Ghanaian Journal of Economics, Vol. 9, December 2021

Oil Revenue and Economic Growth Nexus: Further Empirical Evidence from Ghana using an ARDL Approach

Opoku Adabor[a] and Emmanuel Buabeng[b]

[a] School of Economics, Finance and Marketing (EFM), RMIT University, Melbourne, Australia
[b] Department of Economics, Kwame Nkrumah University of Science and Technology, Kumasi, Wa, Ghana
[*]Corresponding author email: adaboropoku@gmail.com

Abstract

Theoretically, it is well argued that Oil revenue influence economic growth significantly. However, from empirical perspective less is known on how oil revenue affects economic growth, especially in developing countries like Ghana where the oil industry is young and non-competitive on the global market. The present study examines the effect of oil revenue on economic growth of Ghana using bounds test approach to co-integration within the framework of autoregressive distributed lag model (ARDL) as estimation strategy. Our ARDL estimates suggest that an increase in oil revenue generates a significant increase in economic growth of Ghana, implying that oil revenue boost economic growth. Other supplementary finding of the study reveals that non-oil revenue, capital and foreign direct investment (FDI) affect economic growth of Ghana positively while interest rate exerts a negative effect on economic growth of Ghana. Given these findings, our study provides a number of policy recommendations. First, there is the need for policy interventions such as increasing foreign direct investments that are directed to the oil industry or sector in order to increase oil production which will subsequently increase oil revenue to accelerate economic growth. Second, to promote economic growth, policy makers should design policies that aim at reducing interest and increasing capital and foreign direct investment as well as ensuring macroeconomic stability to boost investors' confidence in Ghana's economy. This will increase inflow of foreign direct investment to accelerate economic growth of Ghana.

Keywords*: Oil revenue; economic growth; autoregressive distributed lag model; Ghana.*

JEL Classifications: *E62; G2; O4; O11*

1. Introduction

Crude oil is a natural occurring unrefined petroleum product composed of deposits like hydrocarbon and other minerals. Products such as gasoline, diesel and other petrochemicals are produced from a refined crude oil. Crude oil production is essential because of its significant contribution toward economic growth across different countries in the form of employment, revenue contribution, poverty reduction and social contribution (Olayungbo, 2019; Peach and Starbuck, 2011). For example, Wang (2020) shows that the oil industry generates approximately one million dollar per years towards economic growth and development in some selected 62 countries. Crude oil is one of the essential elements that promotes economic growth, and it is transmitted to promote economic growth through several channels. These channels include pass-through to production cost, inflation expectation, revenue generation, monetary policy and investor confidence (Mork, 1989; Hooker, 1996; Cologni and Manera, 2008). However, crude oil production can also have a negative repercussion on economic growth and development in the form of pollution, displacement of inhabitant and destruction of natural resources (Kadafa *et al*., 2012; Gonzalez *et al*., 2022). For example, Plänitz and Kuzu (2015) found that oil production is associated with displacement of people and high cost of living in communities where they are produced.

In Ghana, crude oil production generates oil revenues which are disbursed into different areas of the economy in the form of expenditure and loans amortization for oil and gas, and development in infrastructure which includes road, capacity building and agricultural modernization. Furthermore, crude oil production contributes to revenue generation, income and poverty reduction (OECD, 2011). The sector approximately generates revenues of about 581 million US dollars per year to support economic development of Ghana (Ministry of Finance/GNPC, 2014). This shows how the oil sector contributes to significant proportion of Ghana's total revenue generated towards economic growth and development. However, oil production can affect Ghana's economy adversely. It has a negative impact on the environment and the livelihood of individuals living in areas where they are produced. Its production affects the quality of life of poor individuals living closed to the production areas. Therefore, policies that ensure effective production and account for environmental cost of oil production will be very important to address the negative effect associated with oil production. In Ghana, oil production contributes about 40% of total revenue generated (GSS, 2017). However, more than half the oil revenue is earned from the exportation of the crude oil. This contributes to export driven growth in Ghana since higher proportion of the revenue generated is earned from exportation.

