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RESEARCH ARTICLE

Empirical Analysis of Crude Oil Consumption and Price on Ghana's Economic Growth

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Abstract:

Crude oil in recent years has become a fulcrum around which all economies in the world revolve as it became a very useful commodity in the post 19th century. Despite its fluctuating prices in the world economy, it remains a medium of measuring the socio-economic wellbeing of countries due to the immense contribution it has on transportation and other sectors of economies. The objective of this paper is to investigate the impact of crude oil consumption and oil price on the growth of the Ghanaian economy. The paper proceeded with annual time series data spanning from 1980 to 2016 and sourced from the World Development Indicator (WDI) and Energy Information Administration (EIA). All variables used in the study are integrated of order one (1) as suggested by the Augmented Dickey-Fuller (ADF) test. Further, the Johansen Cointegration test suggested the existence of cointegration among the variables and used the OLS estimation procedure. The study found a positive and statistically significant relationship between oil price and economic growth in the long run. On the other hand, an inverse relationship was found between crude oil consumption and economic growth in the long run.

Empirical analysis of the study recommends that government diversify the economy to reduce any disturbance that it might experience in times of oil price shocks. Also, risk management instruments like physical reserves and hedging against oil prices should also be employed. Moreover, policies that encourage efficient consumption of crude oil, especially in the productive sectors like industry, should be ascertained to trigger growth. The study suggests effective measures to mitigate the externalities associated with increased production and consumption of crude oil, such as the carbon tax.

Keywords: Crude Oil, Ghana, Economy, Growth

Introduction

Crude oil in recent years has become a fulcrum around which all economies revolve. It has got vast importance across various sectors of every economy, both big and small. Given this importance, the discovery of crude oil triggers jubilation, excitement and optimism of economic emancipation, especially in the developing countries.

Across the world, crude oil plays a cardinal role in the supply of the world's energy demand. It is used in various ways like lighting, power for automobiles and other industrial activities. As such, to accelerate the growth of an economy, access to diverse forms of energy at affordable rates is crucial. Given the role crude oil plays in the economic activities of the world, any substantial change in its price and consumption will influence economic output and consequently the growth of economies.

Most low-income countries face a significant amount of import bill for crude oil, basically because they are net importers of crude oil. Also, for some of these low-income countries, crude oil commands virtually half of their total imports. This means, rampant changes in the price of crude oil on the global scene affects the growth and macroeconomic performance of these countries.

Ghana's productive sectors depend on crude oil to drive its activities. According to Armah (2003), the productive sectors of Ghana consist of the Agriculture, Transport and manufacturing sectors. These being the major pillars of the growth of Ghana's economic growth, any shock in the price of crude oil on the global scene will impact the economic growth of Ghana.

A study conducted by Fosu and Aryeetey (2008) suggested a poor performance of the Ghanaian economy, particularly during periods of oil price hikes on the global market. One instance of this occurred during 1973 to 1983. This period can be described as the dark days of the Ghanaian economy. During this period, the country saw a drop in GDP of a little above 3% each year. This drop in economic performance was attributed to the shock in oil price in 1974 and 1971/81(Aryeetey and Harrigan 2000).

During this period, global prices of crude oil quadrupled from $ 2.48 in 1972 to $11.58 per barrel by 1974 (British Petroleum, 2012). It is quite difficult to ascribe the economic difficulties at the time wholly to the shock in oil prices during those periods. The center for Study of Africa Economies (CSAE, 2014), suggests that, some of the reasons for the downturn in the economy at the time could be as a result of political instability, economic mismanagement and high corruption levels at the time.

The year 2000 and 2008 also saw a spike in crude oil prices across the world selling at an average of $28.3 per barrel in the year 2000. This led to hikes in the domestic prices of crude oil products by more than 20%, triggering an increase in budget deficit by 87.7% and a fall in GDP to 3.7% in 2000 from 4.4% in 1999 with inflation at 40.8% (World Bank, 2012).

Ghana's huge budget deficits over the years have been ascribed to the provision of fuel subsidies by the government, which in turn affects the economy negatively. Ghana's periods of poor economic growth have usually been followed by hikes in oil price and huge fiscal deficit. In his study, Ocran (2007) indicated

that the country's huge fiscal deficit could be ascribed to the government's failure to ensure that, domestic prices of petroleum products to reflect the global prices.

Crude oil in commercial quantities was discovered in 2007, but actual production started in December 2010 at the Jubilee field. The Jubilee field was estimated to produce 120,000 barrels of oil per day. In his work, Ayelazuno (2014) mentioned that, the petroleum reserves for the Jubilee field were estimated to be between 600 million and 1.8 billion barrels. In one of their reports, the World Bank in 2009 estimated that, for the period between 2012 and 2030, Ghana would earn US$ 20 billion from oil production from the Jubilee field.

Aside the Jubilee fields, Ghana recently had production started in new fields; The Tweneboa-Enyenra-Ntomme (TEN) and Sankofa fields both started production in 2016 and 2017 respectively. According to the Ghana Petroleum Commission (GNPC 2016), the TEN field has an estimated reserve of 239 million barrels of oil and 360 billion cubic feet (bcf) of natural gas. The Sankofa field on the other hand has an estimated 204 million barrels of oil and 1071 bcf of natural gas.

Since December 2010 to June 2019, the total volume of crude oil produced in Ghana across all the fields add up to 349,330,993.53 bbls (PIAC 2019).This is depicted in figure 1.

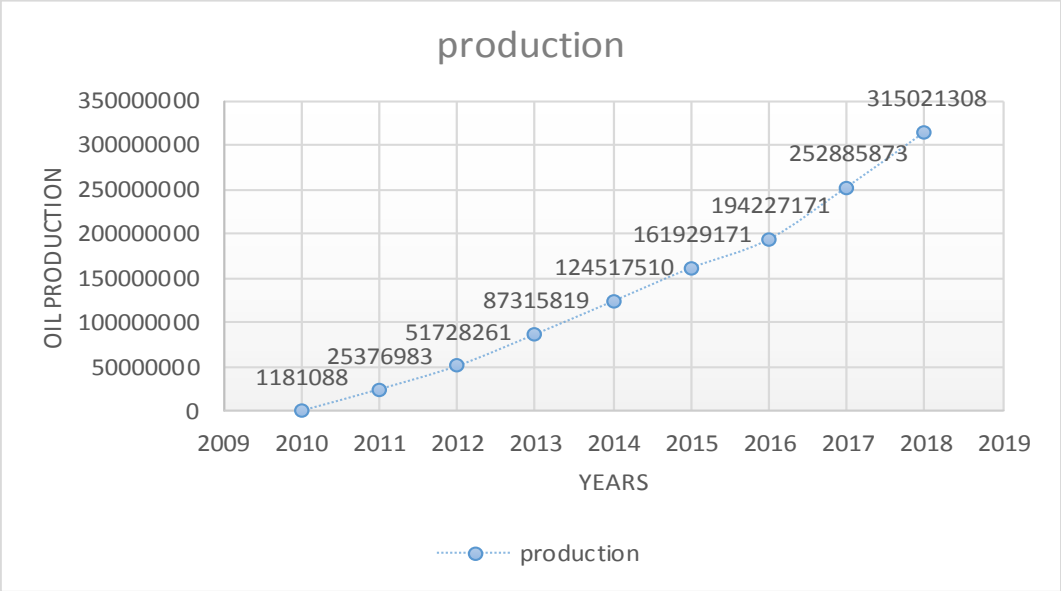


Figure1: Petroleum Production
Source: PIAC report 2019(from 2010 to 2018)

The productive sectors of Ghana rely heavily on crude oil as their primary source of energy. This has led to a rising consumption of petroleum products over the years. The government accrues much revenue from the production of crude oil to support critical sectors of the economy (like infrastructure, agriculture, education etc). In 2017 alone the country received a total of US$ 362,580,316 in petroleum receipts, and a further increase to US$ 712,549,248 in 2018.

Table 1: Total Petroleum Receipts

	2017	2018	2019
Total Petroleum Receipt	US$ 362,580,316	US$ 723,549,248	US$ 668,412,660

Source: Annual Petroleum report fund 2019

Given the importance of crude oil in the economic development of Ghana, This study intends to fill an essential research gap by bringing clarity on how the consumption of crude oil and its price changes on the global scene affect the economic growth of the Ghanaian economy.

The rest of the paper is organized as follows: section 2 reviews empirical literature, section 3 focuses on the data source and methodology, section 4 discusses the empirical results and section 5 concludes with conclusions, recommendations as well as policy implications.

Objectives of the study

This study seeks to examine the nexus between the prices of crude oil and its consumption in Ghana. Specifically,

i. To investigate the impact of a change in global crude oil price on Ghana's economic growth in the long run.
ii. To examine the impact of crude oil consumption on Ghana's economic growth in the long run.

Empirical literature review

Oil price-economic growth relationship

As the world's dependence on crude oil continue to surge, the nexus that exist between economic growth and oil price has drawn a lot of attention among economists. A large number of literature exist on the subject matter, but as to whether oil price is a driver of economic growth remains unclear. Most of these literature focus more on developed countries as such very little empirical literature exist on an emerging oil exporting countries like Ghana.

Hamilton (1983) was one of the early studies to investigate the oil price and economic growth nexus. The study relied on vector auto regression model and found a strong negative association between Gross National Product and changes in crude oil prices. His work gave an indication that, hikes in crude oil prices replicated in a slump in GNP in U.S. Hamilton further suggested that almost all recessions in the U.S can be attributed to hikes in crude oil prices. Gisser and Goodwin (1986) corroborated Hamilton's research by using different data sets and methodology for the U.S economy.

A number of researches have concluded on a negative association between crude oil price increases and the subsequent downturn in the U.S economy (Bernanke et al 1997; Hamilton and Herrera 2001). Other studies conducted in other parts of the world revealed a strong correlation in the long run between macroeconomic variables and world crude oil prices. Such studies include (Boukez

2007; Rodrigue and Sanchez 2004; and Davis et al. 2005). The relationship however proves weaker when data from 1985 upwards is included in the data set. Nonetheless, only few researchers have considered the role of the break-date, 1985-1986.

In a comparative research, Jin (2008) revealed that, hikes in the price of oil causes a decline in the economic growth of Japan and China, nonetheless increase in oil price leads to an expansion of the Russian economy. Specifically, the study concluded that a 10% increase in price of crude oil triggers a 5.16% fall in the GDP of Japan.

With regards to works on Ghana, Cantah G. and Asmah E.,(2015) adopted the ARDL model to investigate oil price and economic growth in Ghana, and found out that increases in international oil price is inimical to the Ghanaian economy. Their study also revealed that, this negative relationship could be reduced by a decrease in government spending in terms of fuel subsidies.

In a similar work, Tweneboah and Adam (2008) estimated both the long and short run linkages between global oil price and monetary policy for the period 1970 to 2006 in Ghana. Their result showed the existence of long run linkages between global oil prices, price levels (domestic), exchange rate, interest rate and GDP. They further showed that, oil price shocks manifest in Ghana through an increase in rate of inflation and a fall in output.

Oil consumption-economic growth relationship

Energy consumption-economic growth hypotheses are grouped into about four categories which includes the growth hypothesis, conservation hypothesis, feedback hypothesis, and neutrality hypothesis.

The growth hypothesis proposes that, the consumption of energy triggers growth in an economy. This suggests that, investments in the energy sector of a country translates into economic growth. Study like the Rezitis and Ahammad (2015) supports this hypothesis.

Further, the conservation hypothesis suggests that when there are increases in economic activities, energy consumption increases. This means investment in other sectors of the economy geared at increasing economic activity increases energy use. This means a fall in economic activities will cause a dip in energy consumption. Kraft and Kraft (1978) and Ozturk et al. (2010) supports this hypothesis.

The feedback hypothesis postulates that economic growth and energy consumption depends on each other. That is economic growth causes energy consumption. Similarly, energy consumption also causes economic growth. This is what is referred to as bidirectional causality. In their study, Tang and Abosedra (2014) found evidence to support this hypothesis.

Finally, the neutrality hypothesis proposes that, there exist no relationship between economic growth and energy consumption. This suggests that, investment in the energy sector will have none or no impact on economic growth and vice-versa. Chen, Kuo and Chen (2007) found no nexus between growth in an economy and energy use.

With regards to specific empirical works on the crude oil consumption and economic growth relationship, Glasure and Lee (1997) examined the causality between GDP and the consumption of energy for South Korea and Singapore by using the granger causality test, together with cointegration and error correction modelling. Their work revealed a causality in both directions between income and

energy for both countries. On the contrary, their work revealed no causality between consumption of energy and GDP for South Korea. It also revealed a one directional causality in the case of Singapore from the consumption of energy to GDP.

Tang (2009) adopted the error correction model and Granger causality approach between the consumption of electricity, income, population and FDI. He used data that spans from 1970 to 2005.The study found a bidirectional causality between electricity consumption, income and FDI in the short run. This was corroborated by Chandra (2010) who used the ARDL approach to test for the causality on the same variables.

Further, Masih and Masih (2007) used annual data spanning from 1995 to 1999 to investigate the causality between energy consumption and GDP by the use of the Vector Error Correction Model (VECM) and the Vector Auto regressive analysis (VAR). The study found a bidirectional causality from energy consumption to GDP in Pakistan, unidirectional causality from energy consumption to GDP in India and unidirectional causality from GDP to energy consumption in Indonesia.

Nasiru Usman and Saidu (2014) examined the causality between oil consumption and economic growth in Nigeria from 1980-2011. The study adopted the granger causality test, and the study found unidirectional causality running from oil consumption to economic growth. This indicates that oil plays an important role in Nigeria's economic growth.

Methodology and data

This study uses time uses time series data spanning 37 years (1980-2016) for all the variables. These variables include real GDP per capita (LGDP), crude oil consumption (LCONS), crude oil price (LOP), and government spending (LGS). All data used in this study were obtained from the World Bank's World Development Indicator (WDI) data base, with the exception of crude oil price and crude oil consumption which were sourced from Energy information Administration (EIA). Logarithm transformation of all variables were taken and Eview 7 was used in the analysis.

GDP per capita (LGDP) refer to a country's economic output for its number of population. It divides the country's GDP by its entire population. Crude oil consumption (LCON) refers to the total quantum of crude oil consumed in the country every year, measured in thousands of barrels. Brent spot prices were used in this study as crude oil price (LOP), measured in dollar per barrel. Brent spot prices were used because Brent is a major benchmark in the trade of crude oil across the world. Government Spending (LGS) refers to government final consumption and includes all government current expenditure for purchase of goods and services (including compensation of employees).

Based on the literature review, the model for this study is specified as;

$$LGDP = \beta_{o+} \beta_1 LCON + \beta_2 LOP + \beta_3 LGS + \varepsilon_t \quad (1)$$

Where the $\beta's$ represents the elasticities of each variable. The meaning of each variable in the model is as defined earlier and ε_t is the error term.

The a priori expectations are $\beta_1 > 0, \beta_2 > 0$, and $\beta_3 > 0$

Estimation strategies

After analyzing the descriptive statistics of all the variables, the study went on to check for stationarity and cointegration behavior among the variables, then further went on to estimate the long run relationship using OLS.

Stationarity/ unit root test

The stationarity of a series, especially when dealing with time series data is an important initiative to undertake because it can influence the behavior of the variables. A series is said to be stationary if it has a constant mean and variance over time. Otherwise, it is said to be non-stationary. This test is conducted to ascertain the order of integration of the variables used. Running of regression on non-stationary time series data might lead to 'spurious regression' thereby leading to a t-statistics that can't be relied upon and hence, arriving at wrong economic conclusions.

A series that is stationary without differencing is said to be integrated of order zero, that is I(0). On the other hand, if the series become stationary upon first differencing, it is said to be integrated of order 1, that is I(1) and so on. This study adopts the Augmented Dickey-Fuller (ADF) test recommended by Dickey and Fuller in testing the stationarity of all variables. The ADF framework is of the form;

$$\Delta y_t = \alpha_o + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

Where Δ is the first difference operator, y_t represent the variables under consideration in this study, t is the time trend, p is the optimal lag length and ε_t represents the error term with zero mean and constant variance. With the test of stationarity, the null hypothesis that states that; the time series is non-stationary, against the alternative hypothesis; the time series is stationary.

Cointegration test

Variable in a time series are said to be cointegrated when they exhibit a long run relationship. When variables are integrated of the same order, the next thing to do is to find if there exist a long run relationship (cointegration) among them. This study adopts the Johansen cointegration procedure in testing for the existence of long run relationship among the variables.

The Johansen cointegration approach uses two tests, which are the maximum eigen value test and trace test. The trace test and the maximum eigen value test are used to determine the number of cointegrating equations in the model.

The trace test is of the form:

$$J_{trace}(r/n) = -T \sum_{i=r+1}^{n} In(1-\lambda_i)$$

The trace test statistics tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. Where n is the number of variables in the system for r = 0, 1, 2,...n-1.

The maximum eigen value statistic tests the null hypothesis of r cointegrating relations against the alternative of r+1 cointegrating relations for r=0, 1, 2...n-1. This computes as;

$$J_{max}(r / n+1) = -TIn(1-\lambda_{r+1})$$

According to Alexander, C. (2001) in cases where there exist conflicting results among the trace test and maximum eigen value test, the trace test takes precedence.

Empirical results

Descriptive statistics

As indicated in table 4.1, all the variables show a high level of consistency as their means lie between the minimum and the maximum value.

Table 4.1: Descriptive statistics of variables

Variable	Mean	Std. Dev	Min	Max
LGDP	6.325105	0.666059	5.554783	7.774082
LCON	3.462006	0.571761	2.639057	4.477337
LGS	20.74426	0.930259	19.28698	22.65694
LOP	3.504329	0.660420	2.546315	4.715190

Preliminary analysis

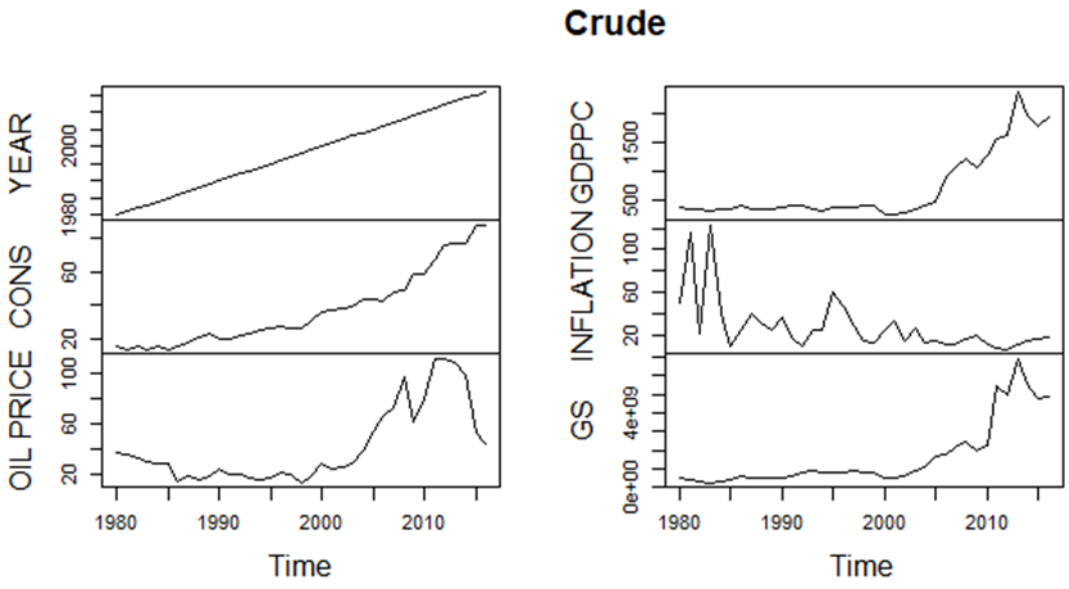


Figure 1: Time series plot of GDP, oil price, consumption, inflation, and government spending over the years under study

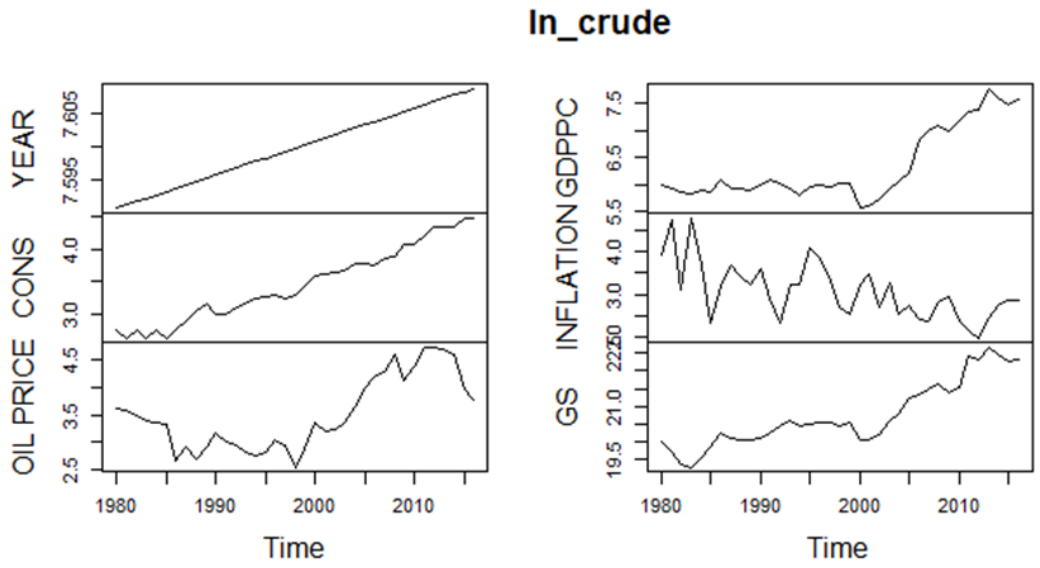
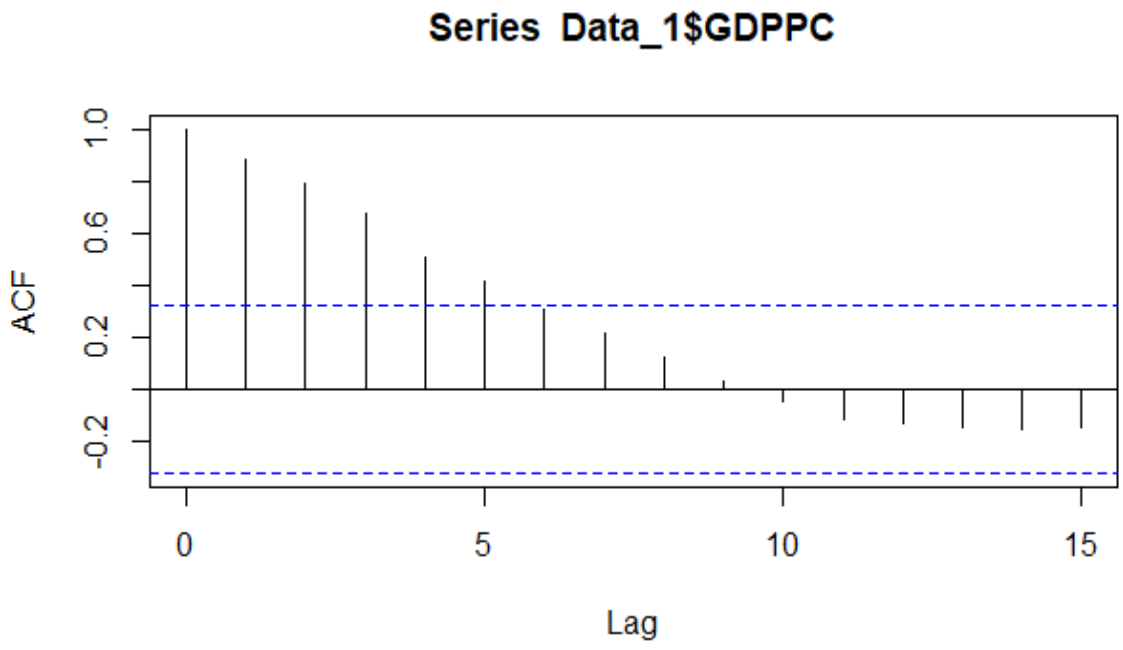


Figure 2: Time series plot of the log of the variables (GDP, oil price, consumption, inflation, and government spending) over the years under study.

Figure 1 and 2 shows a time series plot of the variables under study. Oil price, crude oil consumption, real GDP and government spending tends to show an upward trend from the year 1980 to 2015 but most of upward trend shows highly after the year 2000. Inflation shows otherwise (figure 1). The trend tends to be more stationary with finding the log of the variables (figure 2).

Autocorrelation Plot of variables under study



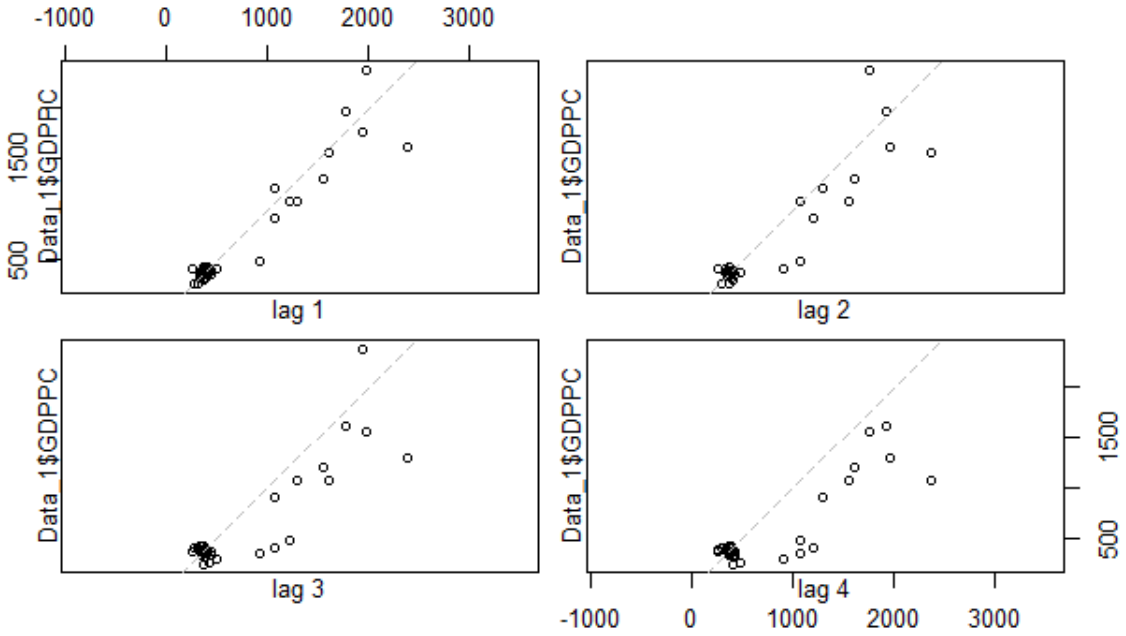
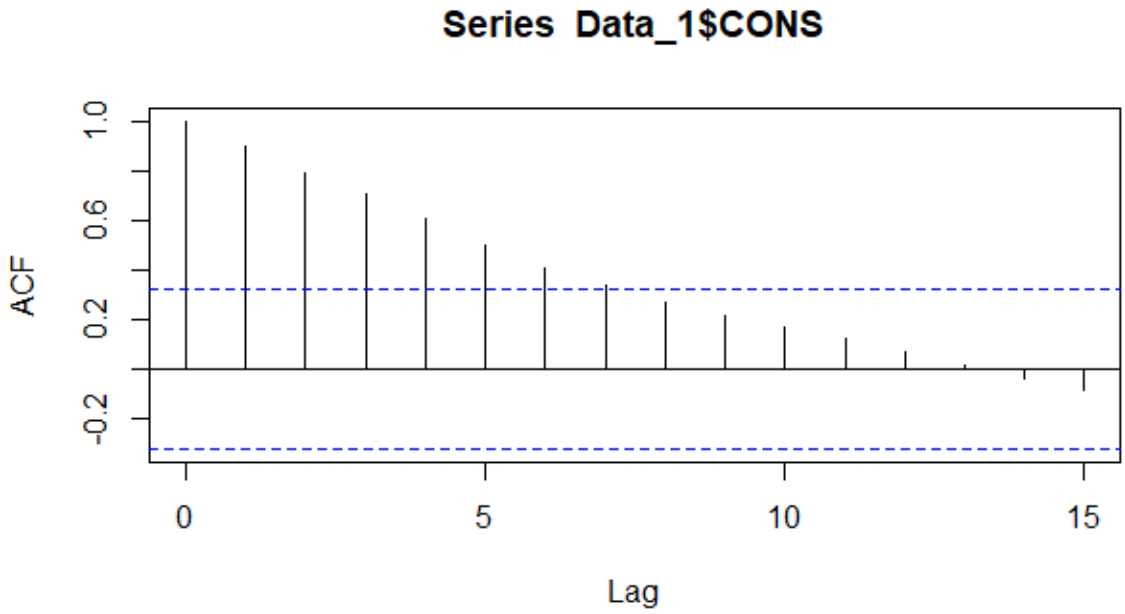


Figure 3: Autocorrelation plot of real GDP at different lags



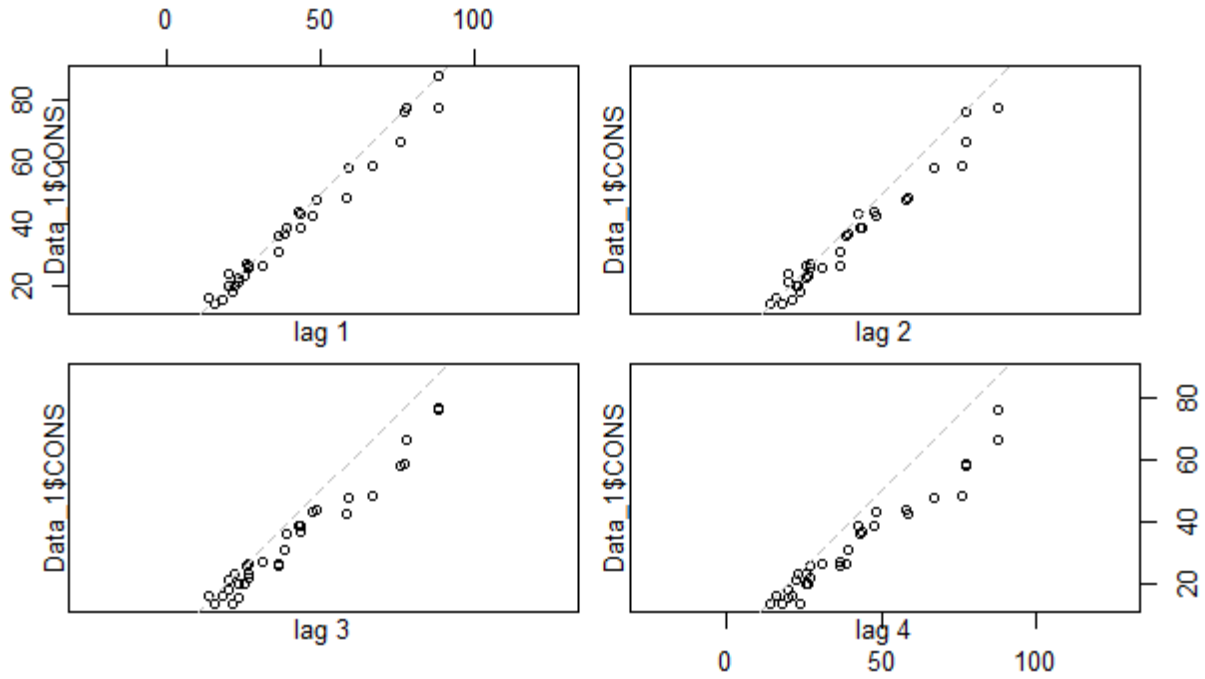
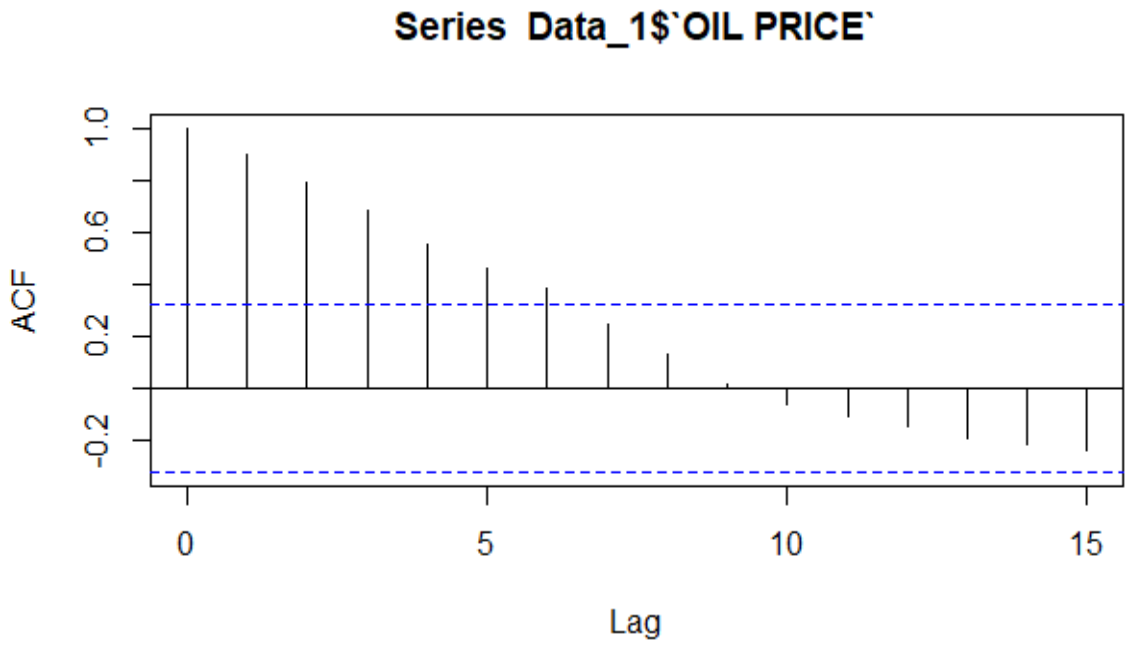


Figure 4: Autocorrelation plot of crude oil consumption at different lags.



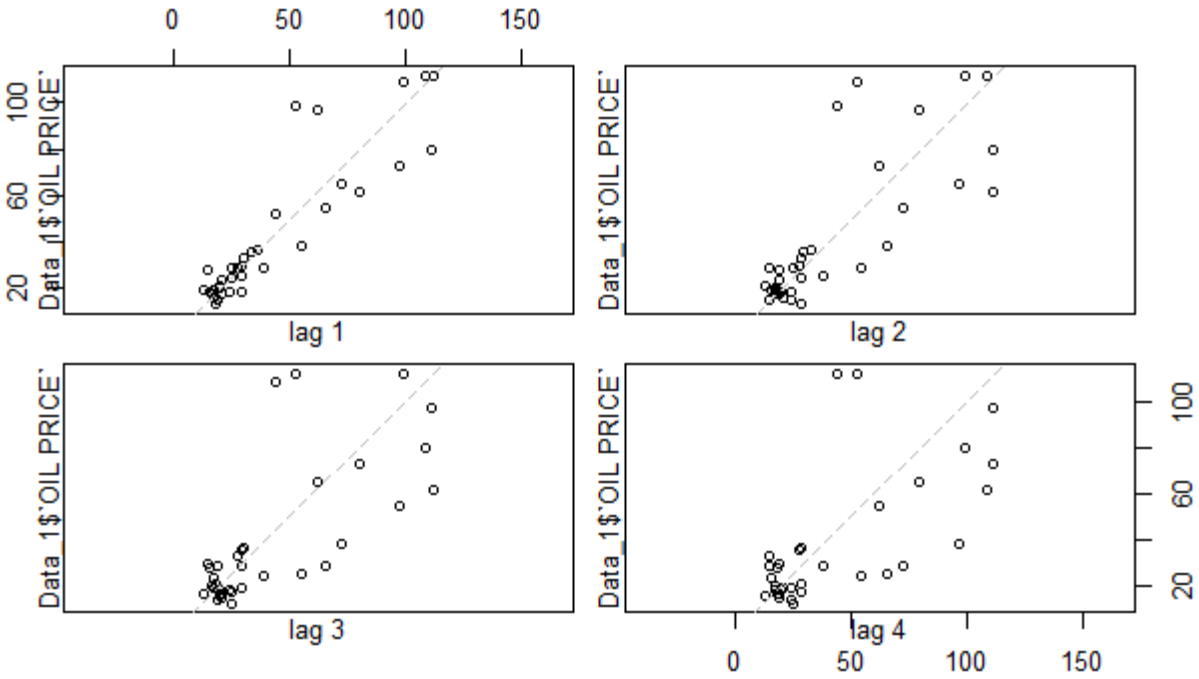
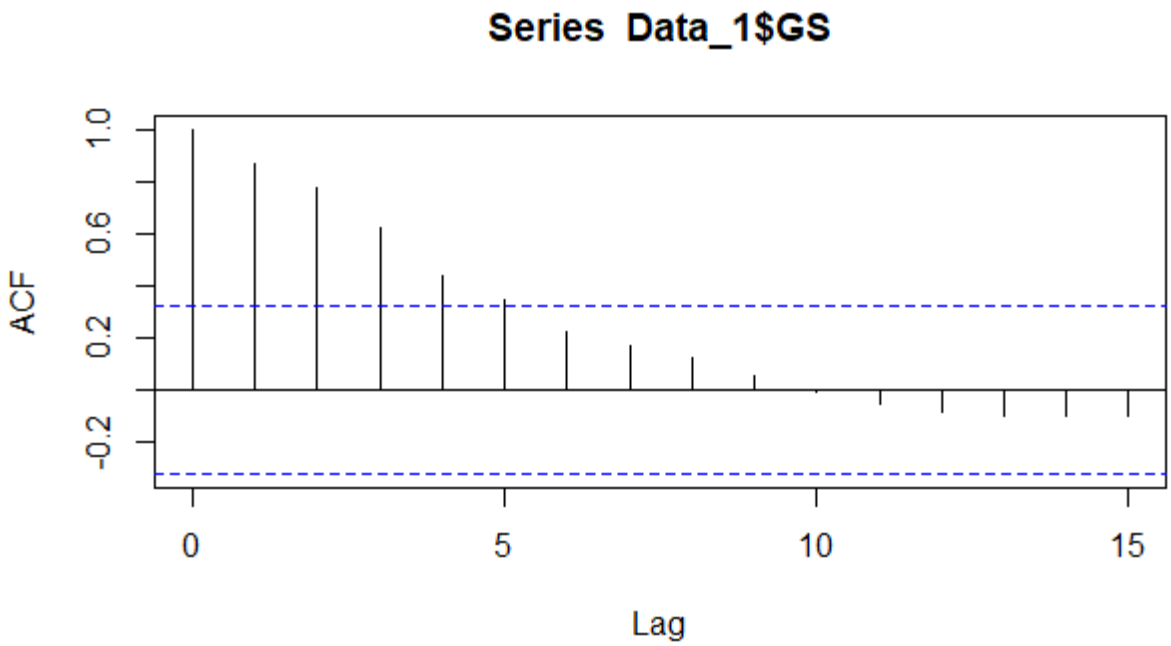


Figure 5: Autocorrelation plot of crude oil prices at different lags.



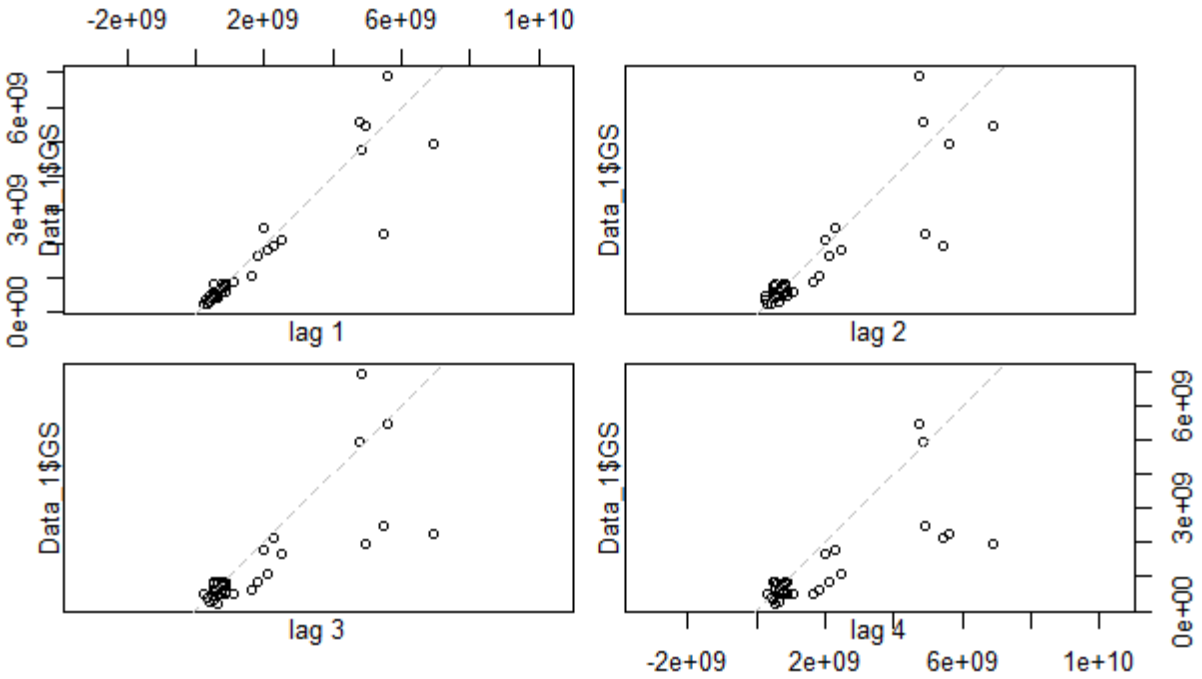


Figure 6: Autocorrelation plot of government consumption at different lags.

Figure 3, 4, 5 and 6 show autocorrelation plot of crude oil consumption, oil price, inflation, and government spending. The higher spikes of government spending and real GDP at lag 1 through lag 5 shows that they are statistically significant at those lags. Oil consumption and oil prices are significant at lag 7 and lag 6, respectively. This represent an indication of autocorrelation at those lags.

Unit root test

Under this section, the data spanning from 1980-2016 were subjected to the stationarity test. The ADF test was conducted to determine the order of integration of the variables. Table 4.2 shows that all the variable are stationary at first difference that is, I(1).

Table 4.2: Augmented Dickey-Fuller (ADF) Unit Root Test

ADF UNIT ROOT TEST AT LEVELS					
VARIABLES	1%	5%	10%	t-test	Prob
LGDP	-3.626784	-2.945842	-2.611531	0.267930	0.9732
LCONS	-3.626784	-2.945842	-2.611531	0.459457	0.9828
LGS	-3.626784	-2.945842	-2.611531	-0.116761	0.9400
LOP	-3.626784	-2.945842	-2.611531	-1.149805	0.6851
ADF UNIT ROOT TEST AT FIRST DIFFERENCE					
VARIABLES	1%	5%	10%	t-test	Prob
LGDP	-3.632900	-2.948404	-2.612874	-5.091210	0.0002
LCONS	-3.632900	-2.948404	-2.612874	-7.815652	0.0000
LGS	-3.632900	-2.948404	-2.612874	-5.270200	0.0001
LOP	-3.632900	-2.948404	-2.612874	-5.581172	0.0000

As indicated in table 4.2, all the variables used in this study were not stationary at levels, but become stationary upon first differencing. Hence, they are all integrated of order one. Since all the variables are integrated of the same order, cointegration analysis is justified.

Johansen cointegration

The Johansen cointegration test i.e the maximum eigen value test and the trace test were used to establish the number of cointegrating vectors. The result is shown in table 4.3.

Table 4.3: Result of Johansen cointegration test

Hypothesized No. CE(s)	Eigenvalue	Trace statistics	5%critical level	Prob.
None*	0.453774	50.71171	47.85613	0.0263
Atmost 1*	0.422111	30.15112	29.79707	0.0455
Atmost 2	0.278264	11.50640	15.49471	0.1822
Atmost 3	0.012251	0.419124	3.841466	0.5174

**denotes rejection of the null hypothesis at 0.05 significance level*

Trace test indicates 2 cointegrating equation at 5%

Maximum Eigen value				
Hypothesized No. CE(s)	Eigenvalue	Max-Eigen statistics	5%critical level	Prob.
None	0.453774	20.56059	27.58434	0.3037
Atmost 1	0.422111	18.64472	21.13162	0.1076
Atmost 2	0.278264	11.08728	14.26460	0.1499
Atmost 3	0.012251	0.419124	3.841466	0.5174

*denotes rejection of the null hypothesis at 0.05 significance level

As table 4.3 indicates, the trace test suggest the existence of two cointegrating equation while the maximum eigen value statistics suggest no cointegration. According to Alexander, C. (2001), in situations where there exist confliction results among the trace test and the maximum eigen value statistics, the result of the trace test takes dominance. Going by the result of the trace test, the study rejects the null hypothesis of no cointegration at 5% level of significance and conclude that, there exist at most, one cointegrating equation.

Table 4.4: Long run regression results

LGDP	coefficient	Std. error	t-statistics	Prob.
LCONS	-0.365578	0.143113	-2.554476	0.0154**
LOP	0.299622	0.074506	4.021445	0.0003***
LGS	0.714988	0.094147	7.594414	0.0000***
C	-8.291143	1.461917	-5.671418	0.0000***
R^2	0.9233	F-stats	132.5709	
Adj. R^2	0.9164	Prob>F	0.0000	

The results as presented in table 4.4 suggests that, the signs on all the independent variables satisfy the a priori expectations with the exception of crude oil consumption (LCONS), which the study found to have a long run negative relationship with economic growth.

The study found the coefficient of crude oil consumption (LCONS) to be -0.365578, and statistically significant at 1% significance level. Which specifically means holding all other variables constant, a percentage increase in the consumption of crude oil will lead to approximately 0.366% decrease in Ghana's economic growth (LGDP) in the long run. This result is in contrast to the study's a prior expectation and could suggest an inefficient use of energy consumption or a decline in energy consumption in the productive sectors of the Ghanaian economy to sectors whose overall contribution to the economy is minimal. This is indicative that, less oil is consumed in the productive sectors of the Ghanaian economy or an overall inefficient use of crude oil in the Ghanaian economy. The result is at variance with a study like Amin et al.(2018) which found a positive relationship between oil consumption and economic growth in in the long run in Bangladesh.

Further, the study found the coefficient of crude oil price (LOP) to have a positive and statistically significant relationship with economic growth. Holding all other variables constant, a percentage increase in crude oil price will increase Ghana's economic growth by approximately 0.2997%. This confirms how fast the Ghanaian economy grew and continue to grow ever since the country discovered and started the exportation of crude oil from 2011. A number of developmental projects spanning various sectors of the economy have been embarked upon, from the revenues accrued from oil exportation as the country is now a net-exporter of crude oil. Ebele, E. (2015) conducted a similar study and also confirms a similar result in Nigeria.

With regards to government spending, (LGS), the coefficients suggest that holding all other things constant a 1% increase in government spending will lead to approximately 0.715% increase in the growth of Ghana's economy at 1% significance level. This is in consonance with economic theory that judicious spending on the part of government have the tendency to stimulate economic growth in the long run. The result is also corroborated by Oladele et al.(2017) which found a positive and statistically relationship in the long run between government expenditure and economic growth in South Africa.

The R-squared of 0.9233 suggest that, approximately 92% of the variations in economic growth (LGDP) is explained by the independent variables. Also the F-statistics has a p-value of 0.0000, hence we reject the null hypothesis that the independent variables are jointly insignificant.

Table 4.5: Long run diagnostic test

Test statistics	F-values	P-value	Decision
Breusch-Pagan test for heteroscedasticity	F(3 , 33) = 1.266	0.3020	Fail to reject
Jarque-Berra normality		0.9217	Fail to reject

The test for heteroskedasticity was undertaken using the Breusch-Pagan test. As table 4.5 indicates, since the probability value of 0.3020 is higher than 0.05, hence the fails to reject the null hypothesis of constant variance and conclude that, the model is free of heteroscedasticity.

The study used the Jarque-Berra test to ascertain the normality of the residuals. The probability value of 0.9217 is greater 0.05, and hence the study fails to reject the null hypothesis and conclude that, the residuals are normally distributed.

Conclusion and policy implications

The focus of the study was to investigate the relationship between crude oil consumption and price on economic growth in Ghana. Time series data from 1980-2016 were used. The study employed analytical techniques like the Augmented Dickey fuller test and the Johansen cointegration test.

The study found a negative and statistically significant relationship between crude oil consumption and economic growth in the long run, suggesting an inefficient use of crude oil or a fall in the use of crude oil in the productive sectors

of the economy. The study further found a positive and statistically significant relationship between crude oil price and Ghana's economic growth. This has been the case in most net oil exporters

Finally, the study also found a positive and statistically significant relationship between government expenditure and economic growth in the long.

Based on the study's findings, it is recommended that, government diversify its source of earnings or revenues across sectors like the agriculture, manufacturing etc to reduce the country's massive reliance from oil revenues. This will help cushion the country from financial shortfalls in times of oil price fluctuations.

Further, the study recommends that policy makers together with the government adopt measures that encourage an efficient consumption of crude oil, especially in the productive sectors of the economy to stimulate growth. One of such is tax holidays for investors who venture into these productive sectors of the Ghanaian economy.

This notwithstanding, the study recommends effective measures to mitigate against the negative externalities associated with increased consumption of crude oil in the long run. One of such is the carbon tax. This could help cut down the emissions from the consumption of crude oil.

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