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The Impact of Crude Oil Price Changes on Output, Inflation, and Exchange Rate in Ghana

Alex Antwi

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School of Business and Economics

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By

Alex Antwi

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Declaration

I, Alex Antwi, hereby declare that this dissertation is entirely my work towards the Master of Science Degree in Economics and that it is devoid of any material previously published by another person or previous project works of other people who have been awarded degrees in the university, except where due acknowledgement and references have been made in the text.

Acknowledgement

First and foremost, I thank the Almighty God for granting me the strength to complete this master thesis. My appreciation and gratitude also go to Prof. Roberto J. Garcia, my supervisor whose guidance has gone a long way to bring this study into shape. I could not have done this master thesis without his contributions and supervision. I also appreciate and acknowledge the authors of articles, books, and journals that I cited in my study. Finally, to my dear parents, Mr. and Mrs. Kwakye, relatives, and colleagues, I thank you for your spiritual and financial support. May the good Lord continue to shower his eternal blessings to you all.

Dedication

I dedicate this master thesis to the Almighty God for favoring me with wisdom and whose grace and love have brought me this far.

Abstract

With oil being an integral of Ghana's economy, Ghana largely depends on the importation of crude oil to meet its numerous needs. This high dependency on oil products in the economy causes macroeconomic variables such as output, inflation, and the exchange rate to be highly affected by changes in the international crude oil price. For this reason, this study aimed to establish the impact of international crude oil price changes on GDP, inflation, and the exchange rate in Ghana. The study employed Vector Autoregression (VAR) to analyze the impact of oil price fluctuation on output, inflation, and the exchange rate in Ghana. Unlike previous studies carried out to show the relationship between oil price and the macroeconomic variables (output, inflation, and exchange rate) in other developed countries, this study is done for Ghana which is known to be a developing country. The study's aim is to establish the impact of crude oil price changes on Ghana's GDP, inflation, and the value of its currency relative to the US dollar and the mechanisms by which oil price changes pass through to affect these macroeconomic indicators using Granger causality. Also, to determine the direction of the causality of oil price changes on output (as measured by GDP), inflation, and the exchange rates. The causality results revealed a unidirectional connection running from oil price to inflation. This means that oil price Granger causes inflation. This suggests that changes in oil price could be used to predict changes in inflation. From the causality analysis, there is a unidirectional relationship between the oil price and the exchange rate. The causation runs from the exchange rate to the oil price, indicating that the exchange rate Ganger causes the oil price. In the causation analysis, GDP and oil price have a unidirectional causal relationship. The causality runs from GDP to oil price. This implies that GDP Granger causes oil prices. Based on the findings, the study recommends that the country should have enough reserves to store oil when the price is relatively low. Furthermore, Ghana is now a producer of oil; the government should expand the production to export more to increase GDP and reduce the exchange rate.

KEY WORDS: Crude oil price, Volatility, impact, Granger causality.

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List of abbreviations

ADF Augmented Dickey-Fuller

BOT Balance of Trade

BOG Bank of Ghana

CEPA Centre for Policy Analysis

CPI Consumer Price Index

ERP Economic Recovery Program

EC Energy Commission of Ghana.

EIA Energy Information Administration

ESMAP Energy Sector Management Assistance Program

GDP Gross Domestic Product

GNPC Ghana National Petroleum Corporation

HIPC Highly Indebted Poor Country

IEA International Energy Agency.

IMF International Monetary Fund

KPSS Kwiatkowski- Philips- Sehmidt- Shin

LPG Liquefied Petroleum Gas

MDRI Multilateral Debt Relief Initiative

NPA National Petroleum Authority

OPEC Organization of Petroleum Exporting Countries

OECD Organization of Economic Cooperation and Development.

PPP Purchasing Power Parity

PFJ Planting for Food and Jobs.

PRGF Poverty Reduction and Growth Facility

PIAC Public Interest and Accountability Committee

PP Philips Perron

RFCC Residual Fluid Catalytic Cracking unit

SAP Structural Adjustment Program

SDG Sustainable Development Goals.

SGN Sankofa – Gye - Nyame

TOR Tema Oil Refinery.

TEN Tweneboa – Enyenra -Ntomme

UAE United Arab Emirates

VAR Vector Auto Regression.

WDI World Development Index

Z-A Zivot and Andrews unit root test

Chapter One
Introduction

1.1 Background of the study

Energy is the primary driver of economic growth and a necessary condition for economic progress. In all aspects of life, from maintaining a household to operating a business, energy is used. Energy is included among the top ten Sustainable Development Goals (SDG). Securing reliable energy and satisfying energy demands are significant elements of overall economic development strategies in all countries, not just developing nations. Because energy is crucial to economic progress, many developing countries put measures to ensure that they have access to energy source that are reliable and efficient. However, energy access alone is insufficient for economic development. Efficient and long-term utilization of energy resources is required.

Many African countries are considered energy- poor because most of the population cannot afford it (African Development Bank, 2009). Africa contributes 12% of the world's oil production, with Libya, Angola, and Nigeria holding the largest reserves. Despite the increased production, oil prices have trended up from 1980 to 2019 due to high production costs and poor infrastructure. Because 38 African countries out of 53 are net oil importers. However, higher prices of oil pose a challenge to the continent's economies. Crude oil is the main energy for productive sectors of the Ghanaian economy. It accounts for about 96.7% of energy consumption in the agricultural sector and 92% in the manufacturing and transport sectors (Armah, 2013). Consequently, changes in the price of crude oil have a substantial effect on the growth of the Ghanaian economy.

Despite the important role oil plays coupled with rising product consumption, the country depends largely on imported crude oil to meet its domestic demand for petroleum products. This makes the country potentially vulnerable to changes in international crude oil price fluctuations. The impact of crude oil price fluctuations on the growth of the economy is transmitted through both demand and supply channels (Jimenez-Rodriguez &Sanchez, 2005). Ghana has experienced changes in growth (GDP), inflation and exchange rate over the period (1980 to 2019) with oil price hikes. The negative growth rate of 3% GDP per capita experienced between 1973 and 1983 has kept the memory of the turbulence of the world oil market in the minds of the public and policy makers (Kpogli, 2015), (Fosu & Aryeetey, 2008). Because oil is closely related to daily life, the oil price

is one of the most economic indicators that needs much attention. However, people are sensitive to their changes. As a result, variations in the price of oil and their causes have been a topic of interest for economists (Yoshizaki, 2011). Therefore, because of its significant contributions to the development of the Ghanaian economy, it is essential to examine the impact of crude oil price changes on output (as measured by GDP), inflation, and the exchange rate.

1.2 **Problem statement**

The interest of the study is to establish the impact of fluctuations in the price of international crude oil prices on output (as measured by GDP), inflation, and the exchange rate in Ghana. The issue of oil price fluctuations has had many impacts on macroeconomic variables and has affected many countries, of which Ghana is one. Oil is heavily used in all sectors of Ghana's economy, particularly in manufacturing, transportation, and power generation. However, oil price fluctuations have been relatively erratic from 1980 to 2019, posing a threat to numerous industries and the general economy of Ghana.

Given the importance of oil for the country's output and development, rising oil prices on the international market also affect inflation. As the oil price spiked in 2000, the inflation rate reached 40.5% but declined moderately afterward (Shakoor, 2016). However, at the end of 2003, inflation rose to 23.6% but declined to 14.8% in 2005 and increased to 18.13% in 2008. This was due to the adjustment measure in the method used to compute inflation instituted in the petroleum sector of the economy (Kpogli, 2015). The primary sources of inflationary pressure in 2003 came mainly from the housing and utility subsector as well as the transportation and communication sector of the economy (BOG, Annual Report, 2003). Inflation increased in the first quarter of 2013 from 10.1% in January to 10.8% by March 2013 and peaked at 11% in July before declining to 11.5% in August. The upward trend in inflation during these seven months was attributed to a combination of demand and supply-side factors, including a rise in petroleum products prices and the impact of the expansionary fiscal policy of 2012. In August, however, inflation declined due to favorable development in non-food prices (BOG, 2013). As a result of rising oil prices, consumers' budgets have been under pressure, business expenditures have risen, and oil producers' profits have increased. These recurring oil price shocks have serious macroeconomic consequences and pose a challenge for policymaking. Because Ghana is a net oil importer, it is essential to empirically understand the implications of oil price shocks on economic activity.

Shocks in the price of energy have a negative impact on energy importers, who may suffer losses due to rising input costs. Energy exporters may see some profits and increased budget revenue, but they may also face inflation (Cantore, Antimiani, and Anciaes, 2012). As much as oil prices have changed so much over the years, its impact on output (measured by GDP), inflation, and the exchange rate is not clear since there has been little analysis done of the effects. Many researchers focus only on the causes of these macroeconomic variables without a proper link to oil price changes. The study will not focus only on the causes of fluctuations that occur in these macroeconomic variables but seeks to establish the direction of the relationship of oil price changes on output (as measured by GDP), inflation and the exchange rate, and the mechanisms they pass through to affect these macroeconomic variables. Therefore, studying the relationship between the oil price and output, inflation, and the exchange rate is interesting due to their significant contribution to Ghana's macroeconomy.

1.3 **Research questions**

The research questions emerging from the problem statement are:

- What is the nature of the relationship between oil price changes and output, inflation, and exchange rate, i.e., do oil prices cause changes in the other indicators or do the other indicators affect the oil price?
- What is the direction of the causality of oil price changes on GDP, inflation, and the exchange rate in Ghana?

1.4 **Objectives of the study**

This study aims to establish the impact of oil price changes on Ghana's GDP, inflation, and the currency value relative to the US dollar and the mechanisms by which oil price changes pass through to affect these macroeconomic indicators. The study will further determine the direction of the causality of oil price changes on GDP, inflation, and the exchange rate. Using annual data from 1980 to 2019, the study employed Vector Autoregression (VAR) to analyze the impact of oil price fluctuations on GDP, inflation, and the exchange rate in Ghana. To assess the relationship between the variables, the cointegration test, Vector autoregression (VAR) model, Phillips Perron (PP) test, Kwiatkowski-Phillips-Sehmidt- Shin (KPSS) test, and Granger causality test will be used. The estimating process begins with a unit root test. That is, to test the data for stationarity.

Because the estimation is based on time series data, the series must be stationary. To determine the stationarity properties of the variables, the Augmented Dickey and Fuller (1979,1981) (ADF), the Phillips Perron (pp) test of (1988), and the KPSS test will be executed. To determine the long-run relationship between the variables, the Johanson co-integration test will be performed. Finally, to also determine the direction of the variables Granger causality test will be used.

1.5 **Organization of the study**

The study is organized into six chapters. The introductory chapter followed by chapter two, which provides background into Ghana's macroeconomy and its oil sector. Chapter three provides a theoretical foundation of the problem and reviews the literature concerning empirical work related to oil price fluctuations and macroeconomic indicators. Chapter four details the methodology used, identifies variables, and reports on the data used. Chapter five analyses, presents, discusses, and the results of the study. The last chapter concludes the study, offers recommendations for policy-making and addresses some limitations and suggestions for future research.

Chapter two

Background into Ghana's macroeconomy and the oil sector

2.1 Introduction

In 1957, Ghana gained independence from Britain after years of economic hardships. The economy was strong, growing at the level of GDP per capita on par with South Korea. After becoming sovereign, Ghana's first President, Kwame Nkrumah, used foreign funds as security to establish agricultural industries for processing primary commodities for export. In the mid-1960s, cocoa prices fell adversely, affecting the economy, resulting in the overthrow of Nkrumah in 1966 and wiping out the fundamental stability and growth of the Ghanaian economy. Afterwards, the economy has experienced high volatility due to reoccurring political instability. Since independence, there have been negative rates of growth. Jong-a-Pin (2009) indicates that a high level of political instability slows down economic growth. In 1983 the economy almost collapsed as inflation reached 123% because of a severe drought, which reduced agricultural commodity production and other export crops such as cocoa (Anyemedu, 1993). High inflation rates increased volatility, deterred investment, distorted relative prices, and hindered sustainable development However, the main cause of poor macroeconomic results, such as per capita (GDP) and inflation rates in the Ghanaian economy, can therefore be linked to political instability. The 1980s were known to be the lost of decade in Africa and Latin America because it was a decade of negative development (Fischer, 1991). This launched the IMFs Economic Recovery Program (ERP) under the Structural Adjustment Program (SAP) of 1983. The program's goal was to rebuild Ghana's economy and its external balance, making the economy more competitive and sustainable and increasing economic growth. In particular, the first phase of the Economic Recovery Program One (ERPI) underlined the promotion of the export sector and the enforced fiscal discipline aimed jointly at eradicating budget deficits. This led to steady GDP growth, lower inflation, budget surpluses, and increased export revenues after 1983. After implementing structural reforms, the economy grew at 8% in 1984, following its negative growth rate of approximately 5% in 1983. In 1984, the rapid response of economic growth was due to the revenues generated from the privatization of state-owned industries and resources. The goal of this policy was to improve productivity and investment and cut government spending. This resulted in a fiscal surplus that increased growth in 1984 following the 1983 structural adjustment.

