considered.

In Africa, evidence to support crude oil production on economic growth was examined by Lucky and Nwosi (2016) using annual data from 1981 to 2014 and the ordinary least square (OLS) method, granger causality test and the vector error correction model (VECM). The study found a long run relationship among the variables but revealed no relationship between oil production (exports, reserves, revenue) and economic growth. Causality was found among the variables. The study concluded that Dutch disease syndrome and classical theory of the paradox of plenty exist in Nigeria. In testing for the Dutch disease syndrome, the real GDP was used as the measurement of economic growth which was not appropriate. In agreement with earlier study, Tamba (2017) employed the vector autoregressive (VAR) model and the wald test using annual data from 1977 to 2010 for Cameroon and reported same findings as Lucky and Nwosi (2016). The study employed a VAR model which is not based on economic theory for imposition of restrictions and that the estimated shocks in the model are not pure shocks.

In contrast to earlier findings, Nwoba and Abah (2017) revealed a positive relationship for Nigeria using the OLS technique for the period of 1960 to 2010. There was high R^2 (0.99) and t-values (10.7, 11.8) and low Durbin (1.2), indicating a spurious regression result. This implies that the time series variables used were non-stationary. Similarly, Mohammed (2018) employed the ARDL approach to cointegration using data from 1985 to 2015 for Angola and found oil production and economic growth to cointegrate. Also, the study reported same results as Nwoba and Abah (2017). The differences in their findings may be justified by the differences in the strengths and weaknesses associated with their methodologies including the data span and econometric techniques applied and also, different economic conditions for the countries. Moreover, the countries used have a different economic condition from Ghana which implies that the results from their study may not be applicable to Ghana.

Employing ordinary least squares approach (OLS), oil revenue, public expenditure and economic performance in Nigeria were investigated by Ademola, Olasode, Raji, and Adedoyin (2015) using annual data from 1982 to 2011. They reported that total health expenditure, oil revenue and post-primary school enrolment showed a positive effect on real GDP. However, primary and tertiary school enrolments were found had a negative impact on real GDP. Similarly, Aregbeyen and Kolawole (2015) also reported same findings as Ademola *et al*. (2015). They adopted OLS, vector error correction model (VECM) and Granger causality from the period 1980 to 2012. On the other hand, Maku and Oyelade (2018) extended the analysis from 1980 to 2014 employing similar estimation technique as Aregbeyen and Kolawole (2015) and revealed same findings. However, money supply had no impact on economic growth. Nigeria has a different economic condition from Ghana which implies that the results from their study may not be applicable to Ghana.

The relationship between crude oil production and export, prices and foreign exchange rate in Nigeria were conducted by Inyiama and Ikechukwu (2015). The OLS, correlation and Granger causality approach were adopted for the study using data from 2006 to 2014. Their findings revealed that the volume of crude oil (production, export and price) did not affect foreign exchange rate. The study concluded that other factors may affect foreign exchange rate other than crude oil production, sales price and export in Nigeria.

Crude oil production could have an impact on the non-oil sectors and this would be extended to economic growth. The interaction and feedback mechanism between agricultural and oil sectors in Nigeria was assessed by Ekperiware and Olomu (2015). They adopted the vector autoregressive (VAR) model using annual data from 1981 to 2012. They revealed a positive impact of oil shock on agricultural sector and output (GDP). In addition, through investment in the agricultural sector from the gains of the oil sector, agricultural output showed a positive effect on economic development. Similarly, Raheem (2016) revealed a negative relationship between oil exports and economic growth while a positive relationship was found between non-oil exports and economic growth. The study employed the Johansen cointegration test, Granger causality test and the vector autoregressive (VAR) model using annual data from 1981 to 2015. These studies employed a VAR model which is not based on economic theory for imposition of restrictions and the estimated shocks in the model are not pure shocks.

Adedokun (2018) employed structural vector autoregressive (SVAR), VAR and VEC models for annual data from 1981 to 2014 and found that oil shocks highly affect government revenues and expenditures which transmit to other macroeconomic variables in the long run. The study Nigeria has a different economic condition from Ghana which implies that the results and recommendations from their study may not be applicable to Ghana.

In Ghana, there is much evidence on crude oil production and economic growth. Dah and Khadijah (2010) employed a case study approach using Dunning's eclectic paradigm. The study used Angola and Norway as a case study. The study found when there is an appropriate implementation of oil revenue, oil production could contribute to economic development and attract more foreign direct investment. The case study approach may be misleading because the countries used for the study have different characteristics from Ghana. Similarly, Acquah-Sam (2014) employed a descriptive analysis and concluded that oil and gas does not transform the economy but the efficient management and use of revenues from the sale of oil and gas production will be crucial to economic development in Ghana. This study employed a descriptive analysis to assess the trend of the variables without an inferential analysis.

In addition, Fragkos, Paroussos and Fragkiadakis (2017) employed computable general equilibrium (CGE) modelling and value chain analysis and found that the oil and gas sector had a greater impact on GDP than employment. The findings indicated that oil and gas fields had limited positive effects on local value chains in terms of skills, employment and development of small and medium enterprises (SMEs). Acquah-Andoh, Gyeyir, Aanye and Ifelebuegu (2018) employed ordinary least squares (OLS) regression from the last quarter of 2010 to the last quarter of 2012 and reported that petroleum revenue does not contribute to the GDP of Ghana after adjusting for the other sectors of the economy. The study further reported a decline in the agricultural share of GDP corresponding to real effective exchange rate appreciation, indicating Dutch disease effect. The sample size (9) used for the study was small, hence the OLS estimation technique used in the study was not appropriate.

Establishing the impacts of oil production on the non-oil sector Asafu-Adjaye (2010) employed the computable general equilibrium (CGE) model using the 2005 social accounting matrix (SAM). It was revealed that oil production causes an increase in GDP growth rate and a deterioration in trade balance. However, oil production had a potential negative impact on the agricultural, manufacturing and services sectors. The CGE model employed for the study was based on theoretical assumption with no time series data to test empirically.

Employing a calibrated multi-sector DSGE model, Dagher, Gottschalk and Portillo (2010) analysed the likely impact of oil windfalls on the Ghanaian economy. The study reported that increase in oil revenue translates into high government spending since revenue accrues directly to government. The study further found inflation and real exchange rate to be moderately affected when there is smooth oil-related spending by the fiscal authorities. Amidst this, the study did not include fiscal balance to check how oil revenues possibly impact the fiscal balance position through the revenue received by government. Also, the DSGE model employed for the study was based on theoretical assumption with no time series data to test empirically.

Oil discovery and macroeconomic management in Ghana were conducted by Bawumia and Halland (2017). The study used an empirical analysis to account for the evolution of fiscal and monetary variables from 2007 to 2014. The variables considered were real exchange rate, inflation, fiscal deficit, real GDP growth, interest rate and current account. The study reported a rapid depreciation in real exchange rate, decline in real GDP growth, high current account and fiscal balance deficits, and a rise in inflation and interest rate. The study concluded that there exist traces of resource curse in Ghana. The study employed descriptive analysis to assess the trend of the variables without inferential analysis to verify the impact of crude oil on the macroeconomic variables.

In line with the aforementioned, the empirical review indicates that majority of the study conducted focused on economic growth, and the expenditure and revenue of the government. There exist limited studies on the impact of oil production on non-oil sectors and macroeconomic variables such as fiscal balance, exchange rate and inflation which are also crucial macroeconomic variables. Besides, some studies did a cross-country analysis which suffers from high level of aggregation and may produce different results if individual countries are considered. In addition, a number of these studies were based on the VAR/VECM model which has been criticised in the literature not be based on theory. In Ghana, there are limited studies on the impact of crude oil production on non-oil sectors, fiscal balance, real effective exchange rate and inflation.

Moreover, the study conducted on the effect of crude oil production on the non-oil sector and macroeconomic variables employed the CGE and DSGE models which are based on theoretical assumption without the application of time series data to empirically check the theoretically based assumptions. The current study investigated the impact of crude oil production on macroeconomic performance in Ghana by focusing on non-oil sectors (agricultural sector, manufacture sector and services sector) and macroeconomic variables (inflation, exchange rate and fiscal balance) of the Ghanaian economy using time series data from 2011 to 2018. Also, the study employed a structural vector autoregressive (SVAR) model to assess the dynamics and the transmission mechanism of crude oil production and macroeconomic performance in Ghana.

Summary

The chapter reviewed literature on crude oil production and macroeconomic performance. The overview presents the history of crude oil production and how the various sectors and the macroeconomic variables performed amidst the production of crude oil. The theoretical review provided theories that explained how crude oil production transmits into the economy and how the economy can be sustained for the future. The theoretical framework provided a linkage on how crude oil affects the sectors and macroeconomic variables using the Dutch disease theory. In addition, the empirical review showed the studies conducted on crude oil production for oil exporting countries and the gaps that exist. The literature review highlighted how crude oil production impact an economy. This provided a need for the current study to be conducted to ascertain the impact of crude oil production on the macroeconomic performance in Ghana.

CHAPTER THREE

RESEARCH METHODS

This chapter presents the design and methods used in achieving the objective of the study. It explains the research design, theoretical and empirical model specifications, measurement and justification of the variables, source of data and the estimation techniques.

Research Design

The study adopted the positivist philosophy. The positivist philosophy presents an opportunity to examine socio-economic phenomena objectively, and clarify the relationship between variables (Cantah, 2017). The philosophy is based on pure facts and explains the research objectively (Levin, 1988). The positivist view allows the researcher to remain neutral and independent from the study. This implies that the philosophy prevents human interference with the phenomenon under study (Crotty, 1998). Besides, the findings and analysis of the research are observable and quantifiable. The philosophy employs quantitative research approach because it allows for objectivity and uses quantitative instruments such as different statistical procedures in the analysis of the data.

The quantitative research approach employed in the study is suitable to determine the impact of crude oil production on macroeconomic performance in Ghana. The approach is based on examining the relationship between variables through data gathering in numerical form and analysis with the aid of statistical methods (Aliaga & Gunderson, 2002). In comparison to qualitative research, results from the quantitative approach are reliable, valid, objective, precise and generalisable (Hammersley, 2008; Saunders, Lewis, & Thornhill, 2012). Specifically, the study adopted the explanatory design since it allows the researcher to identify cause and effect relationship and assign explanation to the relationship. The explanatory research is generally used to evaluate the impacts of specific changes on existing processes. The design provides the best approach to the research because it provides a better insight into the research and draws a better conclusion.

Theoretical Model Specification

To analyse the impact of crude oil production on macroeconomic performance in Ghana, following the review of theoretical and empirical literature, the study adopted the Dutch disease model described by Corden (1984), Corden and Neary (1982), and Rudd (1996). The model explains the negative effect of discovery and exploitation of a booming sector on non-booming and non-tradable sectors of an economy. The core model of the Dutch disease theory posits three sectors of the economy. These are booming sector (oil sector), lagging sector (agricultural and manufacturing sectors) and non-tradable sector (services sector). The booming sector and the lagging sector face a given world price. The output of each sector is produced by a factor specific to that sector and by labour which is assumed to be mobile between the sectors. The model assumes that all factors are internationally immobile and factor prices are flexible. A boom in the oil sector is assumed to occur through technology-induced rise in productivity, windfall discovery of new resource, and rise in world price of oil. The model distinguishes between two separate effects on the lagging sector and the non-tradable sector. These are the resource movement effect and the spending effect.

The spending effect considers the situation where incomes from the booming sector (oil sector) is spent directly by factor owners or indirectly through taxes collected and spent by the government on the non-traded sector (services sector) provided the income elasticity of the non-traded sector is positive. This raises the price of the non-traded sector relative to the price of the traded sectors (booming and lagging) leading to appreciation of the real exchange rate. This draws resources out of the booming and lagging sectors into the non-tradable sector and shifts demand away from the non-tradable sector to the booming and lagging sectors. The resource movement effect occurs when there is movement of labour from the lagging and non-tradable sectors to the booming sector due to a rise in marginal product of labour in the booming sector. At a constant wage, the demand for labour increases in the booming sector leading to a direct deindustrialisation or de-agriculturalization of the economy. Specifically, the study adapted the Dutch disease model developed by Rudd (1996), which can be written as:

$$D = f(SE, RM) \qquad (1)$$

Where D represents decline in manufacturing sector or agricultural sector, SE represents spending effect, and RM represents resource movement effect.

In line with the study, the model was re-specified as:

$$NOS = f(SE, NR) \qquad (2)$$

Where NOS is non-oil sectors, SE is spending effect, and NR is natural resource. The non-oil sectors (NOS) were the agricultural sector, manufacturing sector and services sector. The spending effect (SE) comprised fiscal balance (FB) and real effective exchange rate (REER). The natural resource (NR) was crude oil production (OP).

The current study augmented the Dutch disease model (equation (2)) with the services sector, fiscal balance, crude oil price and inflation as shown in equation (3). The services sector was included to capture the non-traded sector which probably benefits from crude oil production. The fiscal balance (FB) was used to capture the spending effect of the Dutch disease. This is because the government is the first to initiate spending in an economy and that the revenue received contributes to the revenue generated by government in financing its budget. The inclusion of the crude oil price (OPR) is based on its likely impact on the exchange rate position and the revenue earned from the sale of oil. Also, inflation (CPI) was included to capture the spending effect from the increase in income in the economy.

$$NOS_t = f\ (FB_t, REER_t, OP_t, CPI_t, OPR_t) \tag{3}$$

To account for the effect of natural resource on macroeconomic variables which emanates from the spending effect, the model was specified as:

$$MV = f\ (NR) \tag{4}$$

Where MV is macroeconomic variables and NR is natural resource. The macroeconomic variables (MV) comprised the spending effect variables; fiscal balance, inflation and real effective exchange rate. The natural resource (NR) variable was crude oil production (OP). The price of crude oil (OPR) was used as a control variable and the model was re-specified as:

$$MV_t = f\ (OP_t, OPR_t) \tag{5}$$

Empirical Model Specification

Empirical objective 1

This objective examined the impact of crude oil production on non-oil sectors. The equation used was specified as:

$$NOS_t = \beta_0 + \beta_1 OP_t + X_t'\beta_2 + \varepsilon_t \qquad (6)$$

Where NOS is the agricultural (AGR), manufacturing (MAN) and services (SER) sectors, OP is crude oil production and X_t' is a vector of the explanatory variables; fiscal balance (FB), real effective exchange rate (REER), inflation (CPI) and crude oil price (OPR).

Empirical objective 2

The empirical objective 2 investigated the impact of crude oil production on macroeconomic variables. The equation used was specified as:

$$MV_t = \beta_0 + \beta_1 OP_t + \beta_2 OPR_t + \varepsilon_t \qquad (7)$$

Where MV is fiscal balance (FB), real effective exchange rate (REER) and inflation (CPI), OP is crude oil production and OPR is crude oil price.

Measurement and Justification of Variables

The variables that were measured in the study were crude oil production, agricultural sector, manufacturing sector, services sector, inflation, crude oil price, real effective exchange rate and fiscal balance. The data from crude oil production, agricultural sector, manufacturing sector, services sector, real effective exchange rate and crude oil price were transformed using natural log and used for the estimation. This normalised the data to eliminate outliers and ensured easy interpretation of the results.

Crude oil production (OP)

Crude oil production was the main variable of interest and formed the basis of the study. Crude oil production as used in the study was measured in volume terms; that is the total oil produced per millions of barrels in a month. After production of crude oil, only a fraction is exported. To capture the total amount of crude oil produced and ascertain its impact on the economy, it was important to use the total volume produced. The use of the crude oil production instead of the revenue from the production could capture the abundance of the resource and the activities in the oil sector.

Agricultural sector (AGR)

The agricultural sector comprises the sum of the value-added output of crops, forestry and logging, fishing and livestock (subsectors) in value terms (GH₵). The sector was measured as the value-added output in millions of cedi (GH₵). The agricultural sector is an important contributor to Ghana's export earnings and GDP. The share of the sector to GDP has continued to decline despite the use of proceeds from production of crude oil in financing projects in the sector. The Dutch disease affects the competitiveness of this sector.

Manufacturing sector (MAN)

The manufacturing sector was measured as the value-added output in millions of cedi (GH₵). The manufacturing sector is among major sectors of the economy and contributes significantly to GDP. The production of crude oil could affect the manufacturing sector since the production of oil could lead to expansion in the electricity subsector which is a vital input for the manufacturing industries. Besides, the production of oil is known to affect the competitiveness of this sector.

Services sector (SER)

The services sector comprises the sum of the value-added output of hotel and restaurant, information and communication, transport and storage, real estate, financial and insurance activities, repair of vehicles, trade, household goods, social security, public administration and defence, health and social work, education, and administrative, professional and support service activities subsectors in value terms (GH₵). The services sector was measured as the value-added output in millions of cedi (GH₵). This sector is the leading sector in the economy and a large contributor to GDP since 2011. The production of crude oil could influence the services sector through trade and transport and storage subsectors.

Crude oil price (OPR)

It is the monthly international crude oil price measured in dollars ($). Crude oil price was included to assess its effects on the macroeconomic performance in Ghana. The price of crude oil influences the economy due to Dutch disease effect where the price hinders the competitiveness of the non-oil sectors through the exchange rate. The Ghanaian economy does not influence the price of crude oil as a small economy compared to OPEC hence it was treated as an exogeneous variable.

Inflation (CPI)

The consumer price index (CPI) of Ghana was used as a proxy for inflation. Consumer price index (CPI) is measured as the weighted average of prices of a basket of consumer goods and services. The spending effect of crude oil production could affect inflation. For instance, an increase in demand for goods and services owning to the effect of increase in income from crude oil production could lead to inflation. Also, the expenditure incurred by the government due to revenue accrued from the production of crude oil could have an impact on inflation. Inflation was estimated by dividing CPI by 100.

Real effective exchange rate (REER)

Real effective exchange rate (REER) is measured as the value of the Ghanaian cedi against a weighted average of major currencies adjusted for inflation. It has a strong influence on the economic position of a country through the volume of imports and exports of the country. The exportation of crude oil through the effect of crude oil price could influence the real effective exchange rate which could impact the competitiveness of the other sectors especially the non-booming sectors. Also, hikes in crude oil prices and oil revenue volatilities could cause volatilities in government spending if government expenditure is closely associated with oil revenue which could subsequently cause changes in the real effective exchange rate due to the spending effect of crude oil production (Brahmbhatt, Canuto, & Vostroknutova, 2010).

Fiscal balance (FB)

Fiscal balance was measured as the difference between total revenue and grants, and total expenditure and net lending in millions of cedis (GH₵). The amount of money that the government receives from crude oil production will impact the fiscal balance position of the government because part of the revenue is allocated for annual budget funding. Besides, the revenue that the government receives to finance its annual budget funding is used to develop the non-oil sectors. Hence, fiscal balance may have a possible impact on the non-oil sectors through the investment of oil proceeds. The fiscal balance was expressed as a percentage of GDP and used for the estimation.

Sources of Data

The study employed monthly time series data between the period of January 2011 and December 2018 to determine the impact of oil production on macroeconomic performance in Ghana. The data set employed was obtained from secondary sources. Data on inflation, crude oil price, fiscal balance, crude oil production, the sectors and real effective exchange rate (REER) were sourced from Bank of Ghana (BoG), Ghana National Petroleum Corporation (GNPC), Ministry of Finance (MoF) and the Ghana Statistical Service (GSS) and Global Economic Monitor (GEM) indicators of World Bank.