Development in the oil sector is central to restorative growth in Ghana's economy through crude oil revenue receive from export on the world market. For instance,

in 2011 Ghana National Petroleum Corporation (GNPC) received a total amount of US$207.96 million for development in oil fields and gas projects. Out of this amount, US$132,484,815 was used to finance Jubilee Equity Financing Cost which represented 63.7% of the total amount allocated to GNPC, US$30,315,185 (14.6%) was spent on 2,612sq km of 3D Processing and Acquisition and US$28,119,624 (13.5%) was used on gas projects such as installation and fabrication of 14km gas pipeline and related cost (Ofori-Atta, 2017). Furthermore, in 2012 GNPC spent a total amount of US$61,674,215 on projects other than Jubilee. From this amount, development in the North and South Tano Petroleum Projects waved US$17,817,385, Tweneboa Enyenra Ntomme Oil field (TEN) project received US$16,736,362, US$3,090,224 was spent on Volta Basin Petroleum Projects, South Deep water Tano Petroleum Projects received a total fund of US$7,227,672, and the rest was spent on Reservoir Characterization, ICT upgrade and expansion, Data Centre upgrade, R and D Laboratory upgrade, Organizational Development Project and Corporate Investment Projects (GNPC, 2012). Additionally, in 2017 an amount of US$19,074,825.37 was spent on non-Jubilee projects like the Volta Basin Petroleum Projects, OCTP ENI Project, North & South Tano Petroleum Project, South Deep water Tano Petroleum Projects, Maritime Boundary Special Project and others (GNPC, 2017). All these investments were done by the National Oil Company to increase total production, and development of techniques for further production and discoveries.

In 2011, Ghana discovered many Petroleum productions of various statuses. These include DWT/WCTP Tullow's (Jubilee Field) Mahogany-1 and Hyedua-1 fields which discovered oil and were under production. WCT/Tullow Oil's Tweneboa-2 and Owo/Enyenna-1 discovered oil and was under development, and Ntomme and Wawa of Tullow discovered oil and gas while Tweneboa-1 and Ebony discovered gas condensate. Also, Kosmos Energy's fields such as Odum-1, Banda-1 and Mahogany Deep discovered oil whiles Teak-1 and Banda-2 discovered oil and gas and was under appraisal (GNPC, 2011). Furthermore, the Volta Basin occupies 40% of Ghana's total land mass and is Ghana's most important site for producing oil and gas onshore. As part of GNPC's attempt to set up petroleum prospectively of the Volta Basin, geographic expedition of the Volta Basin has acquired the status of Ghana National Petroleum Corporation (GNPC's) flagship project in 2019. GNPC has scheduled the drilling of two conventional exploratory wells of the Volt Basin for 2020 which is expected to increase the quantities of barrels produced daily and annual net production. Ghana's oil industry has advanced quickly in a decade despite the instability to influence international oil price which has been a major challenge to the industry. In mid-2015, the price of oil remained below US$65 per barrel (Ministry of Energy, 2010). Despite this challenge, discovery of new oil fields has given more hope to oil production in Ghana. Furthermore, other challenges that Ghana has been

confronted with are the border disagreement between Ghana and Côte d'Ivoire on its territorial water body which resulted in a long-term dispute between Ghana and Côte d'Ivoire. Côte d'Ivoire claim the area is part of their economic zone (Ministry of Finance/GNPC, 2014).

Literature on the relationship between oil revenue and economic growth is scanty in Ghana because Ghana started it oil production in commercial quantities not long ago (Specifically, commercial oil production started around 2011). However, few studies have been conducted in Ghana. For example, a study in Ghana by Breisinger *et al*. (2010) investigated how the future of Ghana's oil revenue would be managed. The study found out that, policies must be designed to allocate oil revenue to both productivity enhancing-investments and an oil fund is important to achieving shared growth and macroeconomic stability. Manu (2011) examined the benefits associated with oil and gas production and found that oil production creates jobs, improves standard of living, generate revenue and improve the distribution of electricity. A contradictory finding by Acquah-Andoh *et al.* (2018) revealed that the recent production of oil in Ghana does not contribute to GDP growth significantly.

Moving beyond the boundaries of Ghana, Peach and Starbuck (2011) studied the impact of oil and gas production on economic development of New Mexico. The study found that oil and gas production have smaller but encouraging effect on population, income and employment. A related study in Nigeria by Olusegun (2009) revealed that oil and gas activities generates an increase in incomes but causes air prostitution which is detrimental to human health. In the same country, Olayungbo (2019) employed ARDL as an estimation strategy to study the impact of oil revenue and institutional quality on economic growth of Nigeria and found that oil revenue boost Nigeria's economic growth. In Russia, oil industries contributed positively to generating economic profits for the populace (Dubinina, 2008). There is a limited empirical literature on how oil revenue affects economic growth. particularly in Ghana. Much