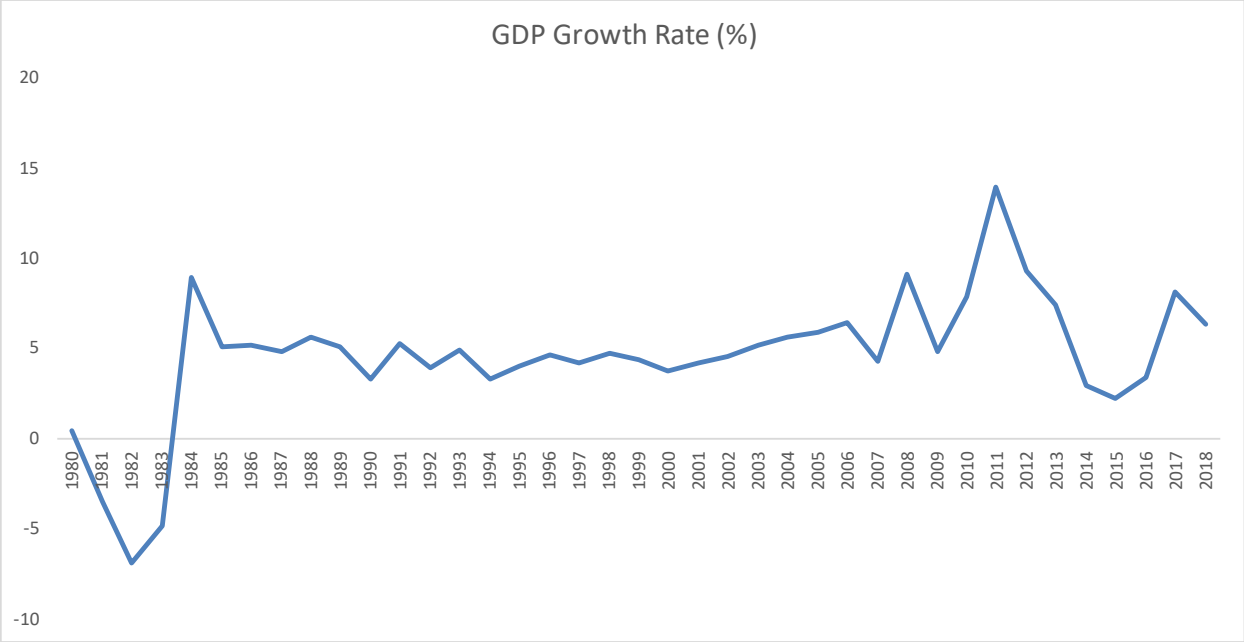

Figure 1: ***GDP growth in Ghana, 1980-2019***

Source: Bank of Ghana (2020).

Ghana's economy declined by 3% at the start of the period, with 1982 and 1983 being the worst-performing years. This performance is attributed to the severe drought and bush fires that destroyed crops and the lowest cocoa prices of the postwar period. With a positive growth rate in GDP, inflation rates slowed from 122.9% in 1983 to 39.7% in 1984 and further to 10.3% in 1985. The growth rate of GDP showed an upward trend from 1986 to 2009 though there was a fluctuation. GDP growth reached its highest rate of 11.28% in 2012. The production of oil in commercial quantities led to the rapid rise in GDP growth rate from 2010 (2.19 %) to 2012 (11.28 %). The fall in the GDP growth rate from 2010 to 2015 is attributed to the power outages that led to the high cost of production coupled with low productivity. The improved GDP growth started in 2017, attributed to the Planting for Food and Jobs (PFJ) initiative, introduced in 2017.

2.2 **GDP contribution by sector**

The participation of three key sectors, services, agriculture, and industry, helped Ghana attain high economic performance and middle-income status. Table 1 shows Ghana's GDP contributions by sector. The agricultural sector contributed the most to GDP growth from 1990 to 2005, with a minimum contribution of 35% and a maximum of 46%. The average contribution from the

agricultural sector over the period was 32%. Prior to 2006, services contributed a minimum of 26% to GDP and a maximum of 37.8%, with an average contribution of 30%. Industry made up a minimum of 16.7% and a maximum of 25.7% of the total. The industry contributed an average of 23% to GDP.

Table 1: ***GDP contribution by sector***

Year	Service, value added (% of GDP)	Agriculture, forestry, and fishing, value added (% of GDP)	Industry, value added (% of GDP)
1990	37.89	44.85	16.77
1991	37.42	45.51	16.96
1992	37.44	44.78	17.38
1993	27.53	36.93	24.82
1994	27.34	37.79	24.90
1995	27.75	38.78	24.28
1996	26.25	38.96	23.58
1997	27.89	35.78	25.67
1998	28.23	36.01	25.27
1999	28.41	35.78	25.41
2000	28.82	35.27	25.40
2001	29.16	35.24	25.22
2002	29.21	35.15	25.28
2003	29.07	36.55	25.21
2004	28.68	37.95	24.72
2005	28.91	37.45	25.13
2006	46.46	28.95	19.80
2007	47.17	27.29	19.49
2008	46.17	29.41	19.40
2009	47.94	30.99	18.51
2010	48.18	28.04	18.01
2011	45.84	23.66	23.86

2012	47.58	22.13	27.14
2013	39.15	20.45	34.86
2014	36.11	20.00	34.59
2015	39.54	20.25	31.68
2016	43.09	20.98	28.23
2017	42.35	19.70	30.78
2018	43.01	18.27	31.53

Source: World Bank (2021)

The GDP contributions by sector in Ghana are shown in table 1. The agricultural sector lost its dominance to the services sector between 2006 and 2018, making the services sector the largest contributor to GDP growth. On average, the services sector contributed 44%, agricultural contributed 24%, and industry 26%.

Ghana's macro-economy has experienced sustained macroeconomic booms and busts over the period 1980-2019 due to the fundamentals of domestic and international markets. Slow economic growth, high fiscal deficits, weak currency and energy supply challenges, low foreign reserves, declining commodity prices, high government debt, and high-interest rates have underscored the fiscal slip in the Ghana's economy. The lower income generation due to low tax and low-income schemes has led developing nations to take on debt to fund government budgets, Owusu-Nantwi & Erickson, (2016). The government's tendency to increase its debt resulted in unsustainable debt to GDP of 198.3% and a deficit of 8.5% of GDP in 2000. The Centre for Policy Analysis Ghana (CEPA) reported that, against macro-economic volatility, in July 2004, the International Monetary Fund (IMF), and other bilateral donor agencies helped the struggling Ghanaian economy by canceling debt and providing debt relief under the Highly Indebted Poor Country (HIPC) initiative and the Multilateral Debt Relief Initiative (MDRI). From 1999 to 2002, Ghana's government ran an economic program called the Poverty Reduction and Growth Facility (PRGF) to raise funds to help the country make significant progress in reducing poverty. The GDP statistics in the table below show that the Ghanaian economy experienced a revival after the start of the stabilization programs in early 2000 to strengthen economic management policies by the government of Ghana, with the public debt percent of GDP falling . The government promotion of fiscal consolidation, monetary discipline, and prudence in public spending during (2000-2004) led to a decrease in

inflation rates from 25.2% in 2000 to 12.6 % in 2004. Ghana's real GDP growth increased from a decade low of 3.8% in 2000 to 5.6% in 2004 due to improved macroeconomic management (table2).

Table 2: ***An overview of how the economy of Ghana has fared***

Year	Exchange rate (CD/$)	Inflation %	Government expenditure (% of GDP)	Government Debt (Million cedi)	Interest rate %	GDP (%)
1980	0.00027	50.1	11.16		12.0	0.5
1981	0.00028	116.5	8.79		18.5	-3.5
1982	0.00027	22.3	6.48		9.5	-6.9
1983	0.00088	122.9	5.86	7.93	13.0	-4.8
1984	0.00359	39.7	7.26	13.09	13.0	9.0
1985	0.00543	10.3	9.39	17.24	17.8	5.1
1986	0.00892	24.6	11.07	29.79	22.8	5.2
1987	0.01537	39.8	10.63	62.97	22.8	4.8
1988	0.02022	31.4	9.71	75.65	19.7	5.6
1989	0.02699	25.2	9.85	105.94	19.9	5.1
1990	0.03262	37.3	9.31	125.7	0.0	3.3
1991	0.03676	18.0	9.48	145.33	20.0	5.3
1992	0.04369	10.1	12.11	208.27	25.4	3.9
1993	0.06487	25.0	14.45	445.8	32.0	4.9
1994	0.09557	24.9	13.72	595.3	32.0	3.3
1995	0.11991	59.5	12.07	821.3	40.5	4.0
1996	0.16355	46.6	12.04	1193.25	42.8	4.6
1997	0.20479	27.9	12.36	1621.65	42.5	4.2
1998	0.23117	14.6	10.32	1838.75	26.8	4.7
1999	0.26664	12.4	10.84	2666.31	34.2	4.4
2000	0.54492	25.2	10.17	4932.07	42.0	3.7
2001	0.71631	32.9	9.72	5391.01	30.1	4.2

2002	0.79242	14.8	9.87	6540.01	26.3	4.5
2003	0.86676	26.7	11.53	8022.58	19.0	5.2
2004	0.89949	12.6	12.17	7523.78	17.1	5.6
2005	0.90628	15.1	15.31	7620.67	11.8	5.9
2006	0.91645	10.9	8.87	4903.7	10.2	6.4
2007	0.93525	10.7	8.52	7189.79	10.6	4.3
2008	1.05786	16.5	8.73	9746.86	24.7	9.1
2009	1.4088	19.3	7.57	13294.96	23.7	4.8
2010	1.43103	10.7	7.07	17410.57	12.3	7.9
2011	1.51185	8.7	13.79	23731.33	10.3	14.0
2012	1.79582	7.1	11.76	35999.64	22.9	9.3
2013	1.95405	11.7	10.93	53081.28	18.8	7.4
2014	2.89978	15.5	10.43	79570.16	25.8	2.9
2015	3.66803	17.2	9.66	100234.94	23.1	2.2
2016	3.9098	17.5	9.95	122263.02	16.8	3.4
2017	4.35074	12.4	8.80	142616.33	13.3	8.1
2018	4.58682	7.8	9.01	173068.7	14.6	6.3
2019	4.9512	7.2	8.88			5.3

Source: (World Bank,2020).

Presented in table 2 is the macroeconomic indicators of Ghana from 1980-2019. Developing economies such as Ghana have witnessed an increasing trend in government debt over the years. According to the 2016 Annual Budget Management Report by the Ministry of Finance, Ghana's total public debt stood at US$ 19,150.8 billion and increased steadily to US$29,227.1 billion at the end of 2016. The report again shows that out of the total debt of US$29,227.1 billion in 2016, domestic debt was US$ 12,766.2 billion, and external debt was US$16,461.0 billion. The total debt as percentage of GDP stood at 33.6% in 2008, rising by more than 10% by 2010 and 2013, before reaching 72.5% in December 2016. Ghana's debt, especially its external debt, has seen a sharp increase over the years because governments resorted to both external loans and domestic borrowing to finance its developmental and sustenance programs. For instance, in 2010, total

government debt was GH₵ 17.5 billion (38.9% of GDP), indicating a 78% rise from 2008. At the same time, GDP annual growth was 7.89% in 2010. By the end of 2012, the debt figure almost doubled from GH₵ 17.5 to GH₵ 35.99 (billion) with a GDP growth of 9.29%, and further increased more than double to GH₵ 79,570 billion in 2014 and was GH₵ 122.26 billion in 2016 (representing 75.5% of GDP) while GDP growth reduced from 9.29% to 3.57%. From 1980 to 2019, Ghana's debt kept increasing as a result of borrowing, which can be seen in table 2 above.

Capital outflows to emerging economies may have slowed as a result of these financial developments in developed economies. According to the government of Ghana 2007 budget statement, there was a supply-side shock in the eight months leading up to the third quarter of 2006, following a rise in crude oil prices on the international commodity market and the National Petroleum Authority's (NPA) implementation of full cost-pass through policy, which undoubtedly posed downside risk by inducing inflation expectations. During this era of rising inflationary pressures, the central bank switched from monetary to inflation-targeting to combat the rising inflationary pressures. This resulted in end-of-year inflation of 10.9 % in 2006, down from 15.2% in 2005,(table 2).