Estimation Procedure

Structural vector autoregressive (SVAR) model

The study employed the structural vector autoregressive (SVAR) which hinges on the maximum likelihood estimation (MLE) technique. The MLE method provides a means to estimate a set of parameters characterising a distribution that is assumed to be known. The technique assumes that the errors are normal and identically distributed. The maximum likelihood estimator is consistent and asymptotically efficient. SVAR approach is used to analyse the dynamics of a model subjected to an unexpected shock, and test and evaluate the effectiveness of economic policies (Gottschalk, 2001; McCoy, 1997).

The SVAR model was preferred to the DSGE model because the SVAR model avoids incredible and strict restrictions, and provides economic transmission mechanism which the DSGE model fails to provide (Gottschalk, 2001; Kamati, 2014; Tovar, 2009). Besides, the DSGE model has numerous assumptions and suited for policy simulation. Moreover, the imposition of identification restrictions on the VAR model is based on the Choleski decomposition which has been criticised (Cooley & LeRoy, 1985). The estimated shocks in the VAR model are not pure shocks but linear combinations of structured disturbances which makes it difficult to assess the dynamic effects of the variables (McCoy, 1997).

The SVAR model can determine the dynamic effects on variables because the dynamic effect depends on all the structural disturbances but not a linear combination of the disturbances, and restrictions imposed are based on economic theory (McCoy, 1997). Besides, the atheoretical approach of the VAR model does not provide a clear economic interpretation for the impulse response function (IRF) and variance decomposition (VD). The SVAR model used in the study was presented as:

$$A_o y_t = \alpha + \sum_{i=1}^{q} A_i y_{t-i} + \gamma W_t + B\varepsilon_t \qquad (8)$$

The matrix A_0 is a 7 × 7 dimension of contemporaneous coefficient relations on y_t, and y_t is a column vector with 7 × 1 endogenous variable. α is a column vector with 7 × 1 constants variables of the endogenous variables. A_i is matrices of structural coefficients on the lagged endogenous variables in the model. The endogenous variables were crude oil production, agricultural sector, manufacturing sector, services sector, fiscal balance, exchange rate and inflation. W_t is an exogenous variable. Crude oil price served as the exogenous variable. Matrix B was set as a diagonal matrix because of the orthogonal assumption of structural innovations. ε_t is a 7 × 1 column vector of structural shocks. It is normally distributed with mean zero and its variance-covariance matrix $\sum_{\varepsilon}$, where $\sum_{\varepsilon}$ is a diagonal (identity) matrix. ordinary least squares (OLS) method cannot be applied to equation (8) because y_t breaks the assumption of no correlation between independent variables in matrix A and structural shocks (Kamati, 2014).

The reduced form of Equation (8) was given as:

$$y_t = A^{-1}{}_0\, \alpha + A^{-1}{}_0\, A_1 y_{t-1} + \ldots + A^{-1}{}_0\, A_q y_{t-q} + A^{-1}{}_0\, \gamma W_t + A^{-1}{}_0 B \varepsilon_t \quad (9)$$

$$y_t = D + C_1 y_{t-1} + \ldots + C_q y_{t-q} + BW_t + u_t \quad (10)$$

From equation (10), the reduced form of the residuals is obtained as u_t. The lagged values of the endogenous variable are on the right-hand side hence OLS can be applied directly to equation (10) because the estimates are consistent and efficient.

Identification Conditions: Short Run SVARs

The structural residuals were obtained from the reduced form residuals by linear transformation:

$$u_t = A^{-1}{}_0 B \varepsilon_t \quad \text{or} \quad A_0 u_t = B \varepsilon_t \quad (11)$$

The restriction was imposed on matrix A_0 and B where the B restriction is the diagonal restrictions placed on the error term. The matrix A_0 contains the instantaneous effect of the structural shocks on the observed variables. There is a need to impose restrictions on the structural model to be able to identify the structural model from an estimated VAR. The minimum number of restrictions that can be imposed on matrix A_0 is $(n^2-n) / 2$. A block-recursive structure was imposed on matrix $A^{-1}{}_0$ (equation (11)). From matrix $A^{-1}{}_0$, the number of restrictions required was 21 based on economic theory and intuition.

$$\begin{pmatrix} \mu_t^{op} \\ \mu_t^{agr} \\ \mu_t^{ser} \\ \mu_t^{man} \\ \mu_t^{fb} \\ \mu_t^{reee} \\ \mu_t^{cpi} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{pmatrix} \times \begin{pmatrix} \varepsilon_t^{op} \\ \varepsilon_t^{agr} \\ \varepsilon_t^{ser} \\ \varepsilon_t^{man} \\ \varepsilon_t^{fb} \\ \varepsilon_t^{reer} \\ \varepsilon_t^{cpi} \end{pmatrix} \qquad (12)$$

The first row of the matrix (equation (12)) represents the equation for crude oil production. It was assumed that at least in the short run the other variables do not have an immediate impact on crude oil production. Crude oil production does not react to variations in the demand for oil. This is because the response to meet market demand will slow down amidst the uncertainty of the market and cost of production of crude oil (Kilian, 2009). This implies that activities in the sectors and the changes in the macroeconomic variables do not determine crude oil production at least in the short run. Crude oil production shocks could affect economic activity due to its importance in the world. Besides, crude oil is a critical input of production in Ghana. In view of this, shocks to crude oil production could affect economic activities including macroeconomic variables.

The second row represents the agricultural sector equation. This was based on the assumption that structural shocks from the other variables do not have an immediate effect on the agricultural sector except crude oil production. The production of crude oil could affect agricultural sector since most of the agricultural products such as rubber, cocoa, forestry and minerals in Ghana come from the Western region where oil is produced and a booming oil industry will shift labour from the agricultural sector to the oil sector. Also, the production of crude oil could benefit the agricultural sector through manufacturing of oil by-products such as fertilisers and insecticides which are very important inputs in agricultural production (Lawson, Adiku, & Danso, 2014). The Dutch disease effect of oil discovery could have an impact on the agricultural sector (Apergis, El-Montasser, Sekyere, Ajmi, & Gupta, 2014; Corden & Neary, 1982).

Despite the interconnectedness between the sectors, changes in the other sectors may not affect agricultural output at least within the shortest time because production in this sector is done on seasonal basis. Changes in real effective exchange rate do not affect agricultural sector output because production in this sector occurs on seasonal basis and most of the agricultural inputs are locally made. Changes in fiscal balance may not affect agricultural sector at least in the short run because budget allocation for a particular period is fixed and cannot be changed within the shortest time. The agricultural sector in developing countries is known to be rural-based and depends heavily on natural resources, hence is likely to be less sensitive to changes in price (Ball & Romer, 1993). Therefore, changes in inflation will not have an immediate impact on the agricultural sector because price change at a particular period may not influence the output produced by the sector.

The third row represents the services sector equation. The equation was based on the assumption that structural shocks from the other variables do not have an immediate effect on services sector except crude oil production and agricultural sector. Changes in the production of crude oil have immediate effects on the services sector through the provision of fuel for the transport and trade subsectors. The production of oil will demand importation of equipment which requires the services of this sector. Also, the exportation and importation of oil have an immediate impact on the trade subsector. Even though interdependency have been observed between the sectors, it takes a long time for manufacturing sector output changes to affect the services sector at least in the short run because it requires time to adjust to these changes.

Changes in the agricultural sector output have contemporaneous effects on the services sector output through the trade subsector by exportation of products from the agricultural sector. Changes in fiscal balance may not have an immediate effect on the services sector at least in the same period. The services sector does not depend on imports, therefore, fluctuations in real effective exchange rate do not have immediate effects on the sector at least in the short run. The services sector is sensitive to inflationary changes since it is urban-based (Ball & Romer, 1993). However, variations in inflation do not have an immediate effect on the services sector in Ghana since it takes time for economic agents to react to price changes.

The fourth row represents the manufacturing sector equation. All the variables was assumed to have a contemporaneous effect on the manufacturing sector output except fiscal balance, exchange rate and inflation. A structural shock from crude oil production has an immediate effect on the manufacturing sector output because changes in crude oil production affect the electricity subsector which provides electricity to industries to produce for the manufacturing sector. The output from agricultural sector serves as inputs for the sector, implying that changes in the agricultural sector have immediate effects on the manufacturing sector which form the basis for industrialisation (Fei & Ranis, 1969; Kuznets, 1966). Also, structural changes in the services sector can affect the output of the sector at least in the shortest time since the manufacturing sector depends on the trade subsector for importation of inputs for production.

Changes in fiscal balance do not have an immediate effect on the manufacturing sector because it may not influence output produced in the sector at least in the same period. The real effective exchange rate changes does not have an immediate impact on manufacturing sector since the inputs used in manufacturing are imported within a period of time. Similarly, inflationary changes may not affect manufacturing sector output in the short run because it takes time for economic agents to respond to inflationary changes. Also, this sector makes purchases of inputs for a specified period, therefore, inflationary pressures may not influence the output of the sector at least for the shortest time.

The fiscal balance equation is represented in the fifth row (equation (12)). The underlying assumption was that structural shocks from crude oil production, agricultural sector, services sector and manufacturing sector could have a contemporaneous effect on fiscal balance except exchange rate and inflation. Shocks to fiscal balance correlate to changes in crude oil production because some of the revenue accrued and tariffs paid (especially royalties) on the oil produced to the government is used to finance expenditure. Changes in the agricultural sector, services sector and manufacturing sector could have an immediate effect on fiscal balance since these sectors generate revenue through trade tariffs or trade tax to the government to finance its expenditure. Changes in real effective exchange rate and inflation may not have a contemporaneous effect on fiscal balance because these variables are determined by current market conditions.

The sixth row represents the exchange rate equation. It was assumed that except inflation structural shocks from the other variables have a contemporaneous effect on real effective exchange rate. Crude oil production could have immediate impact the real effective exchange rate through exportation to the international market. Also, the revenue generated from the sale of crude oil is quoted in US dollars and must be converted into the domestic currency (GH₵), hence affects the exchange rate position. The agricultural sector, services sector and manufacturing sector could similarly have a contemporaneous effect on exchange rate through exportation and importation of goods and services. Structural changes in the fiscal balance could affect real effective exchange rate by the twin deficit hypothesis. Fiscal deficit could lead to deficit in current account which could affect exchange rate. However, inflationary changes do not impact exchange rate at least in the shortest time because it takes long periods for economic agents to respond to inflationary changes through imports of goods and services.

The equation of inflation is indicated in the seventh row. The equation was based on the assumption that all the variables could have an immediate impact on inflation. Structural shocks from crude oil production could affect inflation because crude oil serves as input for production. Besides, the spending effect of Dutch disease has an impact on inflation. Economic theory posits two sources of inflation which are demand-pull and cost-push (Lipsey & Chrystal, 2003). The agricultural sector, services sector and manufacturing sector could have an immediate effect on inflation through the cost-push source since the production cost feeds directly into prices of goods and services.

In addition, an increase in demand for goods and services triggers a rise in the prices of goods and services and affect demand-pull inflation since aggregate supply is vertical in the short run. According to the fiscal theory of inflation, the price level is determined by present and future revenue, government debt and spending plans (Kaur, 2018). Hence, changes in fiscal balance affects inflation. Similarly, real effective exchange rate changes affect inflation through production cost by importation of goods and services which transmit into prices. This conforms to the purchasing power parity theory or the law of one price.

SVAR: Impulse Response Functions and Forecast Error Variance Decomposition

Individual coefficients in an estimated VAR or SVAR are difficult to interpret (Enders, 2010). In light of this, the study considered the structural forecast error variance decompositions (SFEVD) and the structural impulse response functions (SIRF) which are the main outputs of SVAR. The SIRF shows the dynamic response of current and future values of each variable to a unit change in the current value of one structural shock (Kamati, 2014). From equation (8), the impulse response functions were derived as:

$$A_o y_t = \alpha + \mathrm{A}\,(\mathrm{L}) y_t + \gamma W_t + \mathrm{B}\varepsilon_t \quad (13)$$

Where L is the lag operator and A (L) = $\sum_{i=1}^{q} A_i$

$$A_o y_t - \mathrm{A}\,(\mathrm{L}) y_t = \alpha + \gamma W_t + \mathrm{B}\varepsilon_t \quad (14)$$

$$[A_o - \mathrm{A}\,(\mathrm{L})]\, y_t = \alpha + \gamma W_t + \mathrm{B}\varepsilon_t \quad (15)$$

$$y_t = [A_o - \mathrm{A}\,(\mathrm{L})]^{-1}\, \alpha + [A_O - A(L)]^{-1}\, \gamma W_t + [A_o - \mathrm{A}\,(\mathrm{L})]^{-1}\, \mathrm{B}\varepsilon_t \quad (16)$$

Let D = $[A_o - \mathrm{A}\,(\mathrm{L})]^{-1}\, \alpha$, C = $[A_O - A(L)]^{-1}\gamma$, and E = $[A_o - \mathrm{A}\,(\mathrm{L})]^{-1}$

$$y_t = \mathrm{D} + \mathrm{C}W_t + E\ \varepsilon_t \quad (17)$$

$$y_t = D + \mathrm{C}W_t + E_0\varepsilon_t + E_1\varepsilon_{t-1} + \ldots + E\varepsilon_{t-S} \quad (18)$$

$$y_t = \mathrm{D} + \mathrm{C}W_t + \sum_{S=0}^{\infty} E_S\ \varepsilon_{t-S} \quad (19)$$

Equation (19) represents the structural moving average (SMA). SMA traces out the time path of various shocks on the variables in SVAR and is useful in examining the interaction between the variables in y_t (Enders, 2015). The Es stands for the structural dynamic multipliers which constitute the marginal effect of the innovations in the system y_{t+s}. This is expressed as follows:

$$E_S = \frac{\partial y_{t+s}}{\partial \varepsilon_t} \quad (20)$$

The forecast error variance decomposition (FEVD) shows the proportion of movements in a sequence owing to its own shocks against shocks of other variables (Enders, 2015). The SFEVD provides information about the relative importance of each random innovation to the variables in the SVAR.

Pre-Estimation Test

Unit root test

The properties of time series data are very crucial since they are rarely stationary at levels. The problem of spurious regression results arises when a non-stationary time series is regressed. This situation occurs when there is high R^2 and t-test values and low Durbin Watson which indicate a relationship among the variables while there may be not be any economic meaning. Also, when the variables have a unit root, the standard t-test and F-test do not have standard distributions (Stock & Watson, 1988). A time series variable is stationary if the data fluctuates around the mean and if otherwise, non-stationary.

The study employed the Augmented Dickey-Fuller (ADF) and Philip Perron (PP) unit root tests to check spurious regression, ascertain the order of integration of the variables and ensure reliability of the results. These tests only differ in the way they correct for autocorrelation in residuals. The PP test is superior to the ADF test in circumstances where the time series variable under investigation has serial correlation and structural breaks. The test assumes that the errors are weakly dependent and heterogeneously distributed. These properties make PP test a robust estimation test over ADF test. The null hypothesis tested unit root (non-stationary) for the variable considered against the alternative of no unit root (stationary). The ADF tests is a build-up on the DF tests to correct for autocorrelation by including lags. The Akaike information criterion (AIC) and Schwarz information criterion (SIC) was used to check the lag length for the ADF test. The Newey-West Bandwidth and the Andrews Bandwidth were also used to estimate the lag length for the PP test. The ADF equation and the PP equation used are specified in equations (21) and (22) respectively.

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \mu_{1t} \tag{21}$$

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \theta\left(t - \frac{T}{2}\right) + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \mu_{2t} \tag{22}$$

Where Y_t represents the series at time t, Δ is the difference operator, μ_t is the stochastic random disturbance term, and α, δ, ρ and β are parameters to be estimated. The μ_{1t} and μ_{2t} variables served as the covariance stationary random error terms for the ADF test and the PP test respectively.

The ADF and PP unit roots tested the hypothesis that:

H_0: $\rho = 0$

H_1: $\rho < 0$

Diagnostic test

A diagnostic test was conducted before the estimation of the SVAR model. The diagnostic test conducted were lag selection criteria, serial correlation test and stability test. The lag length selection criteria were employed to determine the optimal lag required to include in the model. The degrees of freedom are affected if the number of lags required in the model exceeds the optimal. To avoid this, the log-likelihood (LL), sequential modified likelihood ratio (LR), Akaike information criterion (AIC), final prediction error (FPE), Hannan-Quinn information criterion (HQIC) and Schwarz information criterion (SIC) tests were employed. The Wald test was employed for the lag exclusion test to confirm the inclusion of lags in the model. The Breusch Godfrey Lagrange multiplier test was also employed for the serial correlation test. Finally, the plots of eigen values were used to test for the stability of the model.

Data Analysis

The monthly time series of fiscal balance, agricultural sector, manufacturing sector and services sector were generated by the Chow and Lin (1971) extrapolation technique with E-Views 10 statistical package. The match sum was used to ensure that the monthly data sums up to the quarterly and yearly data available. The descriptive statistics was conducted to describe the variables that were used for the estimation. This was done to determine the nature of the variables. The mean and median were used to measure the central tendencies while standard deviation, skewness and kurtosis were employed as a measure of dispersion. The Jarque-Bera test for normality was done at 5% level of significance. All estimations were done in E-views 10 and STATA 14 statistical packages (IHS Markit, 2017; StataCorp, 2015).

Summary

The positivist philosophy, quantitative approach and the explanatory research design were adopted for the study. Monthly time series data on the agricultural sector, manufacturing sector, services sector, crude oil production, crude oil prices, inflation, exchange rate and fiscal balance from January 2011 to December 2018 were employed for the study. The SVAR model was used to analyse the dynamic response of the variables to various disturbances that occur in the Ghanaian economy. The unit root test and diagnostic test were also conducted before estimation of the SVAR.

CHAPTER FOUR

RESULTS AND DISCUSSION

The chapter presents the results and discussion of the study. It focuses on the descriptive statistics, stationary test, diagnostic test, structural impulse response function (SIRF) and structural forecast error variance decomposition (SFEVD) on the impact of crude oil production on the macroeconomic performance in Ghana.

Descriptive Statistics

The descriptive statistics on crude oil production, crude oil price, agricultural sector, services sector, manufacturing sector, fiscal balance, consumer price index and real effective exchange rate based on data from 2011m1 to 2018m12 are shown in Table 1. Crude oil production (OP) had a mean of 3,230,051 barrels. This implies that an average of 3,230,051 barrels of oil is produced in a month. The maximum amount of crude oil produced (5,506,440 barrels of oil) was about two times the average production for the study period. The minimum amount of crude oil produced was 1,977,347 barrels. Comparison of the mean production with the maximum and minimum productions indicates that there is a progress in the amount of crude oil produced per month.

With the average crude oil production, Ghana is ranked among the first ten major oil producers of Africa (Index Mundi, 2020). The variation from the mean crude oil produced in a month was 1,051,242 barrels. This indicates a low variation in the amount of crude oil produced per month. The skewness and kurtosis values were 0.77 and 2.37 respectively. This implies that the crude oil production is not normally distributed since the values of the skewness and kurtosis deviates from 0 and 3 respectively. This observation conformed to the Jarque-Bera test for normality (p-value = 0.00) at 5% level of significance.