An economic recession hit the global economy in 2007/2008 and increased oil and food prices. However, report from the US Energy Information Administration (EIA) indicates that , crude oil prices increased sharply from 2007 opening price of $60.77 per barrel to a peak of $145.31 per barrel on July 3rd, 2008, before falling to $44.60 per barrel. Although investors' optimism and consumer trust in the global economy has declined, the Ghanaian economy experienced mixed reports over the same period. Ghana's mixed reports were caused by a combination of global shocks, currency depreciation, and unsustainable macroeconomic policies, resulting in inflation rates increasing from 12.7 % in 2007 to 18.1% in 2008. The all-time peak in crude oil prices on the world market, based on EIA oil price figures, from US$99.64 per barrel in January 2008 to a record high of US$145.31 in July 2008, resulted in falls in the 2008 macroeconomic goals set by the 2008 budget, and thus provided the motivation for cost-of-production increases. Facing sluggish global economic growth and the financial crisis, the Ghanaian economy grew to a 9.1% growth rate in 2008, powered by strong growth in bank credit. The increased credit availability coincided with changes in interest rates, which were crucial in managing the Ghanaian economy. According to table 2, the GDP growth rate increased to 14.0% in 2011 due to the issuance of numerous banking licenses to several international banks, which paved the way for increased

competition among banks. The public debt as a percentage of GDP, on the other hand, increased from 33.6 % in 2008 to 39.67 % in 2011. The rise in the public debt was attributed to an increase in the proportion of interest charged as a percentage of total revenue and grants as the government's primary source of funding changed from bilateral and multilateral to commercial borrowing, which involved annual interest payments with the principal sum due at maturity. Ghana's economic landscape has turned around, with real GDP growth decreasing rapidly from 14.0 % in 2011 to 7.3 % in 2013 and then to 3.7 % in 2016. As a percentage of GDP, public debt has increased, even more, rising from 39.67 % in 2011 to 56.8 % in 2013 and then to 73.1 % in 2016.

Since independence, Ghana's inflation dynamics have not been stable. It has been fluctuating and high in some periods, as seen from table 2. From 1980-2019, during periods of macroeconomic instability such as high poverty levels, unemployment, cedi depreciation, and high interest rate, Ghana experienced an increasing level of inflation (Kusi, 2018). Inflation was at its peak in 1983, with inflation being 122.9%. This high inflation can be attributed to the great famine and drought that hit the country in 1983. What made matters worse was the deportation of over 1million people from Nigeria that caused the population of Ghana to increase that year. This caused an increase in demand for scarce goods, which caused inflation to rise. However, this famine was not the only contributing factor, but poor management and bad policies on the part of the government played its role in this inflation hike (Bawumia,2014). According to Ocran (2007), Ghana's inflation percentage change had jumped above 100% on countless occasions during 1990- 2019. Monetary policy rate (MPR) tightening was applied to target inflation at the time, but it did not have the expected effect on inflation. Inflationary pressures increased the cost of living and reduced the purchasing power, affecting production and employment. With constant demand, a decrease in production raises prices, resulting in higher inflation. For policymaking, understanding the causal relationship between inflation and other key macroeconomic variables is very important. From 1980-2019, Ghana has seen an unexpected increase in inflation, triggered by its causal relationship with macroeconomic variables such as low production levels. From 1990 through to 2018, Ghana experienced high inflation, averaging almost 20% and starting from a high of 60% in 1995 to a low of 7% in 2012. These unexpected high rates of inflation (except for 2011, 2012, 2018, and 2019 which recorded single digits) are signs that the cost of living for ordinary Ghanaians has been extremely high.

On the other hand, the exchange rate is calculated using a ratio of local currencies (cedi) and the U.S dollar. The cedi exchange rate has been fluctuating at an increasing rate relative to major currencies such as the dollar, as seen in table 2. From 1980 to 2001, the average exchange rate (cedi/dollar) was 0.21, a minimum of 0.03, and a maximum of 0.72 (table 2). From 2000 to 2019, the average rate increased to 1.99, the minimum and the maximum rates rose to 0.79 and 4.9, respectively.

2.3 **Overview of the petroleum sector in Ghana**

Ghana has been a net importer of petroleum since independence in 1957. Upstream and downstream activities make up Ghana's petroleum sub-sector. Petroleum exploration and related operations are the primary focus of upstream activities. Since 2000, the expansion of exploration activities to deep water has yielded some results, including the commercial discovery of oil at Cape Three Point in the Central Region of Ghana. The Ghana National Petroleum Corporation (GNPC), founded under the Ghana National Petroleum Corporation Law 1983 (P.N.D.C.L 64), encourages and promotes hydrocarbon exploration, production, and growth, as well as regulates upstream activities . The refinery, storage, transportation, distribution, and retailing of petroleum products are downstream activities. The Tema Oil Refinery (TOR), formerly the Ghanaian Italian Petroleum Company Limited (GHAIP) established in 1960, imports and refines all crude oil into the country, apart from the consignment going to the thermal plant. TOR had restructured its refinery capacity over the years, moving from simple hydro skimming to a modern complex refinery in 2002, when the Residual Fluid Catalytic Cracking (RFCC) unit was commissioned .

Other strategic storage facilities and those at TOR can be found in different parts of the country. Before the 2003 reform, the (GNPC) was solely responsible for crude imports and refining. As a result, petroleum products were heavily subsidized in price by the government. A new pricing system was implemented in 2003 because of GNPC's heavy indebtedness and pressure from the International Monetary Fund (IMF). Historically, changes in petroleum prices have been linked to political and social crises. Prior to the economic reforms in the early 1980s, petroleum pricing in Ghana was characterized by heavy subsidies. According to Sanda et al. (2005), cheap energy policy has severely disrupted the energy market. However, the government's long-term goal following the implementation of the Structural Adjustment Program was to reduce the economy's reliance on crude oil imports.

To achieve this goal, the government implemented an upward price review of petroleum products to represent user costs to increase energy efficiency in the production, distribution, and consumption. The rise in fuel prices sends a message to both consumers and petroleum product suppliers. It informs consumers about the actual costs of using petroleum products and encourages them to switch from inefficient methods to effective methods and substitute one energy product for another. It also provides enough cash flow to suppliers to fund their maintenance and expansion of their supplies. Petroleum product prices have been revised upwards since 1983, at least to cover either cost or reflect border prices. The country's ultimate goal in terms of petroleum product pricing was to remove government interference from the market and enable market forces to decide crude oil prices. The ex-refinery price of petroleum products is directly influenced by the exchange rate and crude oil price. Another significant factor influencing domestic petroleum prices is the exchange rate or foreign currency price in terms of the domestic currency. Domestic ex-pump prices are quoted in cedi, while crude prices are quoted in dollars. However, even if the price of crude oil remains unchanged, the depreciation of the domestic currency against the dollar means higher domestic prices for petroleum products.

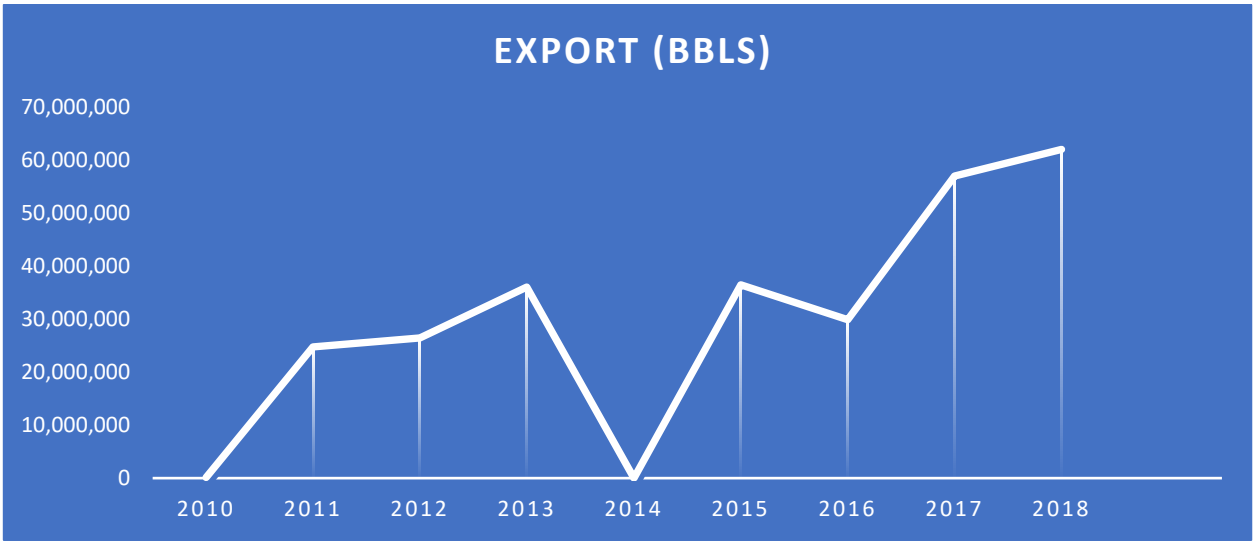

*Figure 2: **Trends of crude oil export in Ghana from 2010 to 2018 (million barrels)***

Source: Bank of Ghana & petroleum commission.

In 2007, oil and gas in commercial quantities were discovered after more than 120 years of intensive search for petroleum resources, investment from both public and private sources, and concerted efforts by successive governments. The area was given the name "Jubilee Field." The

country began producing crude oil in 2010 with 1,267,700 barrels. The total amount of crude oil produced from the Jubilee field increased between 2010 and 2015, as seen in Figure 2. The Tweneboa-Enyenra-Ntomme (TEN) fields, discovered in 2010, started producing oil in August 2016, increasing Ghana's production capacity. Also, Sankofa-Gye-Nyame (SGN) began commercial production in 2017 with 5,455,511.54 barrels of crude oil (PIAC), 2018. The total crude oil produced in 2018 increased from 58,658,064 barrels in 2017 to 62,135,435 barrels after these three fields were fully operational (fig 2). Ghana Statistical Service (2015) reported that Ghana's GDP grew by double digits (14 %) in 2011 following two years of oil exports, thus from a single-digit growth rate (4.8%) in 2009. Since 2011, when crude oil exports began, the country has earned a total of $5.013 billion from crude oil production (PIAC, 2019). The government was given a total of $1,931.70 billion for annual budget funding (PIAC, 2019). From 17.1% in 2011 to 17.7% in 2014, oil revenue grew as a percentage of GDP (IMF, 2015). Moreover, despite being a petroleum producer, Ghana is still a net importer of petroleum products, according to International Energy Statistics (2015). This is due to inadequate midstream infrastructure facilities for petroleum processing, refining, and storage. Since 1980, the Ghanaian economy has depended mainly on petroleum, accounting for 80% of the overall energy mix (excluding biomass) for growth and development. However, as of 2016, local production amounted to only about 5% of overall production, with imported petroleum accounting for 95% (Ghana Energy Commission,2016). In other words, despite producing large amounts of petroleum, Ghana is challenged with importing petroleum products.

Despite the discovery of oil in 2007 and the subsequent lifting of oil in commercial quantities in 2010, Ghana still imports considerable oil. Ghana, as previously mentioned, is an oil-importing country, with petroleum products accounting for about 24% of the country's total energy demand (EC, 2013). This is primarily due to rising consumption and insufficient storage space to engage in commercial production at home. For example, total petroleum products consumed in Ghana in 2012 were about 3.2 million tons, up from 2.8 million tons in 2011, a 14% increase over 2011. Ghana's oil dependency ratio reached 53.6 % in 2001. The transportation sector consumes the most petroleum products in Ghana, accounting for about half of the total supply, with the remaining half going to other sectors (Nnadikwe, 2011).

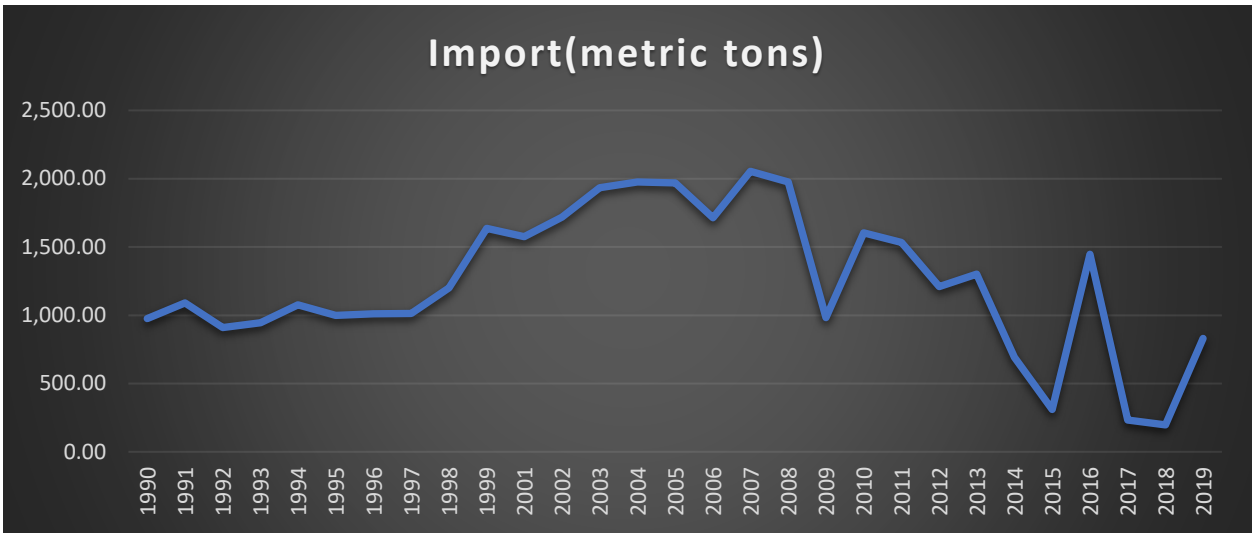

*Figure 3 :**Trends in Ghana's crude oil imports (thousand metric tons)***

Source: Energy commission (Ghana).