Table 1: Summary statistics of crude oil production and macroeconomic performance variables

	OP	OPR	AGR	SER	MAN	FB	REER	CPI
Mean	3230051	81.96	8829.09	19360.11	4311.78	-0.02	77.58	262.11
Median	3075014	79.29	9043.59	19126.53	4858.74	-0.02	74.69	231.71
Max	5506440	124.62	13224.35	24100.02	6231.44	0.00	97.86	1401.10
Min	1977347	31.93	3570.33	14600.36	1220.08	-0.04	54.46	112.01
Std. Dev.	1051242	28.09	1957.74	2678.52	1342.07	0.01	10.47	157.54
Skew	0.77	-0.10	-0.45	0.00	-0.75	-0.53	-0.20	4.02
Kurt	2.37	1.39	3.27	1.91	2.10	3.34	2.19	29.40
J-Bera	10.98	10.54	3.49	4.71	12.35	4.95	3.26	3046.43
Prob	0.00	0.01	0.17	0.09	0.00	0.08	0.20	0.00
Obs	96	96	96	96	96	96	96	96

Max: maximum, Min: minimum, Std. Dev.: Standard deviation, Skew: Skewness, Kurt: Kurtosis, J-Bera: Jarque-Bera, Prob: Probability, Obs: Number of observations.
Source: Tunyo (2020)

The mean price of crude oil was $81.96 (Table 1). The extent to which the observations on crude oil price deviated from the mean value was high ($28.09). Comparison of the mean crude oil price ($81.96) with the maximum crude oil price of $124.62 and the minimum crude oil price of $31.93 indicates that the country has progressed in crude oil price even though the minimum price indicates a low revenue for the country. Based on the mean crude oil production, the expected mean revenue per month was $264,734,980. The skewness (-0.10) and kurtosis (1.39) indicate that crude oil price is not normally distributed. Similarly, the Jarque-Bera test for normality was significant (p-value = 0.01) at 5% level of significance, indicating that crude oil price is not normally distributed.

The agricultural sector recorded a mean value of GH₵8,829.09. This suggest that on average the value-added output of the agricultural sector is GH₵8,829.09. A high value-added output of GH₵1,957.74 deviated from the mean value. A minimum value of GH₵3,570.33 and a maximum value of GH₵13,224.35 were recorded for the agricultural sector. This observation indicates that the agricultural sector is not progressing when compared with the mean value (GH₵8,829.09). The skewness value (-0.45) recorded for the agricultural sector indicated that most of the observations were above the mean. The Jarque-Bera test gave a p-value of 0.17, suggesting that the agricultural sector is normally distributed.

The services sector had a mean value-added output of GH₵19,360.11. The extent to which the value-added output of the services sector deviated from the mean was GH₵2,678.52, indicating a high variation among the observations. The minimum and maximum value-added outputs were GH₵14,600.36 and GH₵24,100.02 respectively. There is a progression in the services sector based on the mean and the minimum and maximum values obtained in the study. The skewness value was 0.00 and the value for kurtosis was 1.91. The p-value (0.09) for the Jarque-Bera test for normality was not significant at 5% significance level. These observations suggest that the services sector is normally distributed.

The value-added output of the manufacturing sector had a mean value of GH₵4,311.78 and the variation from the mean value was GH₵1,342.07. The comparison of the mean value-added output with the minimum (GH₵1,220.08) and maximum (GH₵6,231.44) value-added outputs reveals that there is a progression in the manufacturing sector. The skewness value for the sector was -0.75. This indicates that most of the observations in the sector were above the mean. The kurtosis gave a value of 2.10. The skewness (-0.75) and kurtosis (2.10) values observed imply that the manufacturing sector is not normally distributed. This observation was in line with the results obtained for the Jarque-Bera test for normality (p-value = 0.00).

The mean fiscal balance was --0.02 percentage of GDP (Table 1). The variation of fiscal balance from the mean was 0.01 percentage of GDP. This indicates a low variation among the observations in the fiscal balance. The maximum observation for fiscal balance was 0.00 whilst the minimum observation was -0.04. The skewness value of -0.53 and the kurtosis value of 3.34 indicates that fiscal balance is not normally distributed. In contrast, the Jarque-Bera test for normality was not significant (p-value = 0.08) at 5% level of significance, suggesting that fiscal balance is normally distributed.

The real effective exchange rate recorded a mean value of 77.58. Interestingly, the extent of deviation from the mean was low (10.47). The maximum value for the real effective exchange rate was 97.86. A close value of 54.46 was recorded for the minimum real effective exchange rate. The skewness value (0.20) obtained implies that most of the observations were below the mean. The real effective exchange rate was normally distributed based on the Jarque-Bera test for normality (p-value = 0.20). The mean value of the consumer price index was 262.11. A high fluctuation (157.54) was observed in the consumer price index. The skewness value was 4.02 and suggests that most of the observations were below the mean. The skewness value and kurtosis value of 4.02 and 29.40 shows that the consumer price index is not normally distributed. The Jarque-Bera test for normality similarly showed that consumer price index is not normally distributed with p-value of 0.00 (Table 1).

Stationarity Test

The stationarity level of the variables used in the study was determined to estimate the impact of crude oil production on macroeconomic performance using the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) units root tests. This was done to avoid the spurious regression in the results. The variables were first examined by inspecting their trends graphically (Appendix 1 and 2). All the variables were non-stationary at levels except agricultural sector and consumer price index (Appendix 1). Besides, none of the variables was found to be trending. However, the plots of all the variables in their first differences indicated that the variables were stationary (Appendix 2).

The ADF test for unit root is presented in Table 2. The p-values of the ADF statistic for the all variables was not statistically significant at 1%, 5% and 10% significance levels except consumer price index (CPI) which recorded significant p-values for the ADF statistic at 5% significance level. In light of this, the null hypothesis of the presence of unit root for crude oil production (OP), crude oil price (OPR), agricultural sector (AGR), services sector (SER), manufacturing sector (MAN), real effective exchange rate (REER) and fiscal balance (FB) at their levels was not rejected. This suggests that the variables are not stationary at levels; that is the variables are not integrated of order zero (*I* (0)). In contrast, the null hypothesis of the presence of unit root for CPI at intercept for levels was rejected, indicating that the consumer price index is stationary at levels (*I* (0) variable). Nevertheless, all the variables were stationary at 1% and 5% levels of significance at the first difference. The p-values of the ADF statistic were statistically significant at the 1% and 5% significance levels for all first differenced estimates. The null hypothesis of the presence of unit root (non-stationary) was, therefore, rejected.

Table 2: Results of the ADF unit root test

Variables	Levels		First Difference	
	Intercept	None	Intercept	None
LNOP	-0.144	1.870	-4.340***	-3.868***
LNOPR	-1.4251	-0.7574	-6.775***	-6.772***
LNAGR	-2.049	0.929	-9.103***	-9.064***
LNSER	-0.941	0.843	-3.049**	-2.942***
LNMAN	-2.151	0.651	-8.162***	-8.149***
FB	-2.345	-0.386	-3.606***	-3.571***
LNREER	-1.880	-0.714	-11.869***	-11.869***
CPI	-3.26**	-1.2354	-11.128**	-11.187**

***, ** and * denote significance at 1%, 5% and 10% respectively
Source: Tunyo (2020)

To ensure the reliability and confirmation of the results, the PP test for unit root was conducted (Table 3). The p-values of the PP statistic for all the variables except agricultural sector (AGR) and consumer price index (CPI) were not statistically significant at 1%, 5% and 10% levels of significance. This denotes crude oil production (OP), crude oil price (OPR), services sector (SER), manufacturing sector (MAN), real effective exchange rate (REER) and fiscal balance (FB) were non-stationary at levels. The presence of statistical significance in the p-values of PP statistic of AGR and CPI at all the conventional levels of significance suggests that agricultural sector and consumer price index are stationary at the intercept and integrated of order zero (*I* (0)). However, all the variables were stationary at 1%, 5% and 10% levels of significance at the first difference. The null hypothesis of the presence of unit root (non-stationary) was rejected since the p-values of the PP statistic were statistically significant at 1%, 5% and 10% levels for all first differenced estimates.

Table 3: Results of the PP unit root test

	Levels		First Difference	
Variables	Intercept	None	Intercept	None
LNOP	-0.361	1.633	-2.444	-2.153**
LNOPR	-1.129	-0.681	-6.509***	-6.521***
LNAGR	-3.726***	0.194	-4.236***	-4.251***
LNSER	-1.796	0.429	-2.827*	-2.876***
LNMAN	-2.415	0.504	-3.484**	-3.507***
FB	-1.799	-0.481	-2.427	-2.543**
LNREER	-1.863	-0.744	-11.647**	-11.645**
CPI	-5.306***	-1.904*	-29.973**	-29.710 **

***, ** and * denote significance at 1%, 5% and 10% respectively
Source: Tunyo (2020)

The results from the ADF and PP tests for unit roots indicate that the series is a mixture of variables integrated of order zero (*I* (0)) and order one (*I* (1)). This observation is consistent with the results from the graphical representation (Appendix 1 and 2). According to Bernanke (1986) and Blanchard and Watson (1986), the shocks of *I* (0) variable has a temporal effect. However, the shocks of *I* (1) variable has a permanent effect (Blanchard & Quah,1989; Shapiro & Watson, 1988). In light of the inconsistencies in the results, the combination of *I* (0) and *I* (1) variables makes the interpretation of the impacts of the shocks inconsistent. Therefore, the study used the first difference (*I* (1)) variables to ensure uniformity in the impacts of the shocks.

Diagnostic Test

The diagnostic test on the structural vector autoregressive model (SVAR) is presented in Appendix 3. The lag length criteria were conducted before estimating the VAR model to ensure that the appropriate lag was used in estimating the SVAR model. The sequential modified likelihood ratio (LR), Akaike information criterion (AIC) and final prediction error (FPE) statistics indicated an optimal lag length of four (p = 4) (Appendix 3A). The study, therefore, estimated an SVAR model with a lag order of 4. The lag exclusion test was conducted to ensure inclusion of lags in the model. The null hypothesis was rejected at the lag order (Appendix 3B). The endogenous variables at the given lag were not jointly zero and therefore, the lags of the endogenous variable were included in the model. After the estimation of the VAR model, the serial correlation and stability test were performed to ensure that the model was stable. The study failed to reject the null hypothesis of no serial correlation at the lag order based on the serial correlation test (Appendix 3C). The graph of stability test showed that all eigenvalues were located within the unit circle, implying that the system is stationary and stable (Appendix 3D).

Structural Impulse Response Function (SIRF)

After the investigating the properties of the variables and the diagnostic test after estimating the vector autoregressive (VAR) model, the restrictions were imposed to estimate the SVAR model. Since the coefficients of the SVAR are difficult to interpret. The SIRF was estimated to find the impact of crude oil on the non-oil sectors, fiscal balance, real effective exchange rate and inflation. The results and discussion of the SIRF is divided into three sections. The first section considers non-oil sectors followed by macroeconomic variables and finally, the transmission mechanism from the conceptual framework and the estimation technique was considered.

First Empirical Objective

The response of the non-oil sectors to the structural crude oil shock is shown in figure 7. Crude oil production had no impact on the agricultural sector (AGR), services sector (SER) and manufacturing sector (MAN). This may suggest that the activities of the oil sector are not integrated into the domestic economy because the backward and forward linkages that needs to be shared between the oil sector and the non-oil sectors cannot be seen. The backward linkage of the oil sector deals with the reliance on inputs from the domestic economy. However, most of the inputs used by the oil and gas sector are imported from overseas which reduces the in-country spend that the oil and gas sector could generate for the other sectors. The forward linkage of the oil sector deals with the value addition of the output.

The oil sector demands for food from the agricultural sector for consumption by its workers. Despite this, the output of the agricultural sector is not used as an input for crude oil production which is a hinderance to the sector. The output from oil and gas sector is used to generate power for the agricultural sector and LPG gas for the country respectively. However, petroleum products such as refined oil and fertilizers used by the agricultural sector as inputs for production are imported (Zaato & Suleman, 2020). These hinderances to the oil sector and the agricultural sector could contribute to the lack of impact of crude oil production on the agricultural sector (Figure 7A).

The services sector provides services such as transportation, communication and financial services to the oil sector which is considered as a lateral linkage. These services provided to the oil sector are not enough to meet the demand of the oil sector as a result of limited capacity, inability of contractors to meet high industry standards, high cost of local companies, inadequate standards of certification, and inadequate capital to support local participation and entrepreneurship (Amoako-Tuffour, Aubynn, & Atta-Quayson, 2015; Zaato & Suleman, 2020). Even though the exportation of the crude oil produced requires the services of the trade sector, the petroleum products needed for some subsectors such as transportation and construction are imported (Zaato & Suleman, 2020). These may account for the lack of impact of the crude oil production on the services sector as observed in the study (Figure 7B).

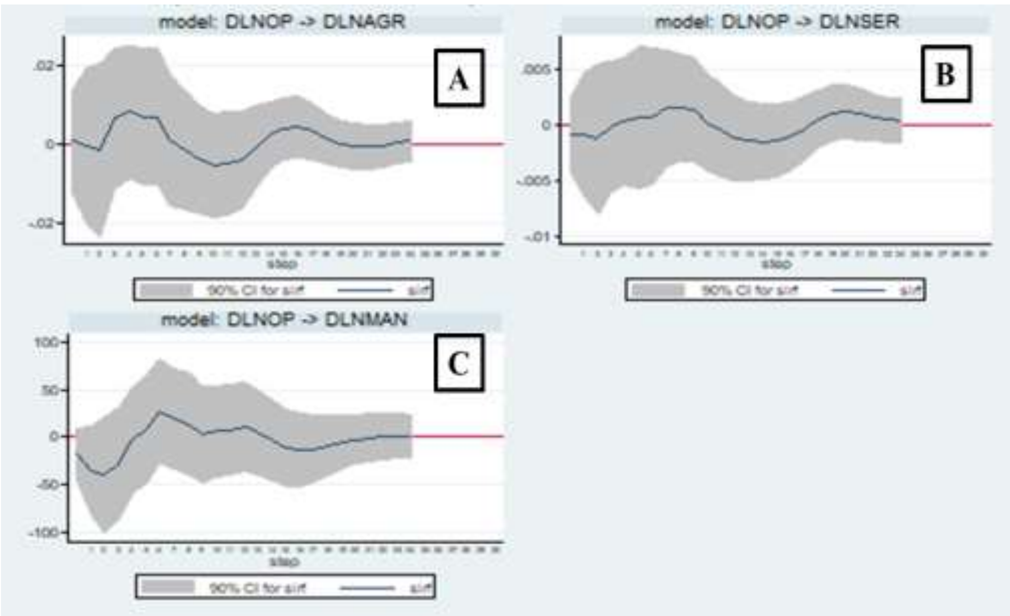

Figure 7: Response of the non-oil sectors to crude oil production structural shock.
Source: Tunyo (2020)

The manufacturing sector could provide the oil sector with technical equipment such as machinery, pipes, protective clothing and safety equipment. However, specialised equipments are needed for oil sector activities which the local manufacturing sector could not provide since the locally produced equipment do not meet international standards. Hence, these equipments are often outsourced. This has limited the interconnection between the activities of the oil sector and the manufacturing sector. The crude oil that is produced in the form of gas is used to generate power for the sector. However, the manufacturing of petrochemicals, plastics and fertilizers has not been established for the value addition of crude oil (Amoako-Tuffour *et al*., 2015; Zaato & Suleman, 2020). This could account for the absence of impact of crude oil production on the manufacturing sector (Figure 7C).

The opportunities associated with the oil sector is not likely to be utilised in the short or medium term with service contract and procurement of local goods since the current effort by Ghana may not be enough to create a significant backward and forward linkages (Amoako-Tuffour *et al*., 2015). Asafu-Adjaye (2010) reported a negative impact of crude oil production on the sectors of the Ghanaian economy. The findings of Asafu-Adjaye (2010) did not identify direct impact on these sectors but rather through trade. The difference in the findings could be due to the different methodology employed since the CGE model used produces a net impact. Al-Mawali, Hasim and Al-Busaidi (2016) and Ekperiware and Olomu (2015) contrary reported positive impact on the sectors and agricultural sector in Oman and Nigeria respectively. The findings did not identify a direct impact but rather through the oil proceeds which is a source of fund to boost the agricultural sector. The difference in these findings could be due different economic conditions experienced by these countries. Besides, these countries started producing crude oil over a long period of time.

Second Empirical Objective

The response of the macroeconomic variables to the structural crude oil shock is shown in figure 8. Crude oil production shock improved fiscal balance through additional revenue generation (Figure 8A). A positive shock to crude oil production increases the volume of crude oil exports which translates into increases in oil revenue. Part of the oil revenue due the Republic of Ghana is in payment of royalties, surface rentals, carried and participation interest, trade tariffs, corporate income tax and other incomes received. Hence, a positive shock to crude oil production leads to increase in the revenue received by the government. This situation improves government fiscal balance position as depicted in Figure 8A. This finding is argued by the Hartwick rule to invest oil proceeds which is always budgetary and affects the fiscal balance of the government. The oil proceeds due Ghana increased from US$444.13 in 2011 to US$978.01 in 2014 due to increase in oil production which improved the fiscal balance for the period.

However, a reduction in the production of crude oil in 2015 and 2016 led to a reduction in the oil proceeds due Ghana from US$441.51 to US$229.1, respectively, which affected the fiscal balance position of the government (Public Interest and Accountability Committee [PIAC], 2019). The deficit on the fiscal balance worsened in 2016. The total revenue allocated to the Annual Budget Funding Amount (ABFA) was 38% (US$1.88 billion) of the total petroleum revenue allocated to the government of Ghana from 2011 to 2018 (PIAC, 2019). Some studies have reported that crude oil shock increases the revenue accrued to government (Adedokun, 2018; Ali & Harvie, 2013).

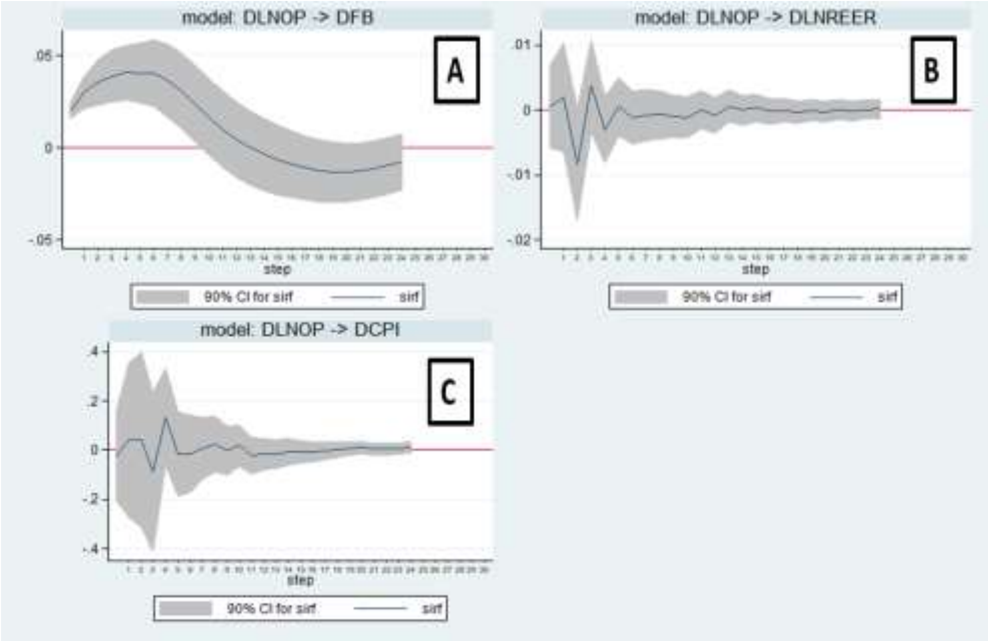

Figure 8: Response of the macroeconomic variables to crude oil production structural shock.
Source: Tunyo (2020)

Moreover, crude oil production had no impact on real effective exchange rate (Figure 8B). This observation may be attributed to the time lag effect of crude oil production since the current study dealt with short term response. Also, this indicates that other factors such as domestic demand pressures by the corporate sectors prices and the reaction of emerging markets to the normalisation of US Fed rate determine the real effective exchange rate despite the importation of inputs and exportation of crude oil (Bank of Ghana [BoG], 2015, 2019). Inyiama and Ikechukwu (2015) similarly reported a lack of impact of crude oil production and export on exchange rate in Nigeria. Dagher, Gottschalk and Portillo (2010) contrary reported a moderate impact on real exchange rate in Ghana. The difference in the findings could be due to the methodology employed and the measurement used for real effective rate.

Crude oil production also showed no impact on consumer price index (Figure 8C). The crude oil produced in Ghana is not directly used in the production of goods and services by the sectors. This may contribute to the lack of impact of crude oil on consumer price index observed in the study since crude oil produced does not transmit to the cost of production of the other sectors which influences consumer prices index. Dagher, Gottschalk and Portillo (2010) contrary reported a moderate impact on inflation especially non-tradeable inflation in Ghana. The difference in the findings could be due to the methodology employed and how inflation was measured in the study.

Transmission Mechanism of Crude oil production shocks through Fiscal balance on the Economy

Since crude oil production tend to have a significant and lasting effect on fiscal balance, it was necessary to determine the impact of fiscal balance on the Ghanaian economy to understand the channels of transmission of the effect of oil production shocks (Figure 9 and 10). For instance, the impact of the oil production may work through other channels such as development of the sectors from oil proceeds as explained by the Hartwick rule. Fiscal balance had no impact on the agricultural sector (Figure 9A). This could be attributed to the inconsistency in investment allocation of the oil revenue (ABFA) to the sector and the misapplication of agricultural receipts to other sectors even though the sector is among the priority areas of crude oil revenue (Ackah, 2016; BoG, 2014, 2015).

The allocation of ABFA to the agricultural sector declined from GH₵13,147,652 (7.4%) to GH₵153,782682 (2.5%) between 2011 and 2013 respectively. The percentages of the revenue allocation varied for 2014

(31.06%), 2015 (5.3%), 2016 (8.89%), 2017 (14.8%) and 2018 (15.3%). Ackah (2016) argued that revenue from oil has replaced the budget allocation for the agricultural sector which accounted for the low performance of the agricultural sector. This could also account for the lack of impact of fiscal balance on the agricultural sector. The study conforms to the findings of Okoh, Amadi, Ojiya and Ani (2019). Earlier studies have contrary reported positive and negative impacts of government expenditure on agricultural sector (Chandio, Jiang, Rehman, & Jingdong, 2016; Ewubare & Eyitope, 2015; Osinowo, 2015; Shevchuk & Kopych, 2017).

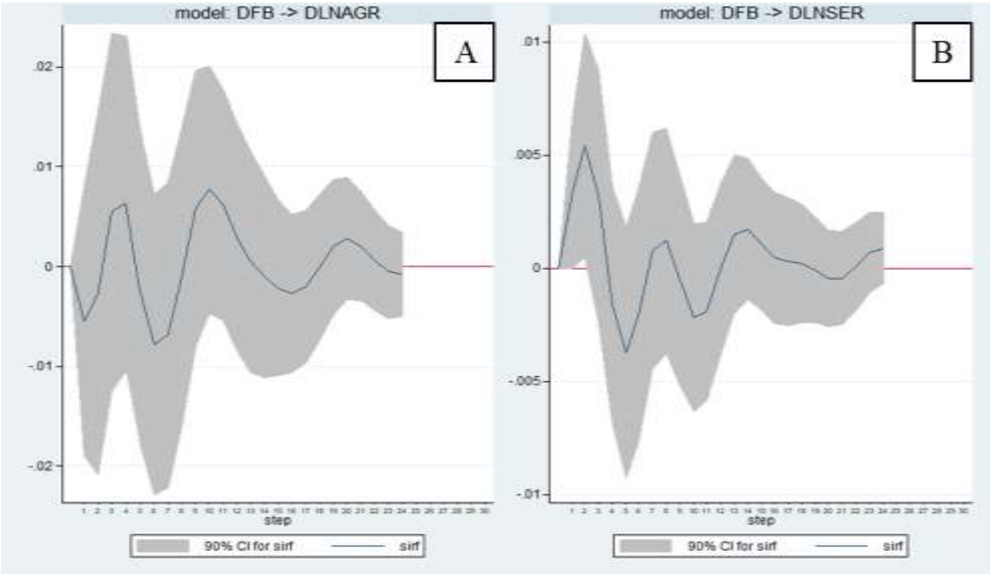

Figure 9: Response of agricultural sector and services sector to fiscal balance structural shock.
Source: Tunyo (2020)

Fiscal balance had a positive impact on the services sector (Figure 9B). This observation could be attributed to the use of revenue from crude oil (ABFA) in financing health, education, roads and railways, and other critical infrastructures. The amount of oil proceeds (ABFA) allocated to this sector declined from 76.5% in 2011 to 64% in 2016. During these periods, the priority of the sector was on infrastructure of roads and railways. However, the priority of the sector expanded from 2017 to 2018 to include education and health which brought an increase in the allocation of the oil proceeds (ABFA) from 76.1% (2017) to 84.3% (2018) to the sector (PIAC, 2017, 2018). Also, the investment in those subsectors could have an impact in the long run but this study considered the short run analysis which could account for a short time impact.

Fiscal balance showed a decreasing impact on the consumer price index (Figure 10A). Once oil proceeds increase revenue, the government will not increase money supply by printing money to finance its expenditures, hence reducing inflation. Besides, the use of oil revenue in productive sectors could decrease the impact on the consumer price index. This finding agrees with Afoakwa (2016) and Olubiyi and Bolarinwa (2018) who reported negative relationships between inflation and fiscal deficit in Ghana and Kenya respectively.

Several studies have reported significant positive impacts of fiscal deficit on inflation (Adu & Marbuah, 2011; Dadson, 2015; Fakher, 2016; Ishaq & Mohsin, 2015; Jalil, Tariq, & Bibi, 2014; Olubiyi & Bolarinwa, 2018). These findings found an impact because of how fiscal deficit was financed (either by printing or borrowing) and how the money was utilised. Some studies have contrary indicated absence of significant impacts of fiscal deficit on inflation (Nwakobi, Echekoba, & Ananwude, 2018; Tiwari, Bolat, & Koçbulut, 2015).

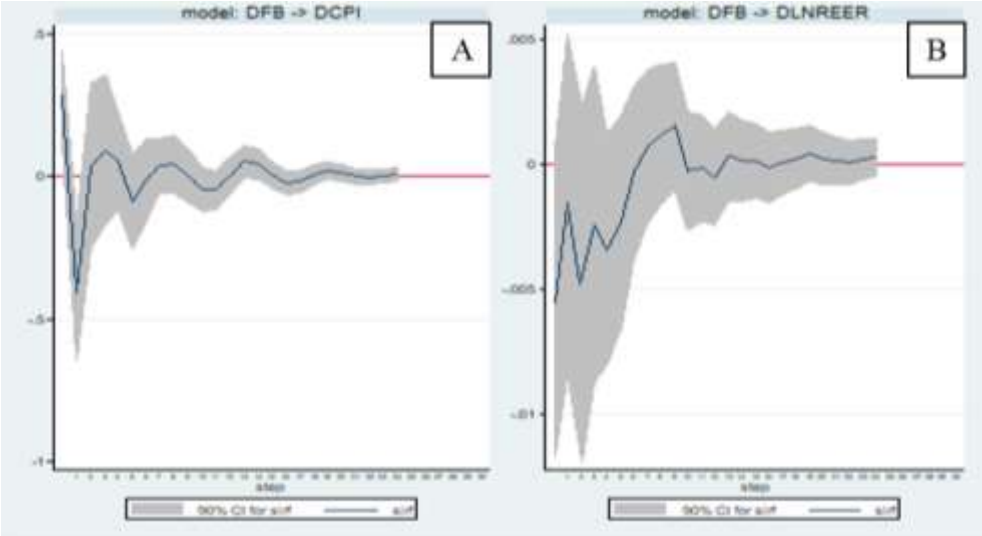

Figure 10: Response of consumer price index and real effective exchange to structural fiscal balance shock.
Source: Tunyo (2020)

Even though fiscal balance showed a negative impact on real effective exchange rate, the relationship was insignificant (Figure 10B). The increase in the revenue of government due to oil proceeds received makes the government borrow less which causes a decline in the demand for loanable funds and domestic interest rate. The decline in domestic interest rate cause an increase in demand for foreign assets compared with domestic assets. The increase in foreign assets further cause an increase in demand for foreign currency on the foreign exchange market, resulting in a fall in the real effective exchange rate (depreciation of the domestic currency). The current study used the short-term response which could contribute to the insignificant impact of fiscal balance on the exchange rate. This conforms to the findings of Atsyor (2018) who reported an insignificant inverse relationship between real exchange rate and budget deficit in the long run.

Consumer price index showed positive and negative impacts on the agricultural sector (Figure 11). The variations in aggregate demand pressures on the agricultural sector (crops, fishing and livestock) may contribute to the positive and negative impacts of consumer price index observed in the sector. Generally, food producers sell their goods to meet demand pressures which either increase or decrease the revenue of the agricultural sector in conformation to the law of supply. The food sector in Ghana faces more persistent inflation than the non-food sector due to seasonal variations, particularly rainfall, in the production sector (BoG, 2011, 2016, 2019; Oduro-Afriyie, Adjasi & Ikhide, n.d). Earlier studies have reported significant positive impacts of inflation on agricultural sector growth (Ayyoub, 2015; De Sormeaux & Pemberten, 2011; Oyinbo & Rekwot, 2014). However, insignificant impacts have been reported by Chaudhry, Ayyoub and Imran (2013) and Enu and Attah-Obeng (2013).

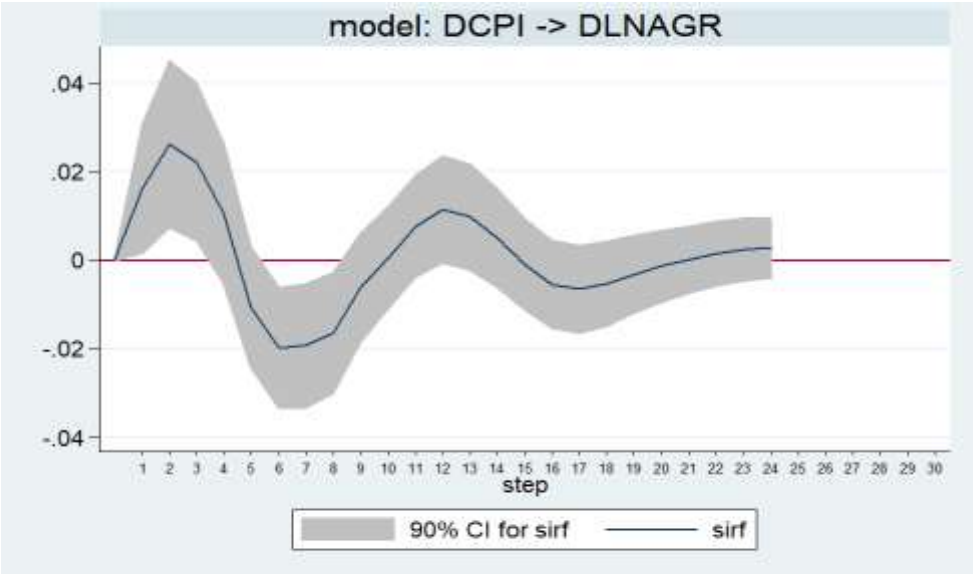

Figure 11: Response of agricultural sector to consumer price index structural shock.

Source: Tunyo (2020)

The response of the services and manufacturing sectors to the agricultural sector is shown in Figure 12. The presence of significant impact between agricultural sector and the services sector and manufacturing sector may be due to inter-sectorial linkages among the sectors. The agricultural sector increased the services sector (Figure 12A). This impact on the services sector could be attributed to the high demand of services such as trade, transportation and storage facilities by the agricultural sector for production. This conforms to the findings of earlier studies that reported positive impacts of the agricultural sector on the services sector (Abdul, 2004; Subramaniam & Reed, 2009; Tiwari & Kg, 2011). However, Blunch and Verner (2006) showed that the agricultural sector had a negative impact on the services sector. In contrast to the services sector, the agricultural sector had positive and negative impacts on the manufacturing sector (Figure 12B). The variation in the impacts could be attributed to the reliance on the agricultural sector outputs as inputs for the manufacturing sector. Blunch and Verner (2006) similarly reported positive and negative impacts between the agricultural sector and the manufacturing sector in Ghana. Besides, a positive impact of agricultural growth on manufacturing growth has been reported (Kanwar, 2000; Shifa, 2015; Tiffin & Irz, 2006).

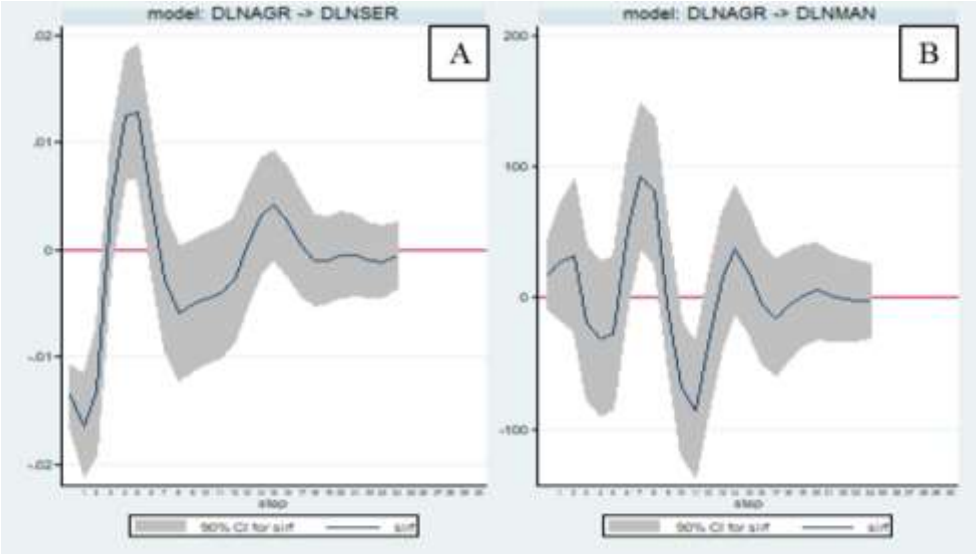

Figure 12: Response of services sector and manufacturing sector to agricultural sector structural shock.
Source: Tunyo (2020)

Figure 13 shows the impact of the services sector on fiscal balance and the manufacturing sector. The services sector had a positive impact on the manufacturing sector (Figure 13A). The dependence of the manufacturing sector on the trade and transport subsectors of the services sector for its inputs of production may account for the observation in the study. The finding conforms to the study by Kanwar (2000) who reported that the services sector had a positive impact on the manufacturing sector. According to Blunch and Verner (2006), the services sector has positive and negative impacts on the manufacturing sector in Ghana. The services sector also had a positive impact on fiscal balance as observed in the study (Figure 13B). The structural transformation from the agricultural sector to the services sector, which places the services sector the highest contributor to GDP, could account for the positive impact of the services sector on fiscal balance. The services sector generates more revenue in the form of tariffs to the government which is used to finance expenditures.

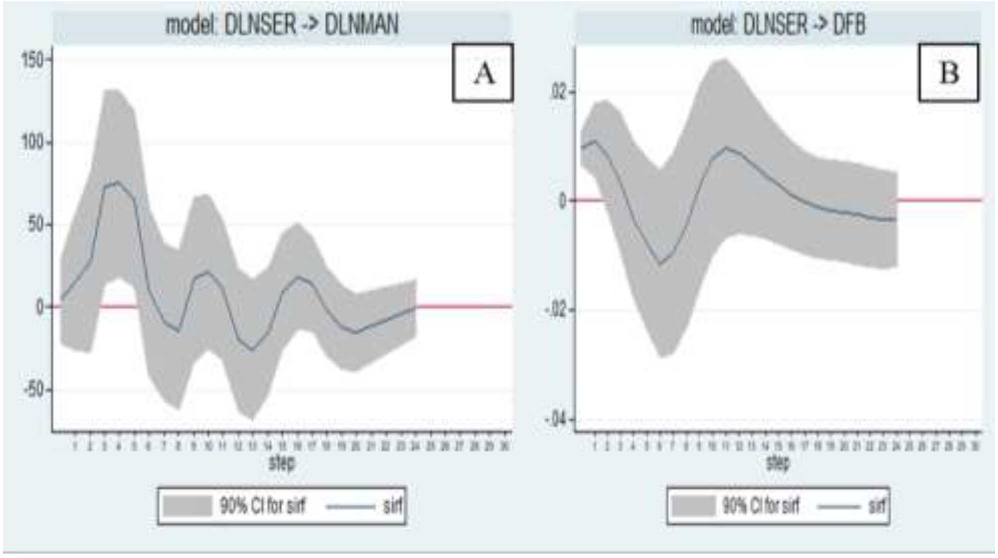

Figure 13: Response of manufacturing sector and fiscal balance to services sector structural shock.

Source: Tunyo (2020)

The manufacturing sector had a decreasing impact on consumer price index (Figure 14A). The large dependence of the manufacturing sector on imported inputs may account for this observation since production cost influences prices of goods and services. However, most of the manufactured consumer goods are imported which could contribute to the decreasing impact on consumer price index. The manufacturing sector also had no impact on real effective exchange rate (Figure 14B). The manufacturing sector influences exchange rate through exportation and importation of goods and services. In addition, other factors that account for changes in real effective exchange rate such as infrastructure development and speculative activity of foreign markets could explain the insignificant impact of the manufacturing sector on real effective exchange rate.

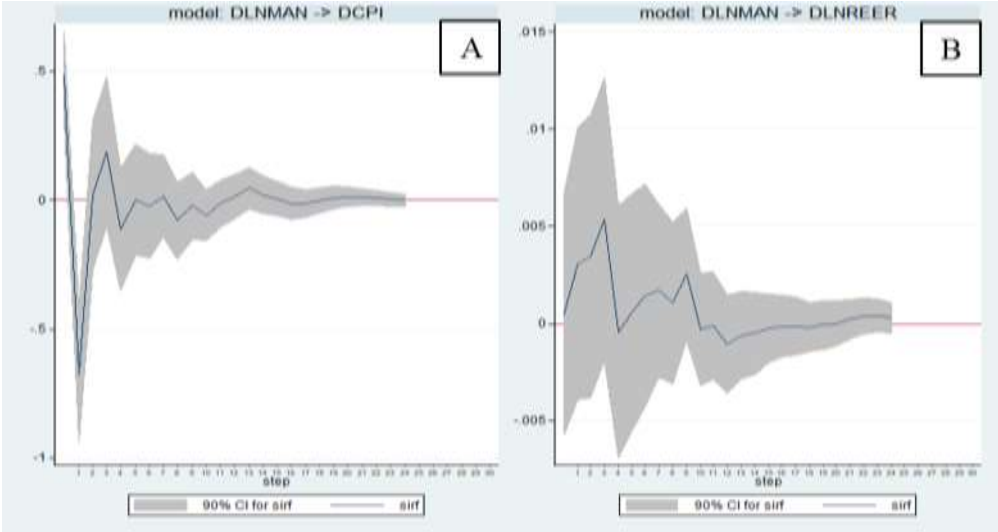

Figure 14: Response of consumer price index and real effective exchange rate to manufacturing sector structural shock.
Source: Tunyo (2020)

The services sector showed an increasing impact on consumer price index (Figure 15A). This could be attributed to the structural transformation of the economy to the services sector. Since the services sector is a non-traded sector, the increase in income results in increase in consumer price index triggered by aggregate demand pressures from households due to the expenditure incurred by government from oil proceeds. Besides, the cost of production in the services sector is too high and shifts to the consumer, leading to a rise in the general price and a positive impact on consumer price index. The result conforms to the findings of Enu and Havi (2014). In contrast, the services sector showed no impact on real effective exchange rate (Figure 12B). The services sector affects exchange rate through importation and exportation of services. However, other factors could account for changes in the real effective exchange rate and explain the insignificant impact of the services sector on real effective exchange rate.

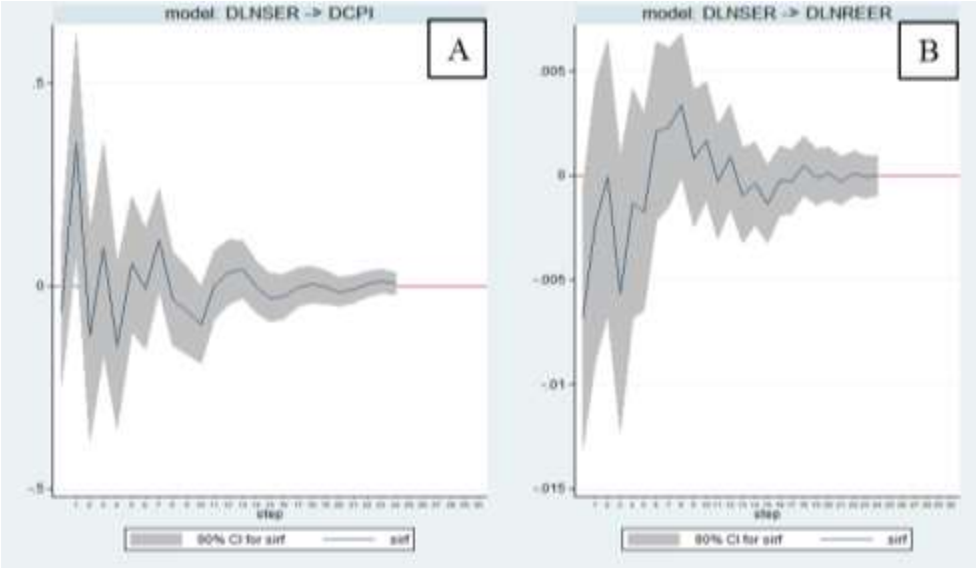

Figure 15: Response of consumer price index and real effective exchange rate to services sector structural shock.
Source: Tunyo (2020)

Figure 16 shows the impact of the agricultural sector on consumer price index and real effective exchange rate. The agricultural sector had no impact on consumer price index (Figure 16A). The agricultural sector output could influence consumer price index through the cost of production and abundance of goods available. Most of the agricultural output are on seasonal basis and will not have an influence on consumer price index in the short run. This may account for the lack of impact of agricultural sector on inflation. Enu and Havi (2014) reported a negative relationship between the agricultural sector and inflation in the long run for Ghana. However, this observation was insignificant in the short run. The agricultural sector similarly showed no impact on real effective exchange rate (Figure 16B). The agricultural sector influences exchange rate through exportation and importation of goods and services. The observation made from the study indicates that other factors besides the import and export of goods could account for variations in the real effective exchange rate and explain the insignificant impact of agricultural sector on real effective exchange rate as observed in the study.

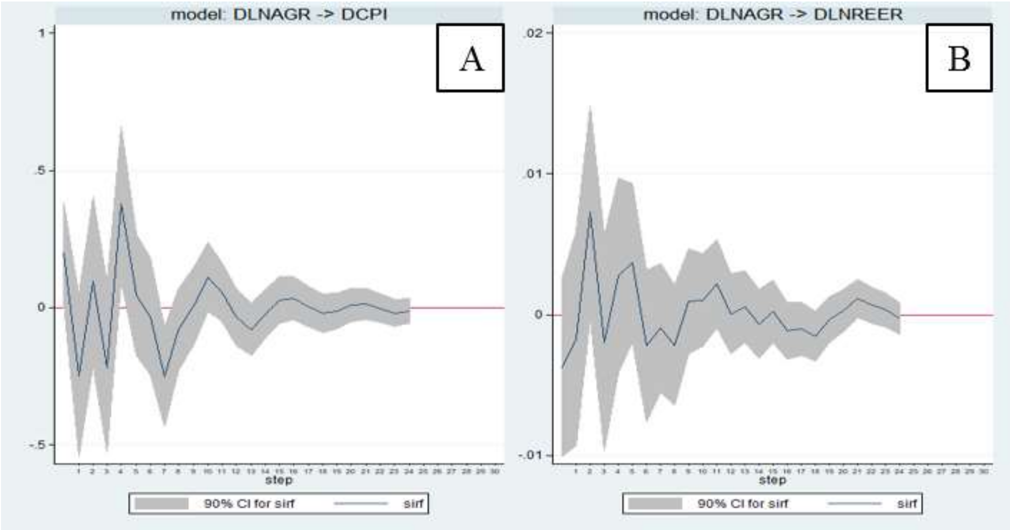

Figure 16: Response of consumer price index and real effective exchange rate to agricultural sector structural shock.
Source: Tunyo (2020)

Consumer price index had no impact on real effective exchange rate (Figure 17). The consumer price index affects real effective exchange rate through imported goods and services due to the variations in domestic prices of goods and services compared with foreign prices of goods and services. The lack of impact of consumer price index on real effective exchange rate observed in the study could be attributed to the fact that other factors such as domestic demand pressures by the corporate sectors, a decline in inflows on account of fall in commodity prices and the reaction of emerging markets to the normalisation of US Fed rate account for changes in real effective exchange rate (BoG, 2013, 2015, 2019). This observation conforms to the findings of Agyemang-Adjei (2019) and Arko (2016) in Ghana. However, significant positive and negative relationships have been established between inflation and exchange rate (Immurana, Iddrisu, & Kyei-Brobbey, 2013; Muchiri, 2017).

Ofori-Abebrese, Pickson and Azumah, (2017) reported a significant negative relationship between exchange rate depreciation and inflation in the long run for Ghana. This relationship was, however, insignificant in the short run.

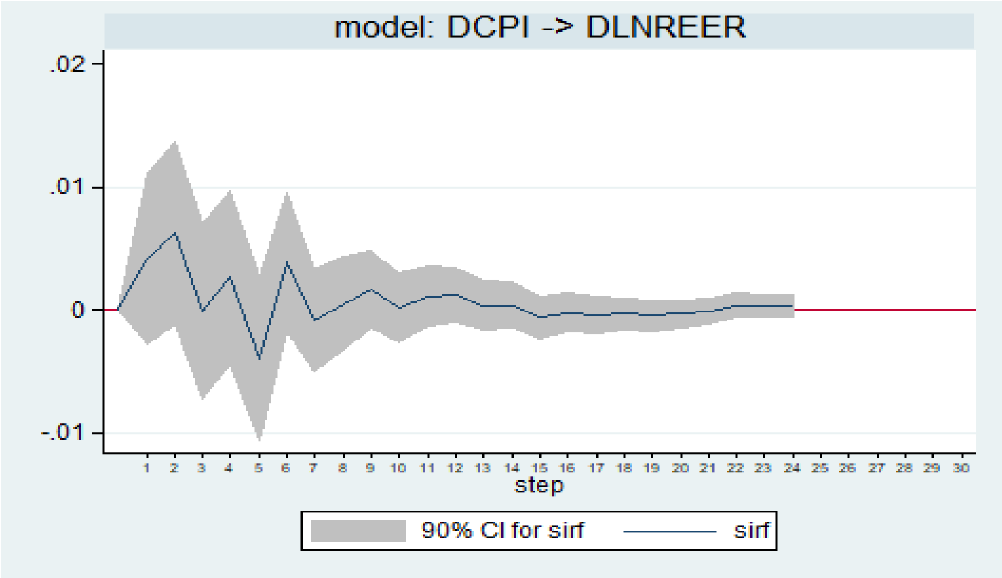

Figure 17: Response of real effective exchange rate to consumer price index structural shock.
Source: Tunyo (2020)

Figure 18 shows that real effective exchange rate had no impact on consumer price index. Real effective exchange rate affects consumer price index through the cost of imported inputs for the production of goods and services. Other factors such as increasing demand pressures for expansionary fiscal policy leading to deficit on the fiscal balance and increase in energy cost and the pass-through effect of upward adjustment in petroleum product prices, utility tariffs and transport fares account for the changes in consumer price index hence could explain the lack of impact (BoG, 2014, 2015, 2017). This observation is consistent with the report by Olubiyi and Bolarinwa (2018) who indicated an insignificant effect between inflation and exchange rate in South Africa and Mali. Studies by Adu and Marbuah (2011) and Dadson (2015) reported negative effects of exchange rate on inflation in Ghana. Positive relationships between inflation and exchange rate have also been established (Agbenorhevi, 2016; Ahiakpor, 2014; Ishaq & Mohsin, 2015; Jalil, Tariq, & Bibi, 2014; Olubiyi & Bolarinwa, 2018).

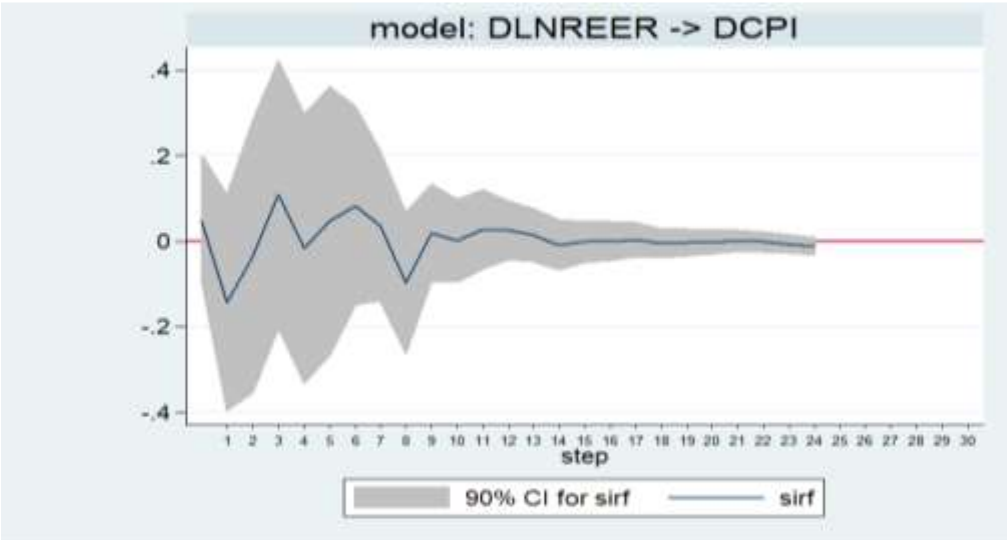

Figure 18: Response of consumer price index to real effective exchange rate structural shock.
Source: Tunyo (2020)

Real effective exchange rate similarly had no significant impact on the agricultural and manufacturing sectors (Figure 19). The insignificant impact of real effective exchange rate on the sectors could be attributed to the inelastic real exchange rate in Ghana as a result of over dependence on imported raw materials for production, and the inelastic demand for local products by foreigners. Earlier studies have reported absence of relationships between exchange rate and the agricultural and manufacturing sectors in Nigeria (Ndubuaku, Onwuka, Onyedika, & Chimezie, 2019; Onakoya, 2018). Positive and negative impacts of exchange rate on the agricultural and manufacturing sectors have also been indicated by previous studies (Abdul-Mumuni, 2016; Gatawa & Mahmud, 2017; Ogunkoya & Shobayo, 2015; Orji, Ogbuabor, Okeke, & Anthony-Orji, 2018; Tulasombat, Bunchapattanasakda, & Ratanakomut, 2015).

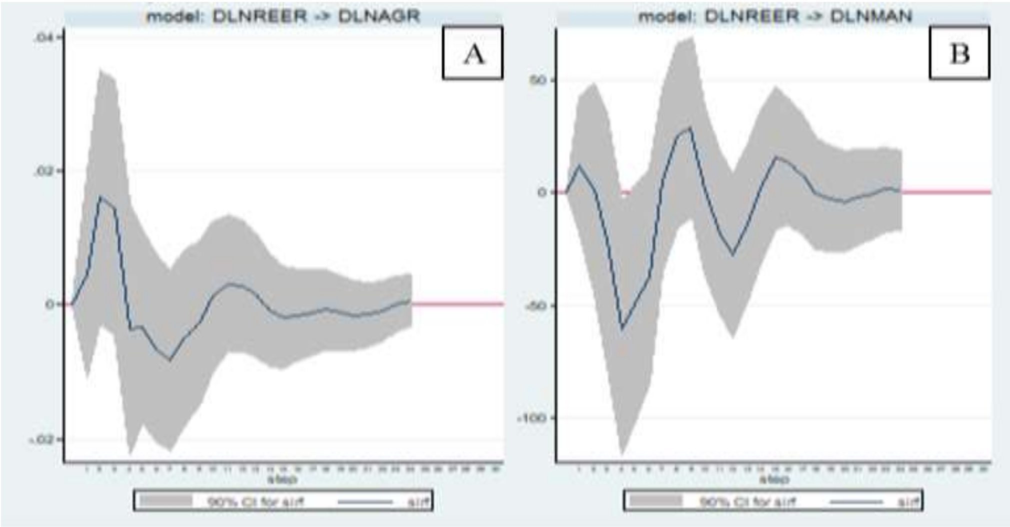

Figure 19: Response of agricultural sector and manufacturing sector to real effective exchange rate structural shock.
Source: Tunyo (2020)

Structural Forecast Error Variance Decomposition (SFEVD)

The structural forecast error variance decomposition (SFEVD) of the variables for 24-months horizon is presented in Tables 4 to 10 and Appendix 6. The structural forecast error variance decomposition for crude oil production is presented in Table 4 and Appendix 6A. In the first month, all the variations in crude oil production were explained by itself. However, the predictive power of crude oil production declined to 66.01% after twenty-four months. The remaining share of variation was accounted by fiscal balance (9.50%), real effective exchange rate (8.03%), manufacturing sector (6.16%), services sector (6.06%), consumer price index (2.96%) and agricultural sector (1.26%). The explanation power of the fiscal balance could be attributed to the expenditure pattern of government, suggesting that a rise in government expenditure requires a rise in crude oil production to generate revenue for the government to offset its deficit.

Table 4: Results of the SFEVD for crude oil production

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	100	0	0	0	0	0	0
2	99.68	0.09	0.05	0.01	0.13	0.01	0.02
12	72.35	1.14	6.42	6.00	11.59	1.96	0.56
22	66.34	1.21	5.78	6.31	9.77	7.54	3.04
23	66.23	1.24	5.89	6.20	9.59	7.84	3.00
24	66.01	1.26	6.06	6.16	9.50	8.03	2.96

Source: Tunyo (2020)

The structural forecast error variance decomposition for the agricultural sector is shown in Table 5 and Appendix 6B. The agricultural sector accounted for almost all of the variation (99.9%) by itself for the first month. However, the contribution by the sector declined to 64.82% in twenty-four months. Consumer price index accounted for the largest portion (15.65%) of the variation. This could be attributed to aggregate demand pressures for consumer goods which affects the agricultural sector. Because the oil sector does not integrate into the agricultural sector, crude oil production explained only 1.71% of the variation. The manufacturing and services sectors accounted for more than 5% of the variations due to the interdependence between the sectors. The fiscal balance explained 1.95% of the variation in the agricultural sector because this sector lacks adequate funding, infrastructure and irrigation even though the sector is among the priority areas of ABFA. This amount alone is not enough to expand the agricultural sector. The exchange rate could not explain much of the variation in the agricultural sector because the agricultural sector does not depend on import. Besides, the real effective exchange rate continues to fall which is an added advantage for agricultural exports.

Table 5: Results of the SFEVD for agricultural sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	0	99.9	0	0	0	0	0
2	0.01	96.45	0.02	0.37	0.30	0.19	2.64
12	1.49	67.40	6.37	4.61	1.85	3.50	14.77
22	1.72	64.75	7.35	5.14	1.95	3.40	15.67
23	1.72	64.77	7.36	5.13	1.94	3.40	15.66
24	1.71	64.82	7.35	5.13	1.95	3.39	15.65

Source: Tunyo (2020)

Table 6 and Appendix 6C presents the structural forecast error variance decomposition for the services sector. The services sector lost substantial predictive power to agricultural sector throughout the period. In the first month, the agricultural sector explained 51.67% of the variation in the services sector with 48.13% explained by itself. The contribution of the services sector reduced to 26.47% in twenty-four months. The remaining share of the variation was explained by crude oil production (1.23%), agricultural sector (53.18%), manufacturing sector (4.99%), consumer price index (6.62%), fiscal balance (4.20%) and real effective exchange rate (3.42%). The high predictive power of the agricultural sector may be attributed to the dependence of the economy on the agricultural sector which plays a critical role in the other sectors despite losing its position to the services sector.

Table 6: Results of the SFEVD for services sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	0.20	51.67	48.13	0	0	0	0
2	0.20	56.13	42.21	0.04	1.34	0.01	0.06
12	0.53	54.78	27.43	4.23	4.12	3.39	5.52
22	1.10	53.27	26.49	4.97	4.18	3.42	6.56
23	1.11	53.23	26.46	4.96	4.18	3.42	6.61
24	1.23	53.18	26.47	4.99	4.20	3.42	6.62

Source: Tunyo (2020)

The structural forecast error variance decomposition for the manufacturing sector is shown in Table 7 and Appendix 6D. The agricultural sector and crude oil production explained about 1.13% and 1.39%, respectively, of the variations in the manufacturing sector in the first month with 97.21% of the variation contributing to itself. The contribution of the variation to itself reduced to 54.36% in twenty-four months. However, the share of the agricultural sector and crude oil production increased to 19.30% and 3.19% respectively. The remaining proportion of the variation was accounted by the services sector (10.18%), fiscal balance (1.59%), real effective exchange rate (5.81%) and consumer price index (5.56%) in twenty-four months. The high explanation power of the agricultural sector could be attributed to the output of the agricultural sector which serves as an input for the manufacturing sector. The manufacturing sector relies on the services sector for services needed for production and accounts for a large share after agricultural sector. Real effective exchange rate plays a major role in the manufacturing sector due to the dependence of the sector on imported raw materials for production.

Table 7: Results of the SFEVD for manufacturing sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	1.39	1.13	0.07	97.21	0	0	0
2	2.71	1.69	0.40	94.61	0.06	0.25	0.26
12	3.08	19.40	9.85	57.44	0.89	5.61	3.70
22	3.19	19.33	10.15	54.42	1.57	5.81	5.52
23	3.18	19.31	10.17	54.38	1.57	5.81	5.55
24	3.19	19.30	10.18	54.36	1.59	5.81	5.56

Source: Tunyo (2020)

The structural forecast error variance decomposition for fiscal balance is presented in Table 8 and Appendix 6E. The fiscal balance lost substantial predictive power to crude oil production throughout the twenty-four months. In the first month, crude oil production accounted for 49.89% of the variations in fiscal balance with 35.69% of the variation contributing to itself and the remaining variation explained by the sectors. The contribution of the variation by all the variables increased within the twenty-four months except fiscal balance which reduced to 11.44%. Crude oil production explained 66.51% of the variation in fiscal balance. The remaining variation was explained by agricultural sector (1.46%), services sector (4.72%), manufacturing sector (4.15%), real effective exchange rate (6.50%) and consumer price index (5.20%). The strong predictive power of crude oil production could be attributed to the oil proceeds allocated to the government. The largest portion of the proceeds comes from carried and participation interest (51%) which constitute the share of the oil production owned by the government (Fosu, 2017). This implies that most of the revenue generated by the government comes from crude oil production. Also, the production of oil is used as collateral for borrowing to finance government expenditures.

Table 8: Results of the SFEVD for fiscal balance

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	49.89	1.07	11.11	2.24	35.69	0	0
2	52.03	0.35	8.36	1.70	37.47	0.08	0
12	67.13	0.61	4.20	4.08	12.42	6.02	5.52
22	66.38	1.45	4.69	4.18	11.54	6.46	5.27
23	66.48	1.46	4.70	4.15	11.48	5.49	5.24
24	66.51	1.46	4.72	4.15	11.44	6.50	5.20

Source: Tunyo (2020)

The structural forecast error variance decomposition for real effective exchange rate is shown in Table 9 and Appendix 6F. The largest portion of the variation in the real effective exchange rate was explained by itself (93.21%) in the first month. The remaining value was accounted by fiscal balance (2.27%), the agricultural sector (1.03%), services sector (3.44%), crude oil production (0.02%) and manufacturing sector (0.01%). However, the variation explained by real effective exchange rate reduced to 71.90% in twenty-four months with the remaining variation explained by crude oil (4.87%), fiscal balance (4.01%), agricultural sector (5.69%), services sector (5.59%) and manufacturing sector (3.11%). The explanation of the sectors and crude oil production to the variations in the real effective exchange rate could be attributed to the exportation and importation of goods and services by the sectors and the oil sector.

Table 9: Results of the SFEVD for real effective exchange rate

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	0.02	1.03	3.44	0.01	2.27	93.21	0
2	0.27	1.07	3.29	0.62	2.21	91.55	1.07
12	4.87	5.39	5.45	3.03	4.01	72.53	4.77

22	4.88	5.67	5.60	3.10	4.01	71.94	4.81
23	4.88	5.69	5.59	3.11	4.00	71.92	4.81
24	4.87	5.69	5.59	3.11	4.01	71.90	4.81

Source: Tunyo (2020)

Table 10 and Appendix 6G show the structural forecast error variance decomposition for consumer price index. In the first month, variation in consumer price index was explained by itself (67.64%), the agricultural sector (3.54%), services sector (0.35%), manufacturing sector (21%), fiscal balance (7.20%) and real effective exchange rate (0.20%). The contributions by the other variables increased over the period. However, the variations due to the consumer price index reduced over the period. In twenty months, variation in the consumer price index was explained by itself (47.82%), crude oil production (1%), agricultural sector (11.97%), services sector (6.30%), manufacturing sector (22.75%), fiscal balance (8.40%) and real effective exchange rate (1.76%). The highest variation was explained by the manufacturing sector whilst the least variation was accounted for by the exchange rate. The high predictive power of the agricultural and manufacturing sectors may be attributed to the cost involved in production of goods in these sectors. The explanation power by fiscal balance could be due to the level of expenditure incurred by the government which influences aggregate demand pressure and affects consumer price index.

Table 10: Results of the SFEVD for consumer price index

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
1	0.05	3.54	0.35	21.00	7.20	0.20	67.64
2	0.08	3.81	4.84	26.29	9.26	0.86	54.84
12	0.97	11.74	6.21	22.86	8.28	1.73	48.17

22	0.99	11.96	6.30	22.76	8.39	1.75	47.84
23	0.99	11.96	6.30	22.76	8.39	1.75	47.83
24	1.00	11.97	6.30	22.75	8.40	1.76	47.82

Source: Tunyo (2020)

Summary

The descriptive statistics and time series properties of the data employed in the study were examined for estimation, presentation and discussion. The ADF and PP tests for unit root revealed that the agricultural sector and consumer price index were stationary at levels while the other variables were differenced to be stationary. The pre-estimation test showed a lag length of four which was employed in estimating the SVAR model. No serial correlation was found at the lag order. The stability test showed that the model was stable.

The results of the structural impulse response function indicated that crude oil production had no impact on the non-oil sectors, exchange rate and inflation. However, crude oil production showed a positive impact on fiscal balance. Also, the results of the structural forecast error variance decomposition evidenced that crude oil production accounted for the least variation in all the variables except fiscal balance which accounted for the largest variation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter provides a summary of the study and the conclusions drawn from the findings. The chapter presents policy recommendations and suggestions for further research on the study.

Summary

The purpose of this study was to investigate the impact of crude oil production on macroeconomic performance in Ghana. Specifically, the study examined how crude oil production impact the non-oil sectors (agricultural sector, services sector and manufacturing sector) and macroeconomic variables (inflation, fiscal balance and real effective exchange rate). The study hypothesized that crude oil production has no impact on the non-oil sectors and macroeconomic variables. In examining the performance of macroeconomic indicators, the study employed the structural vector autoregressive (SVAR) model using monthly data from January 2011 to December 2018.

The macroeconomic time series variable employed were agricultural sector value-added output, services sector value-added output, manufacturing sector value-added output, real effective exchange rate, consumer price index, fiscal balance, crude oil production, and the price of crude oil which was used as a control variable. The SVAR model uses the structural impulse function (SIRF) and structural forecast error variance decomposition as its output because the individual coefficients estimated are difficult to interpret.

The findings of the structural impulse response function revealed that:

- Crude oil production had no impact on agricultural sector, manufacturing sector, services sector, consumer price index and real effective exchange rate. However, crude oil production had a positive impact on fiscal balance.
- Fiscal balance had a positive impact on services sector and a decreasing impact on consumer price index. In contrast, fiscal balance had no significant impact on agricultural sector and real effective exchange rate.
- The agricultural sector had an increasing impact on the services sector but a positive and negative impacts on the manufacturing sector. The sector had no significant impact on inflation and exchange rate.
- Moreover, the services sector had a positive impact on the manufacturing sector, fiscal balance and consumer price index. However, the services sector had no significant impact on real effective exchange rate.
- The manufacturing sector had a decreasing impact on consumer price index and no impact on real effective exchange rate.
- The consumer price index had positive and negative impacts on the agricultural sector. However, consumer price index had no impact on real effective exchange rate.
- Finally, real effective exchange rate had no impact on the agricultural sector, manufacturing sector and consumer price index.

The findings of the structural forecast error variance decomposition showed that:

- Crude oil production accounted for a small amount of variation in the other variables except fiscal balance.
- Fiscal balance contributed the highest share of variation in crude oil production while the agricultural sector explained the least variation in crude oil production.
- The agricultural sector contributed to the highest part of the variations in the services sector and the manufacturing sector.
- Also, the consumer price index explained the largest portion of the variation in the agricultural sector while fiscal balance contributed the least variation in the agricultural and manufacturing sectors.
- Finally, the manufacturing sector and the agricultural sector accounted for the highest portion of the variation in the consumer price index while exchange rate accounted for the least variation.

Conclusions

The contribution of the oil sector to the growth and development of an oil exporting economy largely depends on the extent to which the oil sector is integrated with other sectors of the economy as well as the extent to which revenue received from the oil sector is used to influence the growth of the non-oil sector. Also, the importance of the macroeconomic variables is crucial since crude oil production influence these variables through the spending effect and exchange rate appreciation effect. The empirical findings revealed that crude oil production had no impact on the non-oil sectors of the Ghanaian economy. This could be explained by the low forward and backward linkages due to that the oil sector is not integrated into the domestic economy and hence indicating the enclave effect of the oil sector.

Also, the empirical findings indicate that crude oil production has no impact on real effective exchange rate and inflation. This implied that the export of crude oil and imports of inputs for the production of crude oil do not influence the depreciation of our domestic currency. Also, the consumer price index influenced by the cost of production witnessed an insignificant impact of crude oil production. The refined petroleum product used as input for production by the sectors are imported hence could explain that outcome. However, crude oil production affected fiscal balance positively implying the fulfilment of the financial linkage by the oil and gas sector.

Policy Recommendations

- Based on the evidence that crude oil production does not impact the non-oil sectors because of low forward linkages provided by the oil sector, the study recommends the government through GNPC and other major oil stakeholders such as Tullow Ghana Limited, Kosmos Energy Ghana and Anardako Petroleum Corporation to establish oil refineries, petroleum industries and fertilizer plants domestically to provide a forward linkage for the non-oil sectors and influence inflation. Also, this would help improve fiscal balance since imports of energy related expenditures account for deficit on fiscal balance.
- The government through the Ministry of trade and Industry should develop the manufacturing and services sectors to meet international standards in order to provide a backward linkage to the oil sector in and ensure the integration of the sectors into the oil sector.

- Based on the evidence that crude oil production improves fiscal balance. The government of Ghana (GoG) through the Ministry of Energy needs to negotiate for high terms for royalties, carried and participation interest, surface rentals and others since this would provide more revenue to the government and improve fiscal balance. Also, the government spending by the Ministry of Finance and Economic Planning should be geared towards productive sectors since this will stabilise inflation in the economy.
- Based on the evidence that fiscal balance does not impact the agricultural sector, the Ministry of Finance and Economic Planning should use the revenue generated from crude oil to boost and diversify the agricultural sector to help contribute to the growth of the manufacturing and services sectors and achieve industrialization.

Further Research Areas

- Crude oil production and macroeconomic performance in Ghana should be researched employing the dynamic stochastic general equilibrium (DSGE) model or dynamic computable general equilibrium (DCGE) model.
- A panel analysis of crude oil production and macroeconomic performance of oil-producing countries in Africa should be researched.
- The fiscal balance should be disaggregated into expenditure and revenue to ascertain how crude oil production impacts expenditure and revenue patterns of government.

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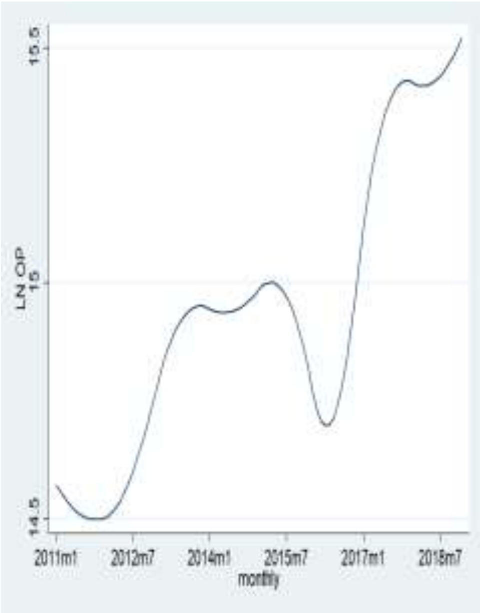
APPENDICES

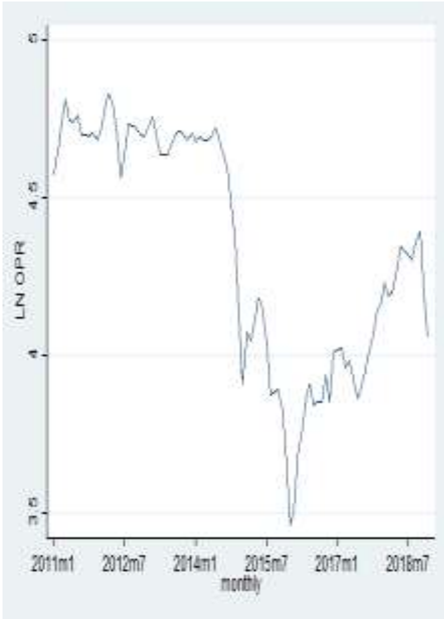
APPENDIX 1

Plot of Variables in Levels

LNOP



LNOPR



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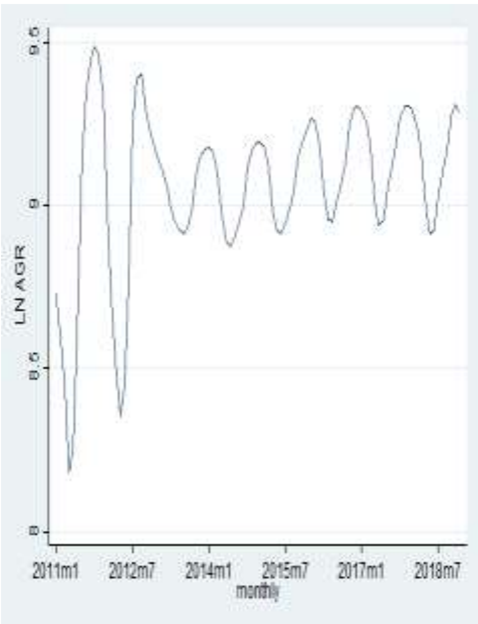
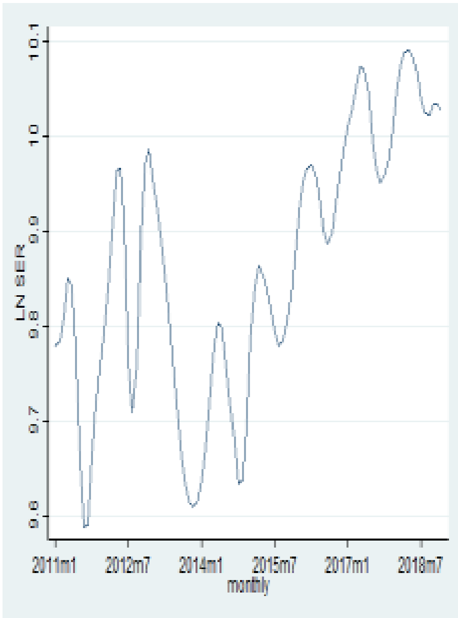
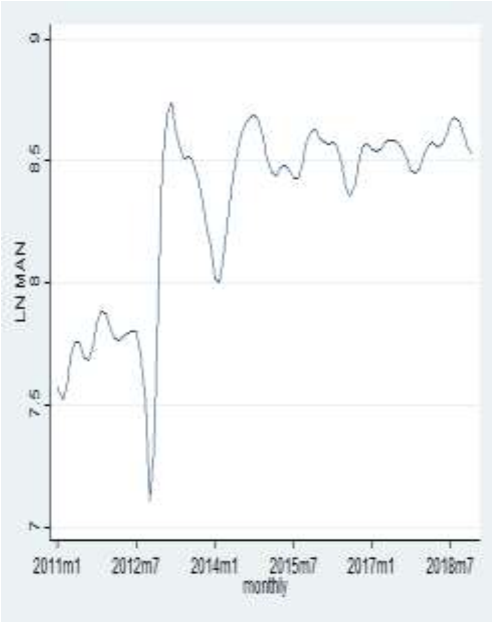


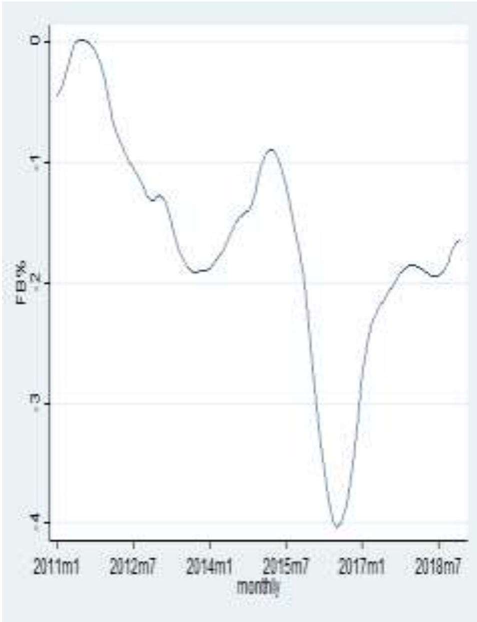
LNSER



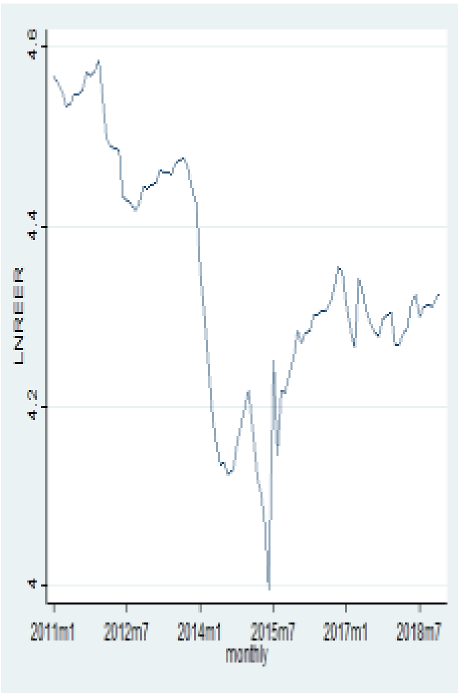
LNMAN



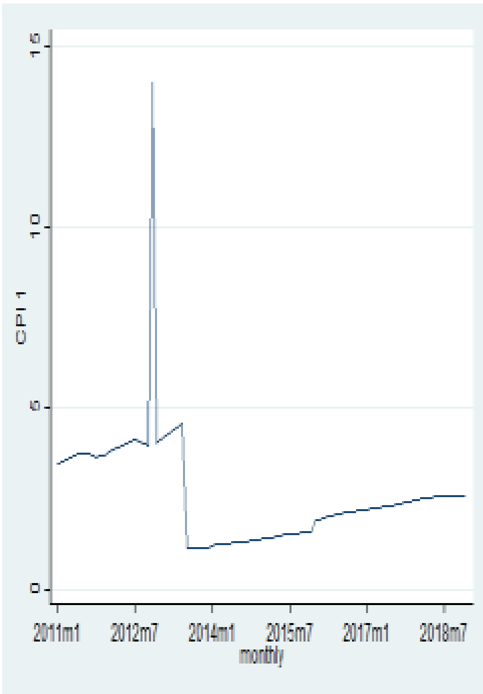
FB



LNREER



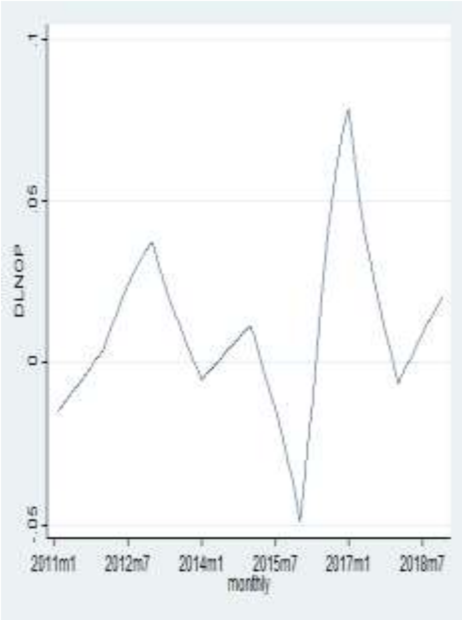
CPI



APPENDIX 2

Plot of Variables in First Difference

DLNOP



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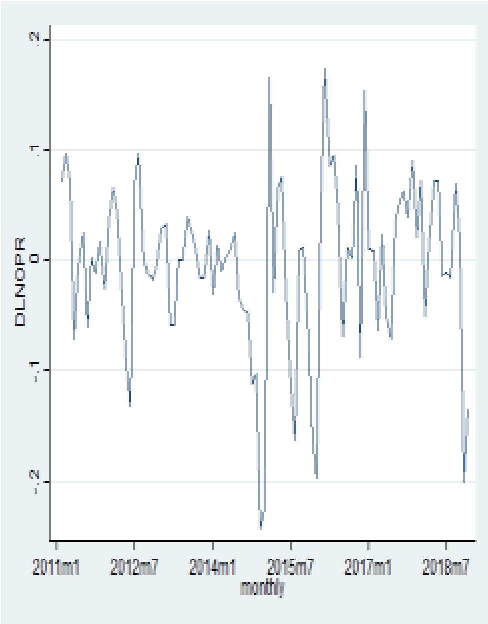
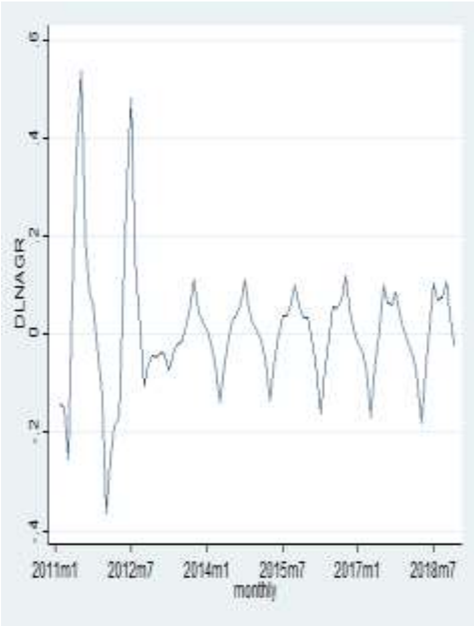


DLNAGR



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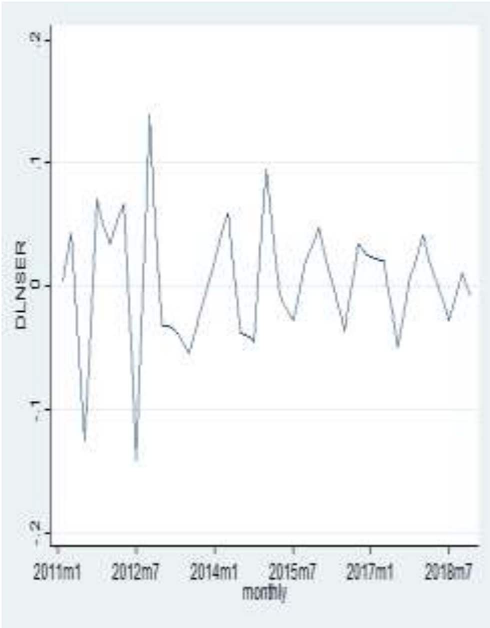
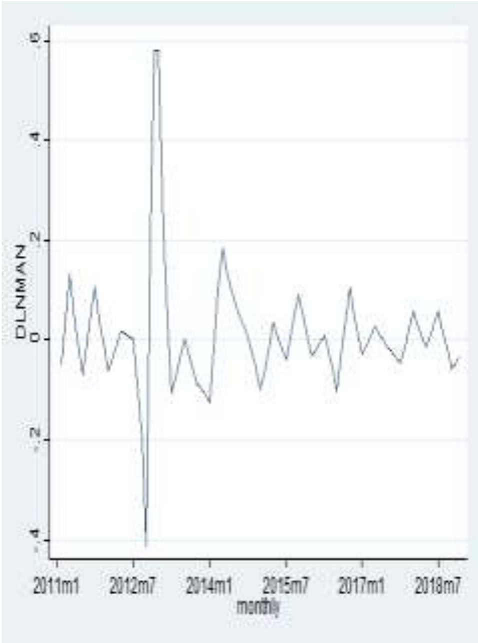
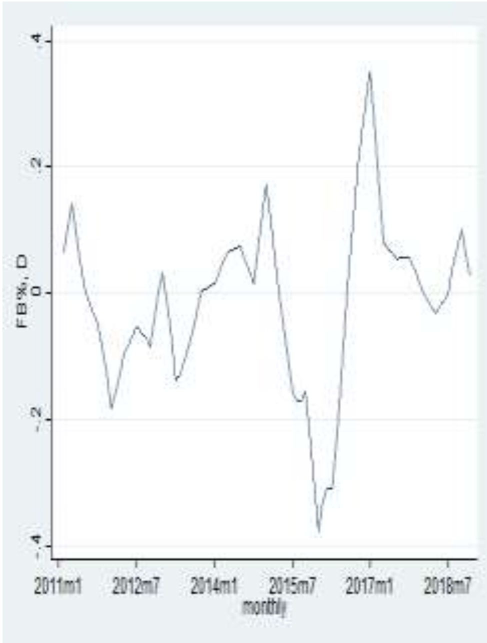


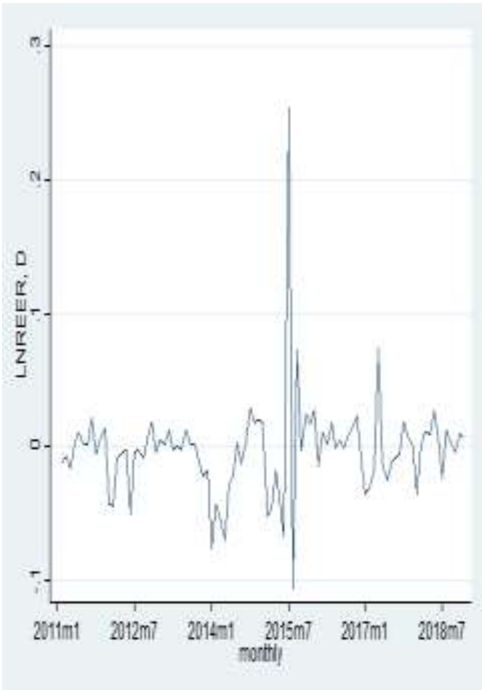
DLNMAN



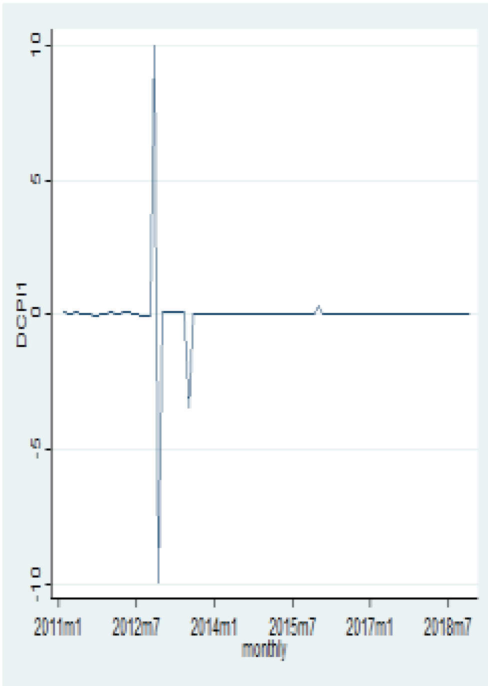
DFB



DLNREER



DCPI



APPENDIX 3

Pre-Estimation Test

Appendix 3A: VAR lag length selection criteria

Lag	LL	LR	FPE	AIC	HQIC	SIC
0	-98.3013		1.4e-09	2.3109	2.3994	2.53018
1	919.338	2035.3	1.4e-18	-18.4204	-17.6238	-16.4468
2	1375.5	912.32	2.8e-22	-26.9456	-25.441	-23.2178*
3	1518.36	285.72	5.5e-23	-28.6599	-26.4473*	-23.1778
4	1593.05	149.39*	5.1e-23*	-28.8924*	-25.9717	-21.656

* indicates lag order selected by the criterion

LL: Log-likelihood

LR: sequential modified LR test statistics (each at 5%level)

FPE: Final prediction error

AIC: Akaike information criterion

SIC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendix 3B: Wald test for lag exclusion

Lag	Chi2	Df	Prob > chi2
1	1104.447	49	0.000
2	112.4607	49	0.000
3	113.7003	49	0.000
4	143.6649	49	0.000

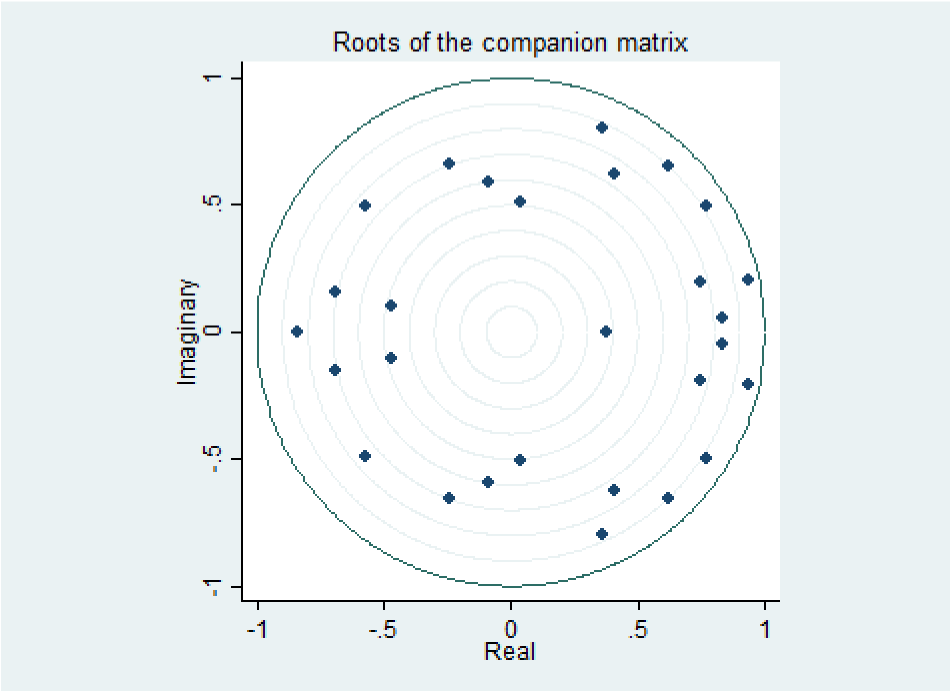
H_0: endogenous variables at lag order are jointly zero

Appendix 3C: Lagrange-multiplier test for serial correlation

Lag	Chi2	df	Prob > chi2
1	103.0194	64	0.00001
2	66.3857	64	0.04960
3	99.9354	64	0.00002
4	50.1866	64	0.42615

H_0: no serial correlation at lag order

Appendix 3D: Plots of eigenvalues



APPENDIX 4

Structural Vector Autoregression Estimates

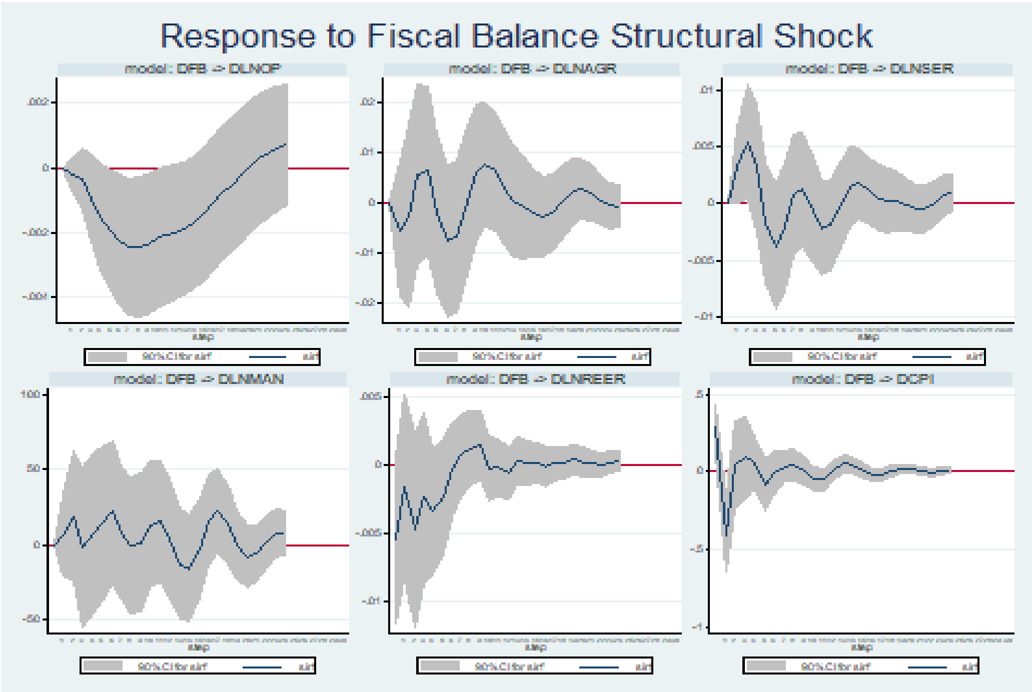
Sample: 2011m6 - 2018m12 Number of obs = 91

Exactly identified model Log likelihood = 805.5087

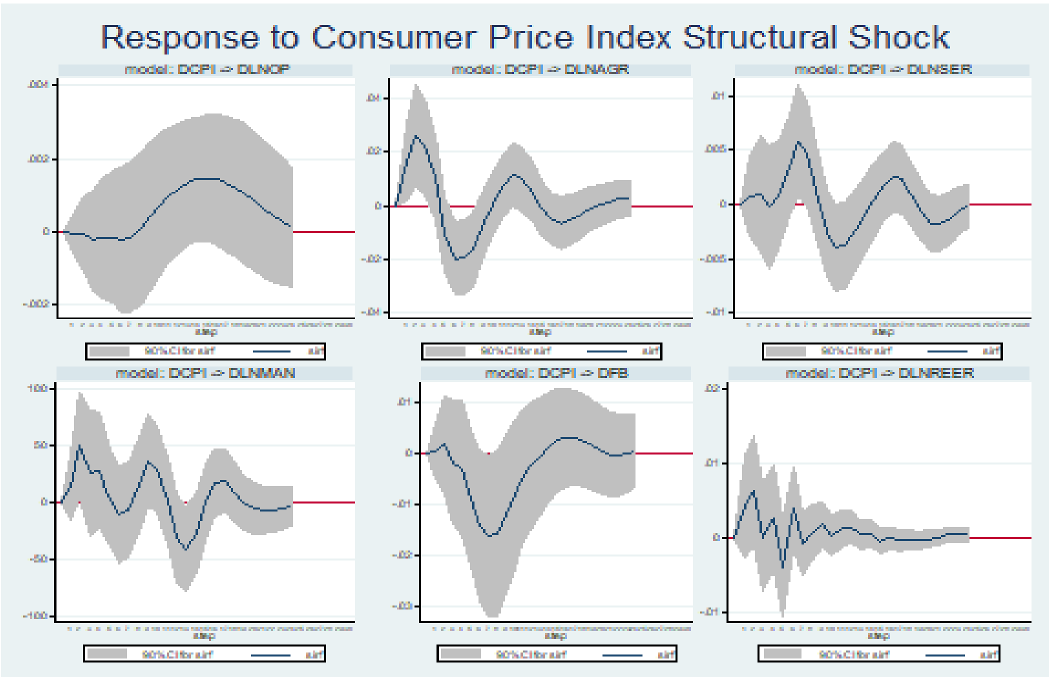
	Coefficient	Std. Error	Z-statistics	P-value
/a_1_1	1 (constrained)			
/a_2_1	-.2373089	2.809767	-0.08	0.933
/a_3_1	.2545918	.4860606	0.52	0.600
/a_4_1	6338.004	5579.305	1.14	0.256
/a_5_1	-7.567528	.6446865	-11.74	0.000
/a_6_1	-2.524063	2.101681	-1.20	0.230
/a_7_1	117.5998	51.97893	2.26	0.024
/a_1_2	0 (constrained)			
/a_2_2	1 (constrained)			
/a_3_2	.1792299	.0181335	9.88	0.000
/a_4_2	-286.8524	299.2773	-0.96	0.338
/a_5_2	-.1627123	.0345116	-4.71	0.000
/a_6_2	.0911176	.079149	1.15	0.250
/a_7_2	1.711751	1.956278	0.88	0.382
/a_1_3	0 (constrained)			
/a_2_3	0 (constrained)			
/a_3_3	1 (constrained)			
/a_4_3	-310.4237	1201.477	-0.26	0.796
/a_5_3	-.7247763	.1379067	-5.26	0.000
/a_6_3	.28805	.3237186	0.89	0.374
/a_7_3	17.3339	7.978009	2.17	0.030
/a_1_4	0 (constrained)			
/a_2_4	0 (constrained)			
/a_3_4	0 (constrained)			
/a_4_4	1 (constrained)			
/a_5_4	-.0000288	.000012	-2.39	0.017
/a_6_4	-.0000124	.0000255	-0.48	0.628
/a_7_4	-.0027349	.0006264	-4.37	0.000
/a_1_5	0 (constrained)			
/a_2_5	0 (constrained)			
/a_3_5	0 (constrained)			
/a_4_5	0 (constrained)			
/a_5_5	1 (constrained)			
/a_6_5	.320853	.2155271	1.49	0.137
/a_7_5	-16.8916	5.352695	-3.16	0.002
/a_1_6	0 (constrained)			
/a_2_6	0 (constrained)			
/a_3_6	0 (constrained)			
/a_4_6	0 (constrained)			
/a_5_6	0 (constrained)			
/a_6_6	1 (constrained)			
/a_7_6	-1.34226	2.57232	-0.52	0.602
/a_1_7	0 (constrained)			
/a_2_7	0 (constrained)			
/a_3_7	0 (constrained)			
/a_4_7	0 (constrained)			
/a_5_7	0 (constrained)			
/a_6_7	0 (constrained)			
/a_7_7	1 (constrained)			

APPENDIX 5

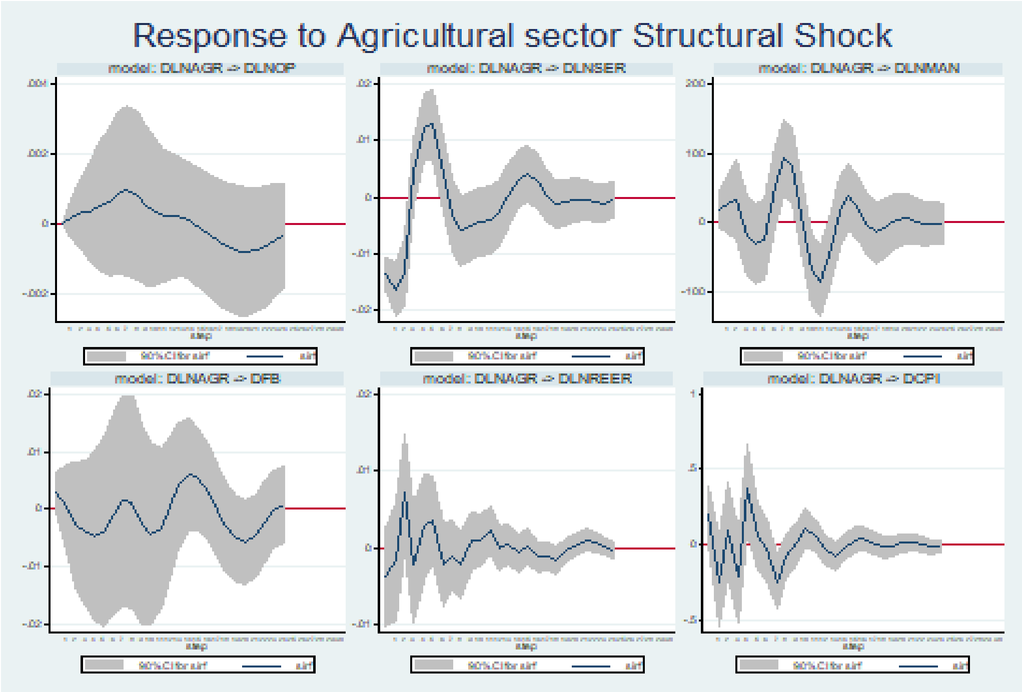
Structural Impulse Response Function



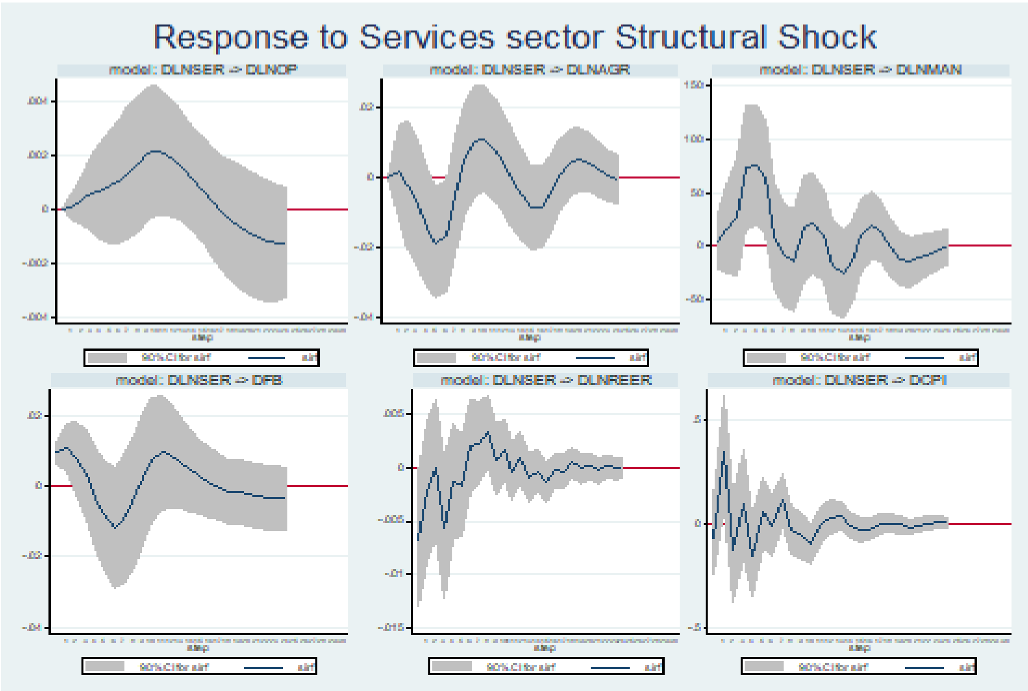
Appendix 5A: Response of the other variables to Fiscal balance Structural shock.



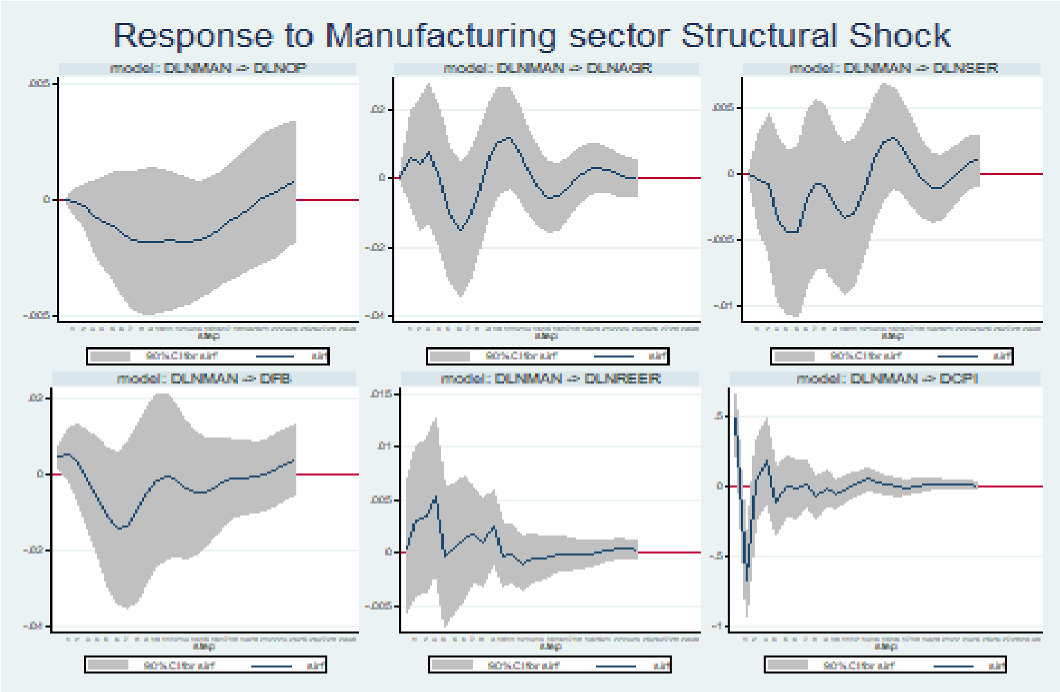
Appendix 5B: Response of the other variables to Consumer price index Structural shock.



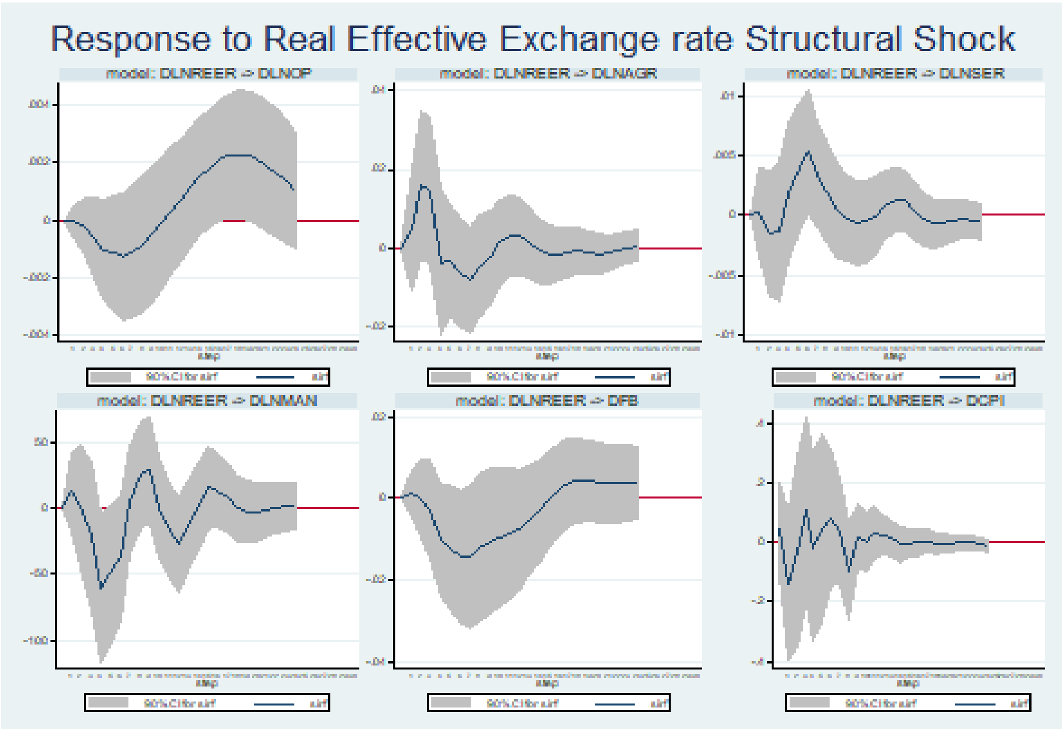
Appendix 5C: Response of the other variables to Agricultural sector Structural shock.



Appendix 5D: Response of the other variables to Services sector Structural shock.



Appendix 5E: Response of the other variables to Manufacturing sector Structural shock.



Appendix 5F: Response of the other variables to Real effective exchange rate Structural shock.

APPENDIX 6

Structural Forecast Error Variance Decomposition

Appendix 6A: Results of the structural FEVD for crude oil production

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	100	0	0	0	0	0	0
2	99.68	0.09	0.05	0.01	0.13	0.01	0.02
3	99.11	0.23	0.24	0.11	0.22	0.08	0.01
4	97.18	0.27	0.50	0.51	1.01	0.45	0.07
5	94.52	0.37	0.71	0.98	2.28	1.06	0.07
6	91.73	0.51	0.97	1.43	3.76	1.53	0.07
7	88.51	0.78	1.30	2.11	5.29	1.94	0.08
8	85.07	1.03	1.88	2.93	6.88	2.14	0.07
9	81.71	1.17	2.77	3.75	8.35	2.18	0.07
10	78.41	1.18	4.00	4.52	9.63	2.11	0.13
11	75.25	1.16	5.31	5.26	10.70	2.02	0.29
12	72.35	1.14	6.42	6.00	11.59	1.96	0.56
13	69.87	1.11	7.14	6.63	12.28	2.02	0.94
14	67.91	1.08	7.45	7.20	12.71	2.28	1.38
15	66.58	1.02	7.41	7.58	12.81	2.75	1.84
16	65.85	0.97	7.13	7.73	12.59	3.42	2.27
17	65.66	0.95	6.74	7.65	12.15	4.23	2.61
18	65.75	0.95	6.37	7.42	11.59	5.07	2.84
19	65.96	0.99	6.05	7.10	11.02	5.87	2.98
20	66.17	1.06	5.85	6.79	10.50	6.57	3.04
21	66.31	1.14	5.76	6.52	10.08	7.12	3.06
22	66.34	1.21	5.78	6.31	9.77	7.54	3.04
23	66.23	1.24	5.89	6.20	9.59	7.84	3.00
24	66.01	1.26	6.06	6.16	9.50	8.03	2.96

Appendix 6B: Results of the structural FEVD for agricultural sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	0	99.9	0	0	0	0	0
2	0.01	96.45	0.02	0.37	0.30	0.19	2.64
3	0.03	88.93	0.07	0.45	0.31	2.29	7.91
4	0.37	82.94	0.37	0.85	0.52	3.75	11.20
5	0.81	80.74	1.84	0.80	0.78	3.64	11.37
6	1.07	78.01	4.03	1.45	0.75	3.43	11.25
7	1.26	73.71	5.32	2.65	1.05	3.39	12.60

Appendix 6B cont'd

8	1.11	731.41	5.19	3.26	1.27	3.60	14.06
9	1.12	70.19	5.21	3.30	1.24	3.64	15.22
10	1.25	69.31	5.70	3.43	1.41	3.63	15.25
11	1.40	68.24	6.21	3.99	1.70	3.56	14.89
12	1.49	67.40	6.37	4.61	1.85	3.50	14.77
13	1.53	66.78	6.35	4.86	1.86	3.47	15.14
14	1.52	66.47	6.30	4.85	1.85	3.45	15.53
15	1.54	66.25	6.42	4.85	1.85	3.45	15.61
16	1.61	65.81	6.76	4.87	1.86	3.44	15.52
17	1.68	65.32	7.06	5.00	1.88	3.42	15.54
18	1.73	65.07	7.13	5.10	1.89	3.42	15.66
19	1.73	65.03	7.10	5.09	1.88	3.40	15.75
20	1.73	64.97	7.16	5.10	1.90	3.39	15.74
21	1.72	64.83	7.27	5.13	1.95	3.40	15.70
22	1.72	64.75	7.35	5.14	1.95	3.40	15.67
23	1.72	64.77	7.36	5.13	1.94	3.40	15.66
24	1.71	64.82	7.35	5.13	1.95	3.39	15.65

Appendix 6C: Results of the structural FEVD for services sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	0.20	51.67	48.13	0	0	0	0
2	0.20	56.13	42.21	0.04	1.34	0.01	0.06
3	0.27	54.45	41.37	0.08	3.50	0.20	0.13
4	0.26	53.66	40.33	1.06	4.19	0.36	0.13
5	0.23	57.84	35.06	2.30	3.84	0.56	0.16
6	0.22	59.80	30.29	3.18	4.15	1.46	0.88
7	0.24	57.68	28.76	3.24	4.17	3.03	2.85
8	0.36	56.53	28.18	3.18	4.09	3.59	4.05
9	0.46	56.62	28.02	3.13	4.04	3.69	4.02
10	0.54	56.00	28.37	3.39	3.92	3.56	4.22
11	0.52	55.21	28.03	3.87	4.03	3.45	4.88
12	0.53	54.78	27.43	4.23	4.12	3.39	5.52
13	0.61	54.67	27.26	4.24	4.08	3.37	5.76
14	0.70	54.41	27.27	4.26	4.18	3.36	5.80
15	0.82	54.29	27.03	4.50	4.28	3.34	5.73
16	0.90	54.27	26.63	4.75	4.26	3.38	5.79
17	0.94	54.07	26.39	4.90	4.23	3.42	6.06
18	0.94	53.90	26.31	4.90	4.23	3.42	6.28
19	0.95	53.85	26.33	4.90	4.22	3.42	6.32
20	1.00	53.67	26.44	4.94	4.20	3.43	6.32
21	1.06	53.40	26.52	4.97	4.19	3.42	6.42
22	1.10	53.27	26.49	4.97	4.18	3.42	6.56
23	1.11	53.23	26.46	4.96	4.18	3.42	6.61
24	1.23	53.18	26.47	4.99	4.20	3.42	6.62

Appendix 6D: Results of the structural FEVD for manufacturing Sector

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	1.39	1.13	0.07	97.21	0	0	0
2	2.71	1.69	0.40	94.61	0.06	0.25	0.26
3	3.17	2.03	0.98	90.79	0.37	0.15	2.51
4	3.53	2.16	5.57	85.07	0.33	0.51	2.82
5	3.22	2.75	9.57	77.54	0.35	3.38	3.18
6	3.05	3.09	12.01	73.44	0.46	4.98	2.96
7	3.42	4.92	11.55	70.66	0.78	5.74	2.91
8	3.45	10.32	10.91	66.36	0.77	5.41	2.78
9	3.38	13.94	10.43	63.21	0.72	5.51	2.77
10	3.33	13.69	10.40	62.39	0.71	5.93	3.55
11	3.10	16.03	10.29	60.05	0.79	5.71	3.89
12	3.08	19.40	9.85	57.44	0.89	5.61	3.70
13	3.02	19. 54	9.76	56.70	0.87	5.87	4.16
14	3.00	19. 19	9.90	56.13	0.95	5.83	5.00
15	3.00	19. 62	9.87	55.42	1.07	5.74	5.30
16	3.04	19.71	9.87	55.20	1.06	5.84	5.27
17	3.10	19.53	9.96	54.97	1.19	5.88	5.36
18	3.16	19.44	9.96	54.66	1.43	5.85	5.49
19	3.19	19.42	9.94	54.58	1.52	5.83	5.52
20	3.20	19.40	10.00	54.53	1.53	5.83	5.51
21	3.20	19.36	10.09	54.46	1.55	5.82	5.51
22	3.19	19.33	10.15	54.42	1.57	5.81	5.52
23	3.18	19.31	10.17	54.38	1.57	5.81	5.55
24	3.19	19.30	10.18	54.36	1.59	5.81	5.56

Appendix 6E: Results of the structural FEVD for fiscal balance

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	49.89	1.07	11.11	2.24	35.69	0	0
2	52.03	0.35	8.36	1.70	37.47	0.08	0
3	55.69	0.35	5.95	1.10	36.79	0.04	0.08
4	62.28	0.50	4.35	0.86	31.76	0.13	0.10
5	67.24	0.63	3.48	1.12	26.02	1.32	0.17
6	69.43	0.67	3.40	2.09	21.15	2.44	0.83
7	69.28	0.54	3.82	3.27	17.29	3.58	2.20
8	68.55	0.49	3.91	4.06	14.96	4.43	3.59
9	68.21	0.45	3.69	4.32	13.65	4.95	4.74
10	68.13	0.46	3.54	4.26	12.98	5.34	5.28
11	67.70	0.56	3.77	4.16	12.61	5.71	5.49
12	67.13	0.61	4.20	4.08	12.42	6.02	5.52
13	66.64	0.60	4.57	4.06	12.31	6.29	5.51
14	66.24	0.70	4.79	4.13	12.25	6.42	5.47

15	65.90	0.88	4.89	4.24	12.22	6.43	5.44
16	65.73	1.02	4.88	4.33	12.19	6.39	5.44
17	65.75	1.05	4.86	4.37	12.13	6.38	5.46
18	65.86	1.04	4.82	4.35	12.03	6.40	5.47
19	66.01	1.08	4.78	4.31	11.92	6.44	5.44
20	66.13	1.22	4.75	4.27	11.78	6.46	5.39
21	66.25	1.36	4.71	4.23	11.64	6.46	5.33
22	66.38	1.45	4.69	4.18	11.54	6.46	5.27
23	66.48	1.46	4.70	4.15	11.48	5.49	5.24
24	66.51	1.46	4.72	4.15	11.44	6.50	5.20

Appendix 6F: Results of the structural FEVD for real effective exchange rate

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	0.02	1.03	3.44	0.01	2.27	93.21	0
2	0.27	1.07	3.29	0.62	2.21	91.55	1.07
3	4.03	3.81	2.82	1.18	3.06	82.07	3.03
4	4.57	3.85	4.38	2.62	3.22	78.44	2.90
5	4.95	4.19	4.39	2.58	3.77	76.93	3.19
6	4.87	4.77	4.46	2.55	3.96	75.45	3.92
7	4.87	4.94	4.62	2.62	3.92	74.42	4.62
8	4.87	5.00	4.85	2.73	3.92	74.02	4.59
9	4.84	5.13	5.35	2.76	3.95	73.35	4.68
10	4.85	5.14	5.34	3.05	4.03	72.89	4.67
11	4.89	5.17	5.45	3.05	4.02	72.74	4.71
12	4.87	5.39	5.45	3.03	4.01	72.53	4.77
13	4.89	5.38	5.47	3.08	4.01	72.40	4.77
14	4.89	5.38	5.51	3.09	4.01	72.31	4.78
15	4.89	5.40	5.51	3.11	4.01	72.29	4.79
16	4.89	5.39	5.60	3.10	4.01	72.20	4.79
17	4.88	5.46	5.60	3.10	4.00	72.16	4.80
18	4.88	5.50	5.60	3.10	4.00	72.11	4.79
19	4.88	5.60	5.60	3.10	3.99	72.02	4.80
20	4.88	5.61	5.60	3.10	4.00	72.00	4.80
21	4.88	5.61	5.60	3.10	4.01	71.99	4.80
22	4.88	5.67	5.60	3.10	4.01	71.94	4.81
23	4.88	5.69	5.59	3.11	4.00	71.92	4.81
24	4.87	5.69	5.59	3.11	4.01	71.90	4.81

Appendix 6G: Results of the structural FEVD for consumer price index

STEPS	SFEVD (1)	SFEVD (2)	SFEVD (3)	SFEVD (4)	SFEVD (5)	SFEVD (6)	SFEVD (7)
0	0	0	0	0	0	0	0
1	0.05	3.54	0.35	21.00	7.20	0.20	67.64
2	0.08	3.81	4.84	26.29	9.26	0.86	54.84
3	0.15	4.02	5.22	25.34	8.97	0.87	55.40
4	0.42	5.45	5.27	25.31	8.83	1.24	53.45
5	0.97	9.64	5.62	23.92	8.30	1.16	50.36
6	0.97	9.66	5.69	23.81	8.50	1.23	50.11
7	0.98	9.63	5.66	23.67	8.45	1.45	50.17
8	0.96	11.34	5.91	23.07	8.27	1.45	49.00
9	0.96	11.43	5.89	23.06	8.26	1.73	48.65
10	0.96	11.40	6.01	23.03	8.25	1.73	48.61
11	0.96	11.67	6.22	22.90	8.23	1.72	48.28
12	0.97	11.74	6.21	22.86	8.28	1.73	48.17
13	0.98	11.76	6.24	22.84	8.28	1.76	48.14
14	0.99	11.89	6.26	22.80	8.32	1.76	47.98
15	0.98	11.90	6.26	22.79	8.37	1.76	47.93
16	0.99	11.92	6.28	22.78	8.36	1.76	47.91
17	0.97	11.95	6.29	22.77	8.38	1.75	47.87
18	0.99	11.94	6.29	22.76	8.38	1.75	47.87
19	0.99	11.95	6.29	22.76	8.38	1.75	47.86
20	0.99	11.95	6.29	22.76	8.40	1.75	47.85
21	0.99	11.95	6.30	22.76	8.40	1.75	47.84
22	0.99	11.96	6.30	22.76	8.39	1.75	47.84
23	0.99	11.96	6.30	22.76	8.39	1.75	47.83
24	1.00	11.97	6.30	22.75	8.40	1.76	47.82