According to reports, Ghana's petroleum consumption as a percentage of total energy consumption in 2010 was about 70%. (Lin et al., 2014). Interestingly, Ghana is an oil-dependent economy and highly sensitive to oil-price shocks with growing consumption due to its socio-economic development. From 1990 to 2003, according to the Energy Sector Management Assistance Program (ESMAP) paper titled vulnerability of African countries to oil price shocks, Ghana's oil vulnerability indicator was high. The vulnerability indicator shows how much a country's GDP is spent due to rising oil prices. Because of a rise in oil prices, the nation spent 4.4% of its GDP in 2003, a 50% increase from 1990 to 2003. Furthermore, the vulnerability indicator for Ghana has risen from 4.4 %in 2003 to about 8.49% in 2006, representing a 93% increase over the 2003 figure (Nnakidwe,2011). Oil's value to Ghana's economy cannot be underestimated, given its crucial position in the country's economic growth.

2.4 **An Overview of the World Oil Market**

Presented in figure 4 is an overview of the world oil market. Internationally, crude oil is traded in US dollars. Where oil prices are higher, oil traders quickly redirect transactions towards such markets. This means that global supply and demand determine such transactions. Oil prices are influenced by the basic law of supply and demand. Gas and oil reserve prices reflect supply and demand pressures over a specific period. When crude oil products demand is high, prices adjust to

sustain future supply levels while considering current production levels. On the other hand, high prices encourage production, increasing supply levels and lowering the price of oil and its products

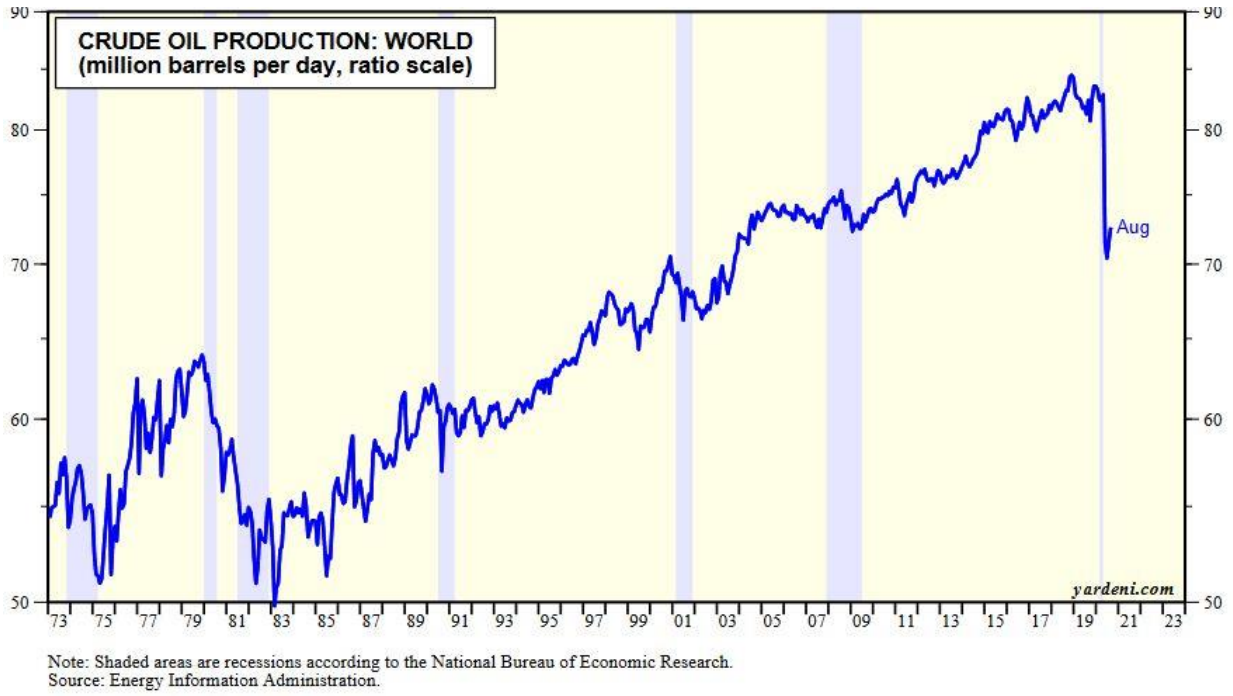

Figure 4: ***World Oil Production***

The market value of crude oil is determined by the demand for petroleum products, particularly in the transportation sector, that is all motor vehicles, aircraft, marine vessels, and trains worldwide are driven by petroleum products (Levine et al., 2014). The global oil consumption exceeds $500 billion, accounting for almost 33% of total global energy use. Crude oil is the most traded commodity globally, accounting for roughly 10% of total global trade. (Namit, 1998). Indeed, demand for crude oil has consistently increased over the last two decades. In the world market, crude oil is one of the most economically matured commodities. On the commodity exchange market, oil suppliers and buyers meet to trade different blends of oil.

Chapter 3

Theoretical Background and Literature review

3.1 **Introduction**

This chapter reviews relevant literature and theories concerning the study. The set of concepts related to the topic serves as a reference for the research in determining the measurement and relationships among study variables. The chapter is divided into three sections. The first section focuses on the theoretical review on the impact of crude oil price fluctuations on output, inflation, and Ghana's exchange rate. The second section is devoted to the empirical review of the impact of crude oil price changes on output, inflation, and the exchange rate in Ghana. The third section presents the summary of the findings from the literature review.

3.2 **Theoretical review**

The theory of production is an attempt to describe the concepts by which a corporation determines how much of each product it offers for sale, how much it produces, and how much of each labor, raw materials, and fixed capital goods that it hires (Dorfman, 1951). This theory contains some basic concepts which involve the relationship between commodity prices and the prices of the productive factors used in production. The theory of production also tries to explain the correlation between the cost of input and the level of output in the economy. Thus, the output declines as the cost of production inputs increase, all things being equal. This implies that the relationship between input price and output is negative. The main tenet behind a firm's behavior is profit maximization. Thus, the goal of any firm or industry is to make the maximum profit out of business. The profit margin that an industry will earn depends primarily on the price of the goods they manufacture, the overall output level, and the cost of inputs in production.

Oil products form part of the inputs that companies in every economy often demand since it is the reliable source of energy for production. The rise in crude oil prices will cause prices of oil to rise as well. This will cause higher production costs for businesses. An increase in the cost of production would then lead to a decline in output, all things being equal. For instance, considering a production function where Q= f(oil). An rise or a fall in the use of oil as an input can lead to an increase or decrease in output. Changes in oil prices could also affect the economy through their effect on aggregate supply. Per this, an increase in oil prices causes an initial upward shift in the aggregate supply curve, which raises prices. Output falls along a downward-sloping aggregate

demand curve. Subsequent wage adjustments, however, can restore the initial level of output and price.

According to Friedman (1956), "inflation is always and everywhere a monetary phenomenon." He believed that the root of all inflation is a high growth rate of money supply: simply by decreasing the growth rate of the money supply to low levels, inflation could be reduced or prevented (Mishkin & Schmidt-Hebbel, 2007). Inflation can be explained as a sustained increase in the general price level of goods in an economy over a period. The rate of Inflation plays a crucial role in an economy as it affects how strong the economy will be. Therefore, the government of every country pays much attention to stabilize it. The continually increasing price level has become a major issue for policymakers, and how to manage it always dominates the discussion on economic policy. The consumer price index (CPI), calculated by the Ghana Statistical Service, is the most used to measure Ghana's inflation rate. CPI is a measure that determines the weighted average of prices of a basket of consumer goods and services, like transportation, food, medical care, etc. A fixed basket of goods is chosen with their respective weights attached to the CPI measurement. The weight of each basket is multiplied by the price of the goods in the basket for every year to get the CPI yearly. To get the inflation rate using the CPI, the previous year's CPI is subtracted from the current year's CPI and then divided by the previous year's CPI and multiplying the whole term by 100 to get the inflation rate for that current year.

Thus, inflation = $\frac{CURRENT\ CPI - PREVIOUS\ CPI}{PREVIOUS\ CPI}$ X 100

Although a measurement such as the GDP deflator is also used to measure inflation, the CPI is commonly used to measure inflation in Ghana. This is because consistent price increases are typically related to the economy's rate of change in oil prices. People generally associate the two as being positively linked; that is, rising oil prices lead to higher inflation. They argue that oil is mainly used to fuel most of the activities of the populace, especially those in the manufacturing sector. Thus, it forms part of the factors needed to produce goods or provide the service. Therefore, as the price of oil goes up, as a factor of production, it causes the cost of production to increase, thereby increasing the general prices of goods and services.

The relationship of oil prices and the cost is summarized as: "when the global oil price rises, the importing costs of domestic petroleum enterprises also rise. In order to maintain a certain profit, domestic petroleum enterprises will enhance refined oils prices and to a greater extent, will rely

on monopoly power. The refined oils are inputs and the raw materials of variety industrial products, so the production cost of various products will increase and push up PPI to a large extent. It will also increase living costs, because households consume substantial refined oil products, and thus push up CPI. However, when the global crude oil prices decline, in order to make more profit, domestic petroleum enterprises can lower the refined oil prices to small extent because of their monopoly power. This means the decline of PPI and CPI is also smaller too" (Long and Liang, 2018, p. 241)

Cost-push is another theory of inflation that suggests that wage increases enforced by unions power inflation. Cost-push inflation is the rise in domestic prices caused by an increase in the prices of inputs. Examples include labor, raw materials, utilities, etc. An increase in the prices of the factors of production leads to a decrease in the supply of these goods, even as demand remains constant. Due to that, the prices of commodities increase, causing a rise in the overall price level. This, in essence, is cost-push inflation. Oil serves as an essential input factor for various firms in the production of goods and services. Thus, when the price of oil increases on the international market, it affects the cost of the input factors. The firms incur a relatively higher cost to produce the same quantity of goods and services needed due to the increase in oil price, which is a critical factor of production. The firm passes on this cost to consumers through an increase in the prices of goods and services. The firms increase the prices of their goods and services to cover the increase in the cost of production and profit since the main aim of business is to make profit. This is one of the channels through which increase in oil prices are transferred to consumers. Others also argue that inflation can occur from a different perspective. Thus, the cause of inflation in the economy is dependent on so many factors.

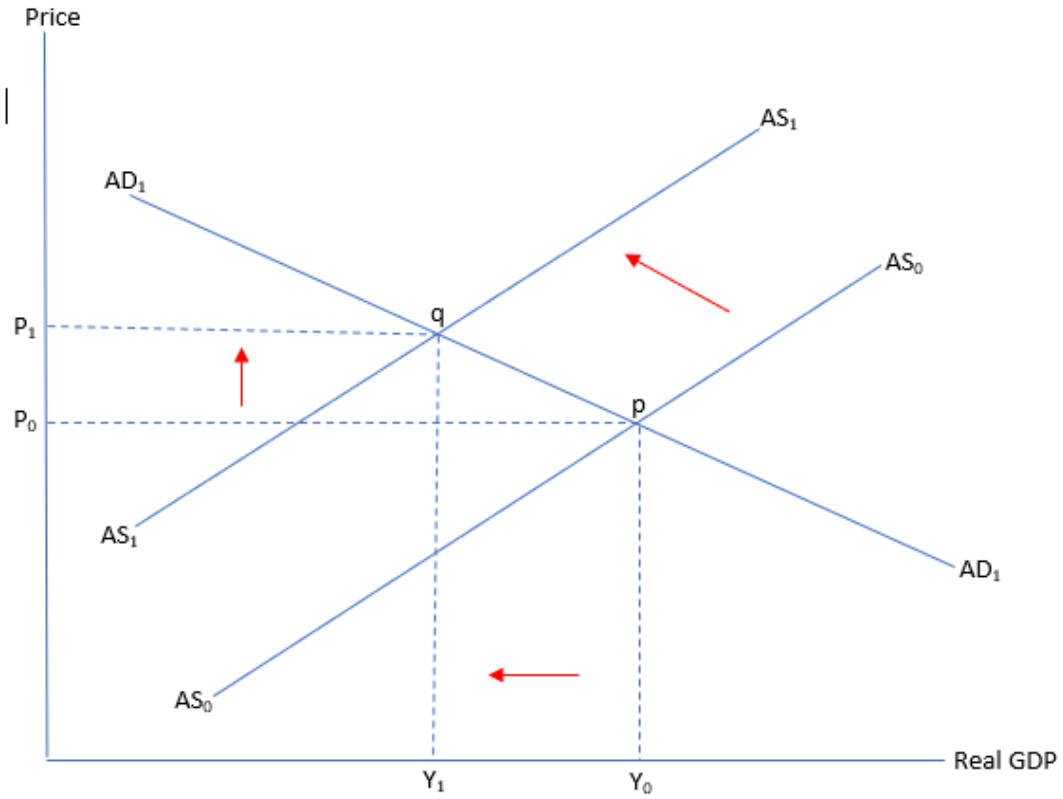

Figure 5 : The cost-push inflation

In figure 5, inflation is pushed up from the supply. When the price of factors of production (oil) increases, it causes real GDP to fall from Y_0 to Y_1, aggregate supply decrease from AS_1 to AS_2. At the same level of aggregate demand, prices rise from P_a to P_b which shows inflation from the supply side. There is also a shift in equilibrium condition from q to p.

The foreign exchange market, usually referred to as FX or FOREX, is the world's largest decentralized market for currencies trading (Levinson, 2005). The FOREX market constitute several markets that operate separately. Market participants, such as market makers, brokers, and consumers, are generally separated on the FOREX, and most transactions are carried out through computer networks. The most common currency traded is the U.S. dollar (USD). Fama (1965), argues that if the foreign exchange market is truly efficient, currencies exchange rates must change randomly after new information is released. Oil price fluctuations influence both oil-exporting and oil-importing countries' current account balances and government revenues. Oil and its by-products are the most traded commodities among economies, so price changes can greatly impact

macroeconomic variables such as the exchange rate. Therefore, positive or negative oil price changes have different consequences on the exchange rates of importing and exporting countries. One of the theoretical mechanisms of transmission between oil price and the exchange rate is Purchasing Power Parity (PPP). The theory of (PPP) accounts for exchange rates by comparing relative price levels between countries. The PPP theory, which Ricardo (1951) supports, advocates that "the value of money is the same everywhere." This indicates that for the exchange rate to be in equilibrium, the two currencies must have equal purchasing power. When a country's domestic price level increases (i.e., a country experiences inflation), that country's exchange rate must depreciate to return to the purchasing power parity. If the price of world crude oil rises, we anticipate currencies of countries with large oil dependence in the tradable sector to depreciate due to higher inflation. The real exchange rate's response is therefore determined by how the nominal exchange rate fluctuates. If a country imports oil and the price of oil increases, it can cause a local currency depreciation. When a country exports oil, an increase in oil price can result in an appreciation of the local currency. When the price of oil rises, more domestic currencies, such as the Ghana Cedis, are required to purchase the same oil as before. The increased supply of the cedi relative to the constant supply of the dollar will cause the price of the dollar to increase due to the interaction of demand and supply in the foreign exchange market, causing the domestic currency to depreciate. This is also consistent with the study findings by Novotný (2012) on the relationship between oil prices and exchange rate.

Another theoretical mechanism of transmission between oil price and the exchange rate is the trade channel. Per some studies, a change in oil price has two unique effects on the exchange rate: the terms of trade and the wealth impacts (Basher et al., 2016; Benassy-Quere et al., 2007; Buetzer et al., 2016; Coudert et al., 2007). Oil-producing and consuming countries are both influenced by terms of trade channel (Amano and Van Norden, 1998a, 1998b; Basher et al., 2016; Cashin et., 2004). Positive terms of trade shocks for oil-exporting countries might trigger the "Dutch disease1" phenomena, which comprises increasing non-tradable prices and a real exchange rate appreciation. Because of disparity in relative productivity between the two sectors, tradable and non-tradable goods, this mechanism is similar to the Balassa–Samuelson effect. This theory is relevant because the country of study which is Ghana is an oil importer.

The law of supply and demand, which emerged in the 1970s, is one of the most common and straightforward explanations for price movement in the foreign exchange market. This indicates

that the law of supply and demand drives the price movement in the foreign exchange market. However, macroeconomic variables such as interest rates, productivity differentials, economic growth, terms of trade, prices, and government debt can all influence currency supply and demand (Bailliu & King, 2005).

The demand and supply channels are another transmission mechanism between oil price and exchange rate. A change in the dollar exchange rate according to Coudert et al. (2007), impacts the prices obtained by oil suppliers and users (except that of the United States), resulting in a change in supply and demand for this commodity. In terms of the demand channel, the price of an oil barrel is expressed in US dollars, and all transactions are conducted in this currency. The price fluctuates due to changes in the exchange rate. Thus, as the price of crude oil increases, the value of the dollar changes. The price they pay in terms of their own currencies changes. In other words, more dollars will be demanded by oil importers to pay for their imports. This means more domestic currency like the Ghana cedi would have to be exchanged for dollars to purchase the same barrel of oil due to an increase in the price of crude oil.

Regarding the supply channel, several transmission mechanisms are identified by Coudert et al. (2007). First, oil companies cover production costs with producing countries' currencies (e.g., employee salaries, taxes, etc.). Second, depreciation might raise inflation and reduce incomes because oil-producing countries' currencies are related to the dollar. A depreciation of the exchange rate may cause a fall in the oil supply. This theory is relevant because Ghana as a country imports oil. However, the demand side channel can be linked.

The last mechanism of transmission between oil price and the exchange rate is the wealth and portfolio channel. In terms of wealth impacts, the Golub (1983) and Krugman (1983) models analyze the connection between the exchange rate and the oil price by examining portfolio choices and current account imbalances. According to these models, the world is divide into three sections: OPEC, the United States, and the European Union (one exporting and two importing countries, respectively). When the price of oil rises, wealth is transferred from oil-importing countries to oil-exporting ones. In the oil sector, an increase in oil prices leads to increased production and real wages. These impacts result in a rise in the relative price of service goods by equalizing real wages between sectors via labor movements and increased income from oil. As a result, the country's competitiveness weakens as the real exchange rate rises, and the long-term economic growth is affected negatively. The impact on the exchange rate is determined by the oil-importing and

exporting countries' portfolio preferences Golub (1983),. According to Krugman (1983), OPEC countries are gradually using their acquired wealth by increasing their imports of goods from industrialized countries., The real exchange rate will be determined by OPEC's geographic distribution of imports rather than its portfolio selections In the long run. Given that oil-exporting countries prefer dollar-denominated assets to US-owned assets, a positive oil shock leads to short-term dollar appreciation but not long-term (Benassy-Quere et al., 2007; Coudert et al., 2007; Golub, 1983; Krugman,1983). In summary, the causal relationship between the oil price and the exchange rate is explained by two key transmission mechanisms. First, through demand and supply channels, the exchange rate influences the price of oil. Second, the price of oil influences the exchange rate through terms of trade and wealth effects.

3.3 **Review of related Literature**

There have been several empirical studies conducted on the relationship between crude oil prices and output. The connection between crude oil prices and economic growth varies depending on a country's sectoral composition, institutional structures, and macroeconomic policies. Crude oil prices have a detrimental impact on the manufacturing sector, resulting in lower production of industrial goods.

Jimenez-Rodrigues and Sanchez (2004) investigated the effects of oil price shocks on GDP growth in OECD nations. Using VAR and Granger causality analyses, they concluded that the interaction between oil price shocks and macroeconomic variables is significant. They predicted different findings from countries that are net oil importers and countries that are net oil exporters on the assumption that a significant increase in oil price has a negative impact on a net oil importing country's real economic activities due to additional costs, but a positive impact on a net oil-exporting country’s real economic activity because of extra income in export. As predicted, the results reviewed that most oil-importing countries' economic growth(output) was negatively affected by an increase in oil prices, according to linear and non-linear models. The findings are vital to that of my study although OECD countries and Ghana are different, Ghana is also an oil-importing country. Again, such findings are relevant because my study is a Granger causality test analysis which is similar.

Focusing on the studies in Ghana, Tweneboah and Adam (2008) used a vector error correction model to investigate the long and short-run links between global crude oil prices and Ghanaian

monetary policy. According to the findings, there is a long-run relationship in Ghana between oil price, domestic price level, GDP, exchange rate, and interest rate. The oil price has a positive effect on price level but a negative impact on output. In Ghana, an unexpected oil price shock is accompanied by a rise in inflation and a decrease in output. The findings are relevant as they directly involve Ghana and use GDP, exchange rate, and oil price. This study may be different because the VECM model will not be used as a method but the VAR model. However, the impact of crude oil price changes on output, inflation, and the exchange in Ghana will be analyzed using the Granger causality test, PP test, KPSS test, and the cointegration test.

Okoro (2014) used the VAR methodology to study oil price volatility and economic growth in Nigeria from 1980 to 2010, linking oil price volatility, crude oil prices, oil revenue, and GDP. Oil price volatility has a substantial impact on Nigeria's economic growth. His findings also show a negative relationship between oil price volatility and economic growth. The study also indicates that the country's budget is linked to a specific crude oil price, suggesting that the Nigerian economy is dependent on crude oil. He suggested, among other things, that policymakers should focus on policies that will improve and stabilize the economy, with a greater emphasis on collecting alternate sources of government revenue. He ended by calling for a reduction in the monetization of crude oil receipts and aggressive future savings of proceeds from oil booms to sustain future oil price fluctuations. The findings may differ with similar variables (GDP) and method (VAR) as the two countries have different crude oil export and import policies. Ghana, in particular, is a net importer of crude oil, while Nigeria is a net exporter.

Jumah and Pastuszyn (2007) use cointegration analysis on time series data covering 1965-2004 to investigate the relationship between the world price of crude oil and aggregate demand (output) through the interest rate channel in Ghana. Although the analysis did not find a direct link between output and crude oil price changes, it found that the international crude price had a direct impact on the price level, which negatively impacted real output. The finding is relevant to this study because the data used in the analysis is a time series covering 1980-2019. Again, the country of study is the same and the cointegration analysis will be executed to check the integration for the variables because the data is time series.

Empirical studies on the impact of crude oil prices on inflation have yielded conflicting results. Kpogli (2015) tried to determine the magnitude and the direction of the relationship between oil price changes and inflation in Ghana. She also tried to determine the presence of asymmetry of oil prices and domestic inflation in Ghana and to uncover the direction of causality and the transmission mechanism through which inflation as a macroeconomic factor is affected in Ghana by oil price changes. Using the Augmented Dickey-Fuller (ADF) Phillips-Perron test, she concluded a positive relationship between oil prices and the consumer price index in the long run. Oil prices were also found to be positively related to domestic price levels in the short run. She also finds that a decrease in oil prices resulted in a decrease in inflation, and an increase in the oil price resulted in an increase in inflation in the short run. She observed that the effect of an increase in oil price on inflation was greater than when the oil price decreased, but the difference appeared to be insignificant. This finding relates to this study in the direction of the relationship between oil price changes on inflation. A VAR Granger causality test (application of the VAR methodology) will be used.

Saleem and Ahmad (2015) used Johansen co-integration to analyze data from 1979 to 2012 in Pakistan. The results show that an increase in crude oil prices accelerated inflation in Pakistan. They concluded that Pakistan quickly responded to international crude oil changes because the economy is mainly dependent on oil and gas. Increases in crude oil prices are quickly reflected in an increase in the cost of production because the industrial sector heavily relies on electricity which is produced by oil and gas. Their findings are relevant to my study because most firms and industries in Ghana also rely mainly on oil and gas for production as a source of energy. However, an increase in crude oil price may affect their cost of production.

Amandan and Ramaswamy (2013) examine crude oil price behavior and its impact on inflation in India with the use of a macroeconomic simulation model. From 2002 to 2011, the results revealed a positive correlation between crude oil prices and inflation growth rate. They claim that humanity is using the world's energy resources so that no other species has ever done and that petroleum-based fuel economy is ruling the world. They believe that the price of oil and inflation are frequently linked in a cause-and-effect framework. When oil prices rise or fall, inflation follows in the same direction. According to them, India's oil prices increase at the same time as global oil prices. Oil prices started rising significantly since the beginning of the twenty-first century. The immediate impact of the oil price shock is the increased cost of production due to increased fuel

cost. Because of inflation in the economy, the cost of production would also increase, causing a decrease in supply. They concluded that the reduction in the effects of exchange rate changes on inflation and lowering oil intensity accounts for a large portion of the decline in global oil pass-through. However, according to their estimates, even after controlling for these factors, part of the fall in oil prices pass-through remains unexplained. Although the country of study and the method used are different, this finding is relevant because people attribute inflation to oil price changes in Ghana. This is because most firms and industries in Ghana rely mainly on oil for production as energy source. Thus, a rise in crude oil prices may affect their cost of production. Firms will try to increase the price of the goods they produce to cater for their cost causing inflation.

Cunado and de Gracia (2005) examine the relationship between oil prices and macroeconomic activity by examining the impact of oil price shocks on economic activity and consumer price indexes in six Asian countries from 1975Q1 to 2002Q2. They analyze the oil price-macroeconomy relationship using applying cointegration and Granger causality tests on the oil price-inflation rate and oil price-production growth rate relationships. They discovered that oil price shocks have a huge impact on economic activity and inflation, but only in the short run. When shocks are transformed into the local currency of the country under review, the findings provide more strong evidence of the shocks impact. If the oil-economic growth relationship is considered, asymmetric responses of oil price inflation relationships can be found in Malaysia, South Korea, Thailand, and Japan. Furthermore, they emphasized that Asian countries respond to oil price shocks in different ways.

Celik& Cetin (2007) used VAR analysis to estimate the impact of changes in fuel oil prices in Turkey. Their estimates based on the vector error correction model find that a 1% rise in fuel oil prices with a one-year lag resulted in a 1.26% increase in the CPI index. They discovered that fuel oil prices in the Turkish economy are subject to continuous fluctuations. Changes in the prices of fuel oil products, which are heavily used in sectors such as manufacturing, transportation, the chemical industry, and agriculture, are expected to have an inflationary impact due to these fluctuations. Furthermore, they could not reject the hypothesis that a rise in fuel oil prices is also the one-way Granger cause of a rise in CPI based on the study findings. Their findings are relevant as it uses similar VAR analysis.

Grisse (2010) analyzed the connection between exchange rate and oil prices in the US from 2003 to 2008 using a structural model that was fully identified by exploiting the heteroskedasticity in

the data. The results show that oil is priced in dollars and that depreciation increases demand for oil and decreases oil producers' purchasing power. Similarly, as prices are raised, the US dollar appreciates because more would be demanded. The paper concludes that, since higher oil prices cause the dollar to depreciate and depreciation causes higher oil prices, the interest rate in the United States explains most of the variations in the two variables. The finding is useful because the objective of this study is to establish the impact of oil price changes on Ghana's GDP, inflation, and the value of its currency (cedi) relative to the dollar and the mechanism by which oil price changes pass through to affect these macroeconomic indicators.

Rautava (2004) used quarterly data such as Russia GDP, the actual exchange rate, North Sea Brent Crude oil price, and Federal Government Revenue from 1995 to 2002 to examine the impact of oil prices from the global market and the actual exchange rate on the Russian economy. The study used vector autoregression, vector error correction model, and cointegration analysis. The results show that the actual exchange rate and international oil price have a considerable impact on Russia's fiscal revenue and domestic oil prices, which affect output based on VAR and cointegration.

The effects of oil production shock on Nigeria were studied by Ayadi, Chatterjee, and Obi (2000). Over the period 1975 to 1992, the analysis used the standard Vector Auto-Regression (VAR) process to estimate the data. The variables included in the estimation were oil production, oil exports, the real exchange rate, net foreign assets, interest rate, inflation, and output There is a positive relationship between the exchange rate and oil production shocks, resulting in a real devalued of the Naira. The real exchange rate's impact response is marginal compared to that of oil production, but the response of the real exchange rate is about two times greater after a year. Nigeria is a net -exporter of crude oil, and Ghana is a net importer. However, with similar variables (exchange rate, inflation, GDP) and method (VAR), the results may be different because Nigeria is a net exporter.

Osigwe (2015) simultaneously studied Nigeria's exchange rate, oil prices, and economic performance using ordinary least squares and two-stage least squares as the estimation techniques. He concluded that the real exchange rate is negatively related to the price of oil. Also, both the real exchange rate and oil price positively affect economic performance, measured as a change in GDP. However, the results might not be the same as the two countries are different in exporting

and importing crude oil. Specifically, Ghana is a net importer of crude oil, and Nigeria is a net exporter.

Aziz and Bakar (2009) conducted research on oil prices and exchange rates in countries that are net oil exporters and net oil importers. The influence of interest rate on the exchange rate was also considered in this report. From 1980 to 2008, he used three modeling exercises on monthly data. The panel co-integration test and the unit root test also revealed that the variables are integrated into order one and that there is co-integration between them. There was no evidence of a long-run relationship between oil prices and exchange rates in net exporting countries using the pooled mean estimator. Finally, he concludes that the oil price and exchange rate positively impact net oil-importing countries. The study is related and relevant because Ghana is a net importer of crude oil.

Chen and Chen (2007) use monthly data from 1972 to 2005 to look at the long-run relationship between oil prices on the global market and real exchange rates in G7 countries using panel cointegration techniques. The results show a positive connection between oil prices and the exchange rate. The finding is relevant because the G7 countries and Ghana are different. Ghana is a developing country that relies on the importation of crude oil to meet its needs.

In summary, the major gap found from the reviewed literature is the time lag; most of the data sources did not exceed 2015. Because of the dynamic nature of oil price volatility, it is necessary to extend the analysis period to assess the impact of recent oil shocks. Again, there have also been several discrepancies in the results of the various studies. Due to that, this study aims to contribute to the empirical studies in the literature. This research aims to determine the impact of oil price fluctuations on Ghana's GDP, inflation, and the currency value (cedi) against the US dollar, as well as the mechanisms by which oil price fluctuations affect these macroeconomic indicators. Using annual data from 1980-2019, the study will move further to determine the direction of the relationship of oil price changes on Ghana's GDP, inflation, and the exchange rate using the Granger causality test. At the end of the study, the questions below will be answered.

- What is the nature of the relationship between oil price changes and GDP, inflation, and exchange rate, i.e., do oil prices cause changes in the other indicators, or do the other indicators affect the oil price?
- What is the direction of causality of oil price changes on GDP, inflation, and the exchange rate in Ghana?

Chapter four

Methodology and model specification

4.1 **Introduction**

The aim of the study investigate the impact of crude oil fluctuations on inflation, exchange rate, and GDP in Ghana and other macroeconomic indicators (variables) that may affect GDP, inflation, and exchange rate directly or indirectly. Also, the study will determine the direction of causality of oil price changes on GDP, inflation, and the exchange rate in Ghana. For that purpose, this chapter seeks to show the models, estimation techniques, and data sources used for the analysis. The study's model is described in both functional and regression form in this chapter. The variable definitions or measurements are also discussed in this chapter. The key variables used in analysis are the oil price (dollar per barrel), the exchange rate (CD per dollar), inflation (%,) and GDP (%). The oil price is the main independent variable for the study, and it runs through all the models.

4.2 **Data sources**

To empirically test the impact of international oil prices on output, inflation, and exchange rate, annual data from 1980 to 2019 are used. Data on GDP, interest rate, the balance of trade (BOT), and government debt were sourced from Bank of Ghana. Data on the exchange rate, government expenditures, and inflation were sourced from the World Bank's development indicators (2020). Brent crude oil prices as international oil prices are obtained from the US Energy Information Administration (2019). All the variables were in their raw state. However, logs were taken for all the variables except GDP because some figures were negative. Taking the logs of the variables linearizes the possible exponential sequence in the series and thus stabilizes the variance or spread of the stochastic process. Again, taking the logs helps to reduce the coefficient size.

4.3 **Description and justification of independent variable**

The following are the key variables used in the analysis. Oil price (dollar per barrel), the exchange rate (cedi per dollar rate), inflation (%), and GDP (% change). The oil price is the main independent variable for the study, and it runs through all the models in this study. Various petroleum products such as diesel and liquified petroleum gas (LPG) derive their prices from the price of crude oil. Crude oil is a worldwide commodity whose price is set on a global market that countries have no

control over. This variable was used in the study to see how variations in Brent crude oil prices on the international market affect Ghana's output (as measured by GDP), inflation, and the exchange rate. The oil price is determined by two factors, demand and supply and sentiments. Empirical evidence shows that the mode in which it affects the economy is both direct and indirect. Demand and supply in the sense that as demand increases, the prices should go up, and as demand falls, the prices should go down, all other things being equal. Also, as individuals expect oil prices to rise in the future can lead to a current rise in oil prices.

This variable is relevant to output because most production firms in Ghana use oil products as the source of their energy for production.Due to that, the price of oil is factored into their production costs. Because Ghana is an oil importer, the price of oil is exogenous. The international crude oil price is usually quoted in US dollars. Therefore, high crude oil price means that cost of production will be more expensive, which will drive many firms out of business. As a result, the output will fall or decrease. From this, it is expected that the oil price will granger cause output in Ghana.

The exchange rate is the average annual value of the cedi relative to the dollar. If the exchange rate is high, more domestic currency must be given to get a unit of the US dollar. For example, oil is mostly required in Ghana for production and to boost the energy sector, but because the price of oil is determined in the international market, the currency that is most quoted is the US dollars, therefore for Ghana to get the maximum of oil require for the country, they must trade our local currency to get dollars for such transaction. This causes depreciation in our local currency, hence when oil price increases, we must trade more of our local currencies (cedi) to get a unit of the dollar to purchase the oil, which causes the exchange rate to shoot. From this theory, the exchange rate is expected to Granger cause oil price in Ghana.

Inflation is expected to be a very important independent variable in the exchange rate model. This is because a higher inflation causes the price of domestic goods to become expensive in the world market. This results in the depreciation of the domestic currency and a deficit in the current account; thus, the receipt on import will exceed that of export. This is because other countries will not patronize the homegrown goods. A current account deficit raises the exchange rate because more of the depreciated currency is needed to import products into the country. However, we can see that both inflation and exchange rate Granger cause each other.

OP is not only relevant to output but also inflation. International crude oil price is uncontrollable. Thus, the price is determined in the international market, hence the domestic oil price includes international oil price plus other factors such as taxes. The domestic oil prices may not be suitable because the oil becomes a finished product in Ghana. Considering the large usage of oil in the economy's manufacturing sector, higher oil prices may cause a high cost of production, which will cause a higher persistent increase in prices of goods and services in the country. For this reasoning, the oil price is expected to Granger cause inflation.

This inclusion of the exchange rate as an independent variable in the inflation model is based on the fact that most firms use oil in their production, which forms part of the cost of production. With oil prices quoted in US dollars, a high exchange rate means more of the domestic currency is required to make purchases which increase the cost of production of firms, and hence firms also increase their prices of goods and services.

The level of output in the economy is a determining factor to the rate of inflation. In the case of low output, the economy's demand for goods and services will exceed the goods available for sale. This excessive demand will tend to drive prices up and hence causes inflation to increase. Output is expected to Granger cause inflation in Ghana.

4.4 **Model specification.**

The study seeks to determine whether oil price fluctuations influence GDP, inflation, and the exchange rate in Ghana. The econometric model used in this study takes the oil price (OP) as the main independent variable. However, a model for the study can be started as:

OP= f (GDP, INF, EXR (1)

Where GDP, OP, INF, and EXR represent the gross domestic product, oil price, inflation, and the exchange rate (cedi for US dollar), respectively.

The study then transformed equation 1 to its econometric estimable form in equation 2 as:

$$lnOP_t = \gamma_2 + \sum_{i=1}^{p} \beta_1 lnINF_{t-i} + \sum_{i=1}^{p} \beta_2 lnOP_{t-i} + \sum_{i=1}^{p} \beta_3 lnEXR_{t-i} + \sum_{i=1}^{p} \beta_4 OPUT_{t-i} + \varepsilon_{2t} \quad (2)$$

Where γ_2 is the constant term, $\beta_1, \beta_2, \beta_3, \ and \ \beta_4$ are the parameters for the augmented lagged differences, p represents the maximum number of lags, ε_{2t} is the error term.

4.5 **Estimation strategy**

The study uses the vector autoregression (VAR) model and the Granger causality test to analyze the relationship between the variables, specifically to analyze the impact of crude oil price on output, inflation, and the exchange rate in Ghana. For some years, macroeconomists have used the Vector Autoregression (VAR) model to analyze multivariate time series data. Its flexibility and simplicity have been key to its success over the years. Its flexibility has led to its wide usage in macroeconomic applications and its use in data description and forecasting. The VAR model which is a multivariate version of the univariate autoregressions model, provides a framework in which changes in the variables under study are related to changes in their own lags (Edesiri, 2014). It can be used to describe the active conduct of economic time series and forecast it. In practice, the VAR model is used to examine the dynamic effects of one error term of the model or the total impact of receiving some form of shock and the dynamic structural analysis of the variables. The application of the VAR as a method is based on the following authentications. First, the VAR can only be used when all the variables are either integrated of order zero or one. Second, the ordinary least squares method can estimate the level and the first difference relationship between variables. Some empirical literature has used a VAR framework to examine the link between oil prices and key macroeconomic indicators. One benefit of the VAR approach is that it does not entail any strict economic theory within which the model is grounded. By treating every endogenous variable in the system as a function of the lagged values of all endogenous variables, the VAR method eliminates the need for structural modeling. However, the Granger causality model within the VAR framework can be specified as:

$$lnINF_t = \gamma_1 + \sum_{i=1}^{p} \delta_1 lnINF_{t-i} + \sum_{i=1}^{p} \delta_2 lnOP_{t-i} + \sum_{i=1}^{p} \delta_3 lnEXR_{t-i} + \sum_{i=1}^{p} \delta_4 OPUT_{t-i} + \varepsilon_{1t} \quad (3)$$

$$lnOP_t = \gamma_2 + \sum_{i=1}^{p} \beta_1 lnINF_{t-i} + \sum_{i=1}^{p} \beta_2 lnOP_{t-i} + \sum_{i=1}^{p} \beta_3 lnEXR_{t-i} + \sum_{i=1}^{p} \beta_4 OPUT_{t-i} + \varepsilon_{2t} \quad (4)$$

$$\ln EXR_t = \gamma_3 + \sum_{i=1}^{p} \lambda_1 lnINF_{t-i} + \sum_{i=1}^{p} \lambda_2 lnOP_{t-i} + \sum_{i=1}^{p} \lambda_3 lnEXR_{t-i} + \sum_{i=1}^{p} \lambda_4 OPUT_{t-i} + \varepsilon_{3t} \quad (5)$$

$$OPUT_t = \gamma_1 + \sum_{i=1}^{p} \tau_1 lnINF_{t-i} + \sum_{i=1}^{p} \tau_2 lnOP_{t-i} + \sum_{i=1}^{p} \tau_3 lnEXR_{t-i} + \sum_{i=1}^{p} \tau_4 OPUT_{t-i} + \varepsilon_{4t} \quad (6)$$

4.6 **VAR Granger causality Test**

Granger causality is the most widely used model for causality between two variables. For instance, Bui (2018) used the causality test to check the long-run causal relationship between the exchange rate and Vietnam's stock market valuation. To investigate the direction of the effect of a causal relationship between oil price and other variables such as output, inflation, and the exchange rate, the study used the Granger Causality test model within the VAR framework. Granger (1969) proposed that for a pair of linear covariance stationary time series X and Y: X causes Y if the previous values of X can be used to forcast Y precisely than simply using the past values of Y.

The Granger causality test requires the use of test-statistic to test whether lagged information on a variable say "Y" provides any statistical information about another variable say "X"; if not then, "Y" does not Granger cause "X". Hence, it provides useful information regarding the suitable technique for estimating a given problem (Granger, 1969). Taking equation 4, for example, "X" is the oil price and "Y" is the right-hand variables. However, a change in "X" (oil price) could be used to predict changes in "Y" (other variables such as inflation).

4.7 **Unit root test**

In analyzing time series data, it is imperative to perform a stationarity test or unit root test to prevent spurious estimates. Pesaran (2007) postulates that using nonstationary variables leads to biased and inconsistent results and hence, spurious results. Despite that, this study employed both the parametric and nonparametric unit root test to ensure whether the sample variables exhibit unit root or have no unit root. Specifically, the Augmented Dickey and Fuller (1979,1981) (ADF) test, the Phillips Perron (PP) test (1988), the Kwiatkowski-Phillips -Sehmidt- Shin (KPSS) test, and the Zivot and Andrews (Z-A) unit root test is used to ascertain the stationarity properties of the variables in this study. Under these tests, the null hypothesis of unit root (no stationarity) is tested against the alternate hypothesis that the series used exhibit no unit root (or are stationary).

4.8 **Cointegration test**

A unit root test determines the number of times a variable must be differenced to make it stationary. Due to the differencing of the data series, the long-run information would be lost if unit root tests were performed. Therefore, a cointegration analysis was used to obtain long-run information by examining whether there is a long-run relationship between the variables. To specify dynamic

adjustment among the variables in the model, the study adopted the Johansen cointegration approach. However, the cointegration analysis is executed to check the integration for the variables in the study.

4.9 **Optimal lag test**

It is vital to remember that a suitable or appropriate lag must be chosen before specifying a VAR model. Turning to the lag order selection criteria, the study used the Final Prediction Error (FPE), Akaike Information Criterion (AIC), the Hannan–Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC) for the optimal lag test in this study.

4.10 **Diagnostic test**

To ensure that the study's estimates or results are free from econometric issues like normality, serial correlation, and stability condition, which are associated with the used vector autoregressive model, this study conducted tests of VAR. The VAR model was verified for the existence or nonexistence of normality, serial correlation in the residuals, and stability condition.

Chapter 5

Analysis and discussion of results

5.1 **Introduction**

This chapter contains a discussion of outcomes and analysis of data acquired for the context of this research in both tables and charts. Again, the test for the unit-roots, presented in tables and charts, is also discussed. The major goal of the study, which is to look at the impact of oil price fluctuations on Ghana's GDP, inflation, and the exchange rate, is discussed next.

5.2 **Descriptive Statistics and Correlation Matrix**

Table 3 presents the results of descriptive statistics and the correlation matrix of the variables used for this study.

*Table 3**: Descriptive Statistics and Correlation Matrix***

Variable	**Observation**	**Mean**	**Standard Deviation**	**Minimum Value**	**Maximum Value**
lnINF	40	3.0070	0.6887	1.9638	4.8111
lnOP	40	3.5539	0.6585	2.5431	4.7181
lnEXR	40	-1.8270	2.8533	-8.1993	1.5733
OPUT	40	4.5568	3.6246	-6.92	14
Correlation Matrix					
	lnINF	lnOP	lnEXR	OPUT	
lnINF	1				
lnOP	-0.4927***	1			
lnEXR	-0.6751***	0.5075***	1		
OPUT	-0.5701***	0.3117***	0.5983***	1	

The average inflation in Ghana in log terms within the time frame is approximately 3%, with a minimum and maximum value of 1.96 and 4.81%, respectively. The oil price in logs has an average value of 3.55 with minimum and maximum values of 2.54 and 4.72. The exchange rate and GDP growth in Ghana have a mean value of -1.83 and 4.56, respectively. There exists a smaller

dispersion in the dataset as the standard deviation of the variables does not deviate much from their means except for the exchange rate.

Turning to the correlation among the variables, Table 3 shows that all the variables (oil price, exchange rate, and output growth) have a negative association with inflation with a magnitude in value greater than 0.49. This signifies that none of the variables move in the same direction with inflation. Moreover, it is observed that exchange rate and output growth positively correlate with the oil price. This suggests that oil price has a possible influence on the exchange rate and output growth in Ghana. Output growth was also noticed to correlate with exchange rate positively, and the strength of association is strong. It is further observed that the strength of correlation existing among the variables are significant at one percent error level. Additionally, none of the correlation coefficients exceed 0.70. This is an indication of an absence of multicollinearity in the dataset employed (Kennedy, 2008).

5.3 **Unit Root Test Results**

The unit root test results, which determine the stationarity of the series, are presented in Table 4. The table reveals that the series (inflation, oil price, exchange rate, and output growth) is stationary at the first difference as required. Specifically, the ADF, P-P, and KPSS tests indicate that the variables are stationary at *I* (1). However, the ADF shows that the exchange rate has a unit root at the first difference. Due to statistical weaknesses (such as failing to account for structural breaks) of the ADF, P-P, and KPSS, the study further augments the ADF, P-P, and KPSS findings by using the Zivot and Andrews (Z-A) unit root test, which account for structural breaks. The Z-A test indicates that all the variables exhibit no unit root (stationary) at the first difference at a 1% error level. After confirmation of the stationarity properties of the variables at *I* (1), the VAR becomes appropriate for the Granger causality test of the variables.

Table 4 ***: Unit Root Test Results***

	ADF	**P-P**	**KPSS**	**Z-A**
Variable	*I* (1)	*I* (1)	*I* (1)	*I* (1)
lnINF	-4.875***	-10.516***	0.015***	-6.74***
lnOP	-3.418**	-5.775***	0.107***	-6.546***
lnEXR	-2.469	-3.634***	0.081***	-9.950***
OPUT	-5.260***	-7.640***	0.022***	-7.249***

Note: ** and *** denote the significance level at 5% and 1% significance level, respectively, for ADF, P-P, and Z-A. For KPSS, *** represents the nonrejection of the null hypothesis of trend stationarity at 1% error level. *I* (1) denote stationarity at first difference. INF, OP, EXR, and OPUT represent inflation, oil price, exchange rate, and output growth, respectively.

Source: Author's estimation.

5.4 **The Results of Optimal Lag Test**

Presented in table 5 is the optimal lag test. The VAR requires an appropriate lag for future analysis. Given this, the study conducted an optimal lag test, and the findings are reported in Table 5. The Final Prediction Error and Akaike Information Criterion conclude an optimal lag of 2. In contrast, the Hannan–Quinn Information Criterion and Schwarz Bayesian Information Criterion also indicate the appropriate lag to be 1. Given these, it is established that the most appropriate lag to be chosen for the VAR model is between 1 and 2. Hence, the study chooses an optimal lag of 2 for the VAR model. However, p, which represents the maximum number of lags in equations (3), (4), (5), and (6) in chapter four, is 2. After selecting optimal lag of 2, the study proceeds to establish whether inflation, oil price, exchange rate, and output in Ghana have a long-run relationship. However, the study employs the Johansen cointegration test to determine the number of cointegration existing among the variables.

Table 5: ***Optimal Lag Test Results***

Lag	LL	LR	df	P-value	FPE	AIC	HQIC	SBIC
0	-191.852				0.625	10.881	10.942	11.057
1	-68.574	246.560	16	0.000	0.002	4.921	5.228*	5.801*
2	-50.707	35.733	16	0.003	0.00152*	4.817*	5.370	6.401
3	-38.056	25.303	16	0.065	0.002	5.003	5.801	7.290
4	-20957	34.198*	16	0.005	0.002	4.942	5.986	7.933

Note: * denote the optimal lag. LR, FPE, AIC, HQIC, and SBIC denote the Likelihood ratio, Final Prediction Error, Akaike Information Criterion, Hannan–Quinn Information Criterion, and Schwarz Bayesian Information Criterion, respectively.

Source: Author's estimation.

5.5 **Cointegration Test Results**

In Table 6, the study presents the results of the Johansen cointegration test (both trace statistics and maximum eigenvalue). The test shows that there exists a long-run relationship between the variables employed for the study. Specifically, the trace statistic and the maximum eigenvalue indicate that at a 5% significance level, there exist 2 and 1 cointegration equations, respectively.

*Table 6**: Johansen Cointegration Test Results***

Maximum Rank	**Params**	**LL**	**Eigenvalue**	**Trace Statistic**	**Critical Value (5%)**
0	24	-109.9192		72.3732	54.64
1	31	-94.1565	0.5638	40.8476	34.55
2	36	-81.2560	0.4929	15.0468*	18.17
3	39	-75.6907	0.2539	3.9161	3.74
4	40	-73.7326	0.0979		
Maximum Rank	**Params**	**LL**	**Eigenvalue**	**Maximum Eigenvalue**	**Critical Value (5%)**
0	24	-109.9192		31.5255	30.33
1	31	-94.1565	0.5638	25.8008	23.78
2	36	-81.2560	0.4929	11.1307	16.87
3	39	-75.6907	0.2539	3.9161	3.74
4	40	-73.7326	0.0979		

Note: * represents the selected rank of cointegration equations.

Source: Author's estimation.

This demonstrates the presence of a long-run relationship between inflation, oil price, exchange rate, and output growth. Although the cointegration tests indicate the long-run relationship's

existence, the direction of the relationship is not shown. As a result, the study proceeds further to determine the direction of causality using the Granger causality test within the VAR framework.

5.6 **Diagnostic Test Results**

Reported in Table 7 are the results of the diagnostic tests conducted to ensure that the VAR model is free from time series econometric problems.

Table 7: VAR Diagnostic Test Results

Diagnostic Test	**Test Statistic**
Normality	5.674
	(0.6837)
Serial Correlation	18.867
	(0.2756)
Eigenvalue stability condition	Satisfied

Note: Reported in the parenthesis are the probability values.

Source: Author's estimation.

The VAR model from which the Granger causality is performed shows an absence of serial correlation (the major issue with time series data) and further indicate that the variables employed (inflation, oil price, exchange rate, and output) are normally distributed. This is because the probability values of 0.6837 and 0.2756 indicate nonrejection of the null hypothesis of the variables normally distributed and no serial correlation, respectively. Furthermore, the eigenvalue stability condition revealed that the VAR model is stable since all the eigenvalues lie within the unit circle. Therefore, given that the VAR model does not exhibit any econometric problems, the Granger causality findings are robust, efficient, and consistent.

5.7 **VAR Granger Causality Test Results**

Presented in table 8 are the Granger causality test results within a VAR framework. Granger causality is conducted in equations (3), (4), (5), and (6) below. There is one lag in each equation.

$$lnINF_t = \gamma_1 + \sum_{i=1}^{p} \delta_1 lnINF_{t-i} + \sum_{i=1}^{p} \delta_2 lnOP_{t-i} + \sum_{i=1}^{p} \delta_3 lnEXR_{t-i} + \sum_{i=1}^{p} \delta_4 OPUT_{t-i} + \varepsilon_{1t} \quad (3)$$

$$lnOP_t = \gamma_2 + \sum_{i=1}^{p} \beta_1 lnINF_{t-i} + \sum_{i=1}^{p} \beta_2 lnOP_{t-i} + \sum_{i=1}^{p} \beta_3 lnEXR_{t-i} + \sum_{i=1}^{p} \beta_4 OPUT_{t-i} + \varepsilon_{2t}$$ (4)

$$\ln EXR_t = \gamma_3 + \sum_{i=1}^{p} \lambda_1 lnINF_{t-i} + \sum_{i=1}^{p} \lambda_2 lnOP_{t-i} + \sum_{i=1}^{p} \lambda_3 lnEXR_{t-i} + \sum_{i=1}^{p} \lambda_4 OPUT_{t-i} + \varepsilon_{3t}$$ (5)

$$OPUT_t = \gamma_1 + \sum_{i=1}^{p} \tau_1 lnINF_{t-i} + \sum_{i=1}^{p} \tau_2 lnOP_{t-i} + \sum_{i=1}^{p} \tau_3 lnEXR_{t-i} + \sum_{i=1}^{p} \tau_4 OPUT_{t-i} + \varepsilon_{4t}$$ (6)

The Granger causality results revealed a unidirectional connection running from oil price to inflation. This means that oil price Granger causes inflation in Ghana because the chi-square of (7.842) is significant at 5% level. On the other hand, the chi-square of inflation (1.702) is insignificant, which means that inflation does not Granger cause oil price. This indicates that changes in oil price could be used to predict changes in inflation. Ghana is an oil-importing country; therefore, the price of oil is exogenous. However, the price of crude oil on the international market is determined by factors such as demand, supply, and sentiments. With sentiments, as people expect oil prices to increase at some point in the future, can lead to a current increase in oil prices. As a result, the price is set on the international market, and the domestic oil price incorporates the international price and other factors like taxes or subsidies. The causality result makes sense considering the large usage of oil in the manufacturing sector of the economy, higher oil price may cause a high cost of production which will cause a higher persistent increase in prices of goods and services in the country. By this reasoning, it is expected that changes in international oil price would Granger causes inflation in Ghana as long as the Ghanaian economy depends on oil to facilitate growth and development. This result is consistent with Saleem and Ahmad (2015), who concluded that changes in crude oil prices accelerated inflation in Pakistan. This finding, however, is linked to equation (4) in Chapter four.

Table 8 : ***VAR Granger Causality Test Results***

Causal Direction			⇒	⇐
Pair Variables			**Chi-square Statistics**	**Chi-square Statistics**
lnINF	⇐	lnOP	1.702	7.842**
lnINF	⇔	lnEXR	22.096***	5.938*
lnINF	⇐	OPUT	1.340	14.818***
lnOP	⇐	lnEXR	0.711	8.149**
lnOP	⇐	OPUT	0.316	6.612**
lnEXR	⇔	OPUT	5..035*	23.535***

Note: ***, **, and * denote the significance level at a 1%, 5%, and 10% significance level. INF, OP, EXR, and OPUT represent inflation, oil price, exchange rate, and output growth, respectively.

Source: Author's estimation.

The Granger causality test indicated a bidirectional connection between inflation and the exchange rate. Both inflation and exchange rate are significant at 1% and 10% levels of significance, as seen from the causality test table above. Meaning Granger causality in bi-directional. Oil is primarily used in Ghana for production and to strengthen the country's energy sector. Most firms in Ghana use oil in their production, which forms part of the cost of production. International oil price is quoted in US dollars; therefore, a high exchange rate means more of our domestic currency is required to make purchases, which increases the cost of production of firms. Hence, firms also increase their prices of goods and services. However, the persistent increase in the prices of goods and services leads to inflation. On the other hand, inflation also Granger causes the exchange rate. The persistent increment in the prices of goods and services at the domestic level will cause the price of domestic products to become expensive in the world market. This results in the depreciation of the domestic currency and a deficit in the current account. Thus the receipt on import will exceed that of export. This is because other countries will not patronize the domestic goods. A current account deficit will cause the exchange rate to rise since more of our depreciated currency will be required to import goods into the country. From this, we can see that both inflation and exchange rate Granger cause each other.

The Granger causality test revealed a unidirectional causality between inflation and GDP. The chi-square of inflation (1.340) is insignificant, which means that inflation does not Granger causes

output in Ghana. Instead, the causality runs from GDP to inflation which implies that GDP Granger causes inflation in Ghana. This means that changes in GDP can be used to forecast variations in inflation. And this can be seen from the causality test results. Production in Ghana by firms uses oil products as a source of energy. However, the price of oil is included in their cost of production. Given the significant use of oil in the industrial sector of the economy, higher oil prices may result in higher production costs, resulting in a higher persistent increase in prices of goods and services in the country. And this persistent increment in the prices of goods leads to inflation.

From the causality test results, there is a unidirectional relationship running from exchange rate to oil price. This means that the exchange rate Granger causes the oil price because the chi-square value for the exchange rate (8.149) is significant at the 5% level. The chi-square value of oil price (0.711) is insignificant, which indicates that oil price volatility does not Granger cause the exchange rate in Ghana. The demand and supply measure the exchange rate for domestic currency with respect to foreign currency. The price of oil, which is a factor of production, is exogenous and quoted in dollars. It means for firms to get access to this factor of production, they must trade more of the local currency (Ghana cedi) to get US dollars before purchasing the oil. If the exchange rate is high, more of the local currency must be given to obtain a unit of the US dollar. The cost of oil becomes more expensive in local currency terms. This outcome is consistent with Grisse (2010), who analyzed the drivers of the connection between exchange rate and oil prices in the US. The paper concludes that higher oil prices cause the dollar to depreciate, and depreciation causes higher oil prices in the US. This result, however, is connected to equation (5) in Chapter 4. There is also unidirectional causality between GDP and oil price in the causation table above. The causality runs from GDP growth to the price of oil. This implies that GDP Granger causes the oil price because it is significant at the 5% level. The chi-square value for oil price (0.316) is insignificant. The results show that oil price fluctuations have no significant effect on GDP and do not Granger cause GDP in Ghana. However, this result is related to equation (6) in chapter four.

The Granger causality test also found a bidirectional connection between GDP and exchange rate. At the 1% and 10% levels, both GDP and exchange rate are significant. The causality runs towards each other, indicating that both Grangers cause each other in Ghana, as seen from the causality test results. The exchange rate is an important variable to consider when dealing with how output in Ghana can be affected. A higher exchange rate means a depreciation of the cedi, which tends to increase GDP through higher exports (cheaper export due to the cedi depreciation) and therefore,

increases economic growth. Higher demand for export leads to expansion of output in industries, which results in a higher GDP and economic growth. Also, a lower exchange rate means appreciation of the cedi, which tends to lower GDP through a fall in export (export becomes expensive due to cedi appreciation) and hence economic growth. The price of oil, which is a production factor, is exogenous and expressed in dollars. It means that firms must first trade our local currency (cedi) for US dollars before purchasing this factor of production. If the exchange rate is high, and we must give more of our domestic currency to obtain a unit of US dollar, then the cost of oil in our local currency will be high, and many businesses cannot afford it and will close down. This will cause the output of the country to fall. On the other hand, if the exchange rate is low, and we must give less of the Ghana cedi to get a unit of US dollar, it means the cost of oil in our local currency (cedi) will be low. So many firms could afford it. This low price of oil, as a result, will increase output because the cost of production will be low.

The Granger causality analysis from table 8 answers the first and the second research questions of this study. The study's first research question seeks to know whether oil prices cause changes in the other indicators or other indicators affect the oil price. The second research question concerns the direction of the causality of oil price changes on GDP, inflation, and the exchange rate in Ghana. The analysis have shown both the causal relationship and direction.

Chapter 6

Summary, conclusion, and policy recommendations.

6.1 **Introduction**

This chapter summarizes and concludes the entire results, gives the necessary recommendations based on the analysis. This includes an explanation of the importance of the results and approaches used in meeting the expectations of the study. Limitations of the study are also outlined in this chapter.

6.2 **Summary of the findings**

The study aimed at finding the impact of international crude oil prices changes on GDP, inflation, and the exchange rate in Ghana. Also, to determine the direction of the relationship of oil price changes on Ghana's GDP, inflation, and the value of its currency relative to the US dollar and the mechanisms by which oil price changes pass through to affect these macroeconomic indicators. To achieve these objectives, The presence of unit root was found using the ADF test, the PP test, the KPSS, and the Z-A procedure. After testing, the variables were stationary. The study employs the Johansen cointegration test to determine whether there exists a long-run relationship between the variables used in the study (OP, GDP, inflation, and exchange rate). Although the cointegration tests indicate the existence of the long-run relationship, however, the direction of the relationship was not shown. Due to that, the study further determine the direction of causality using the Granger causality test within the VAR framework.

6.3 **Conclusion**

Oil is heavily used in all sectors of Ghana's economy, particularly in manufacturing, transportation, and power generation. The research intent was to establish the impact of oil price changes on output (as measured by GDP), inflation, and the exchange rate in Ghana. Also, to determine the direction of causality between oil price and GDP, inflation, and the exchange rate. The Granger causality test was used to show the variable's directional influence. In the causality analysis, one-way causation was seen running from oil price volatility to inflation. This indicates that changes in oil price could be used to predict changes in inflation. From the causality test results, there is a unidirectional relationship running from exchange rate to oil price. This shows that the exchange rate Granger causes the oil price. There is also unidirectional causality between

GDP and oil price in the causality analysis. The causality runs from GDP growth to oil price, indicating that oil price changes do not Granger causes GDP in Ghana. Based on the causality findings, the study concludes that oil price changes have an impact on inflation but have no impact on both GDP and the exchange rate in Ghana.

6.4 **Recommendations**

From the Granger test results, oil price changes Granger causes inflation in Ghana. Therefore, the government should reduce the taxes on petroleum products (subsidizing) to ease the poor from inflationary pressures during the period of rising oil prices. Ghana is now a producer of oil; the government should expand the production so that they can export more to increase GDP and reduce the exchange rate. The Ghanaian cedi is still losing value against the dollar as a result of the oil price increase. However, the study also recommends that the country should have enough reserves to store oil when the price is relatively low. Finally, the government should also provide a public transport system at a reduced fare to protect the poor from the implications of the oil price increase.

6.5 **Limitations of the study**

To get a more general perspective, the study could use more extensive data on the studied variables covering 1957 (after independence) to 2020, but due to the unavailability of data, such periods were not covered. Hence, the findings could not be applied to such periods because the findings could vary as the period progresses. Time constraints partly also limited the study.

6.6 **Recommendation for future studies**

Future research could investigate the causal relationship between oil price volatility and other microeconomic variables that were not included in the analysis of the study, such as interest rate, the balance of payment, government debt, and foreign reserve. This will expose further the level of oil price impact on macro-economic performances.

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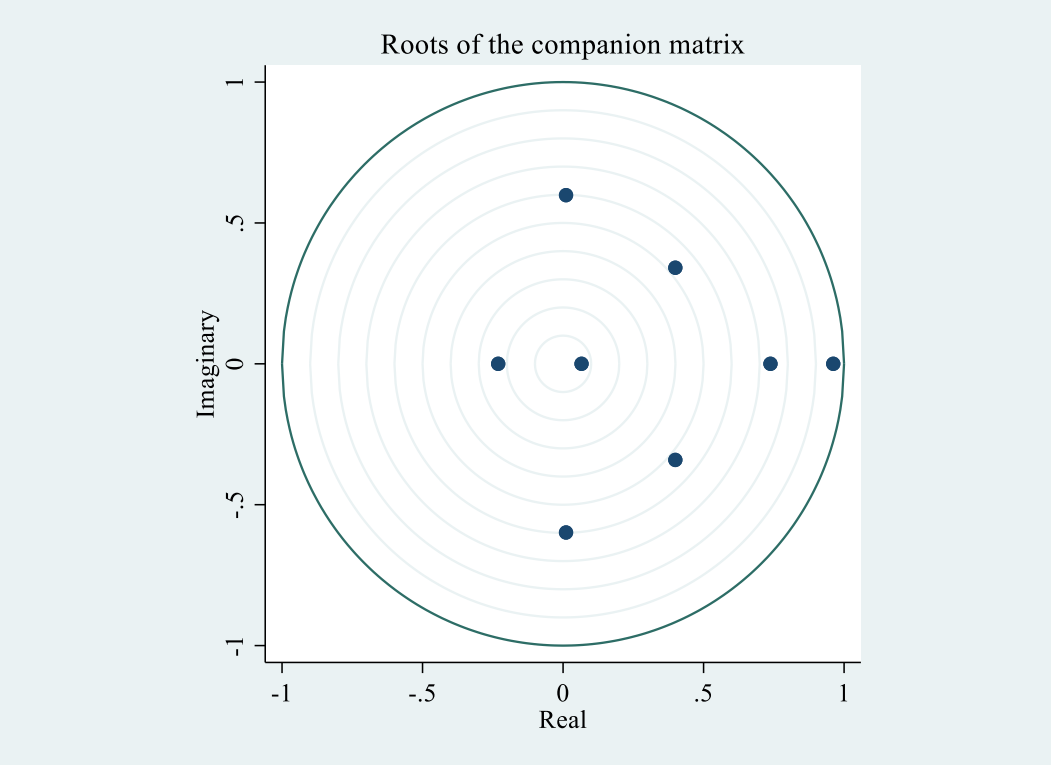
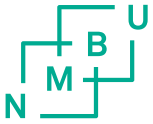
Appendix

Figure 6: Eigenvalue Stability Condition



Source: Author's constriction from Stata 17.



Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitskapelege universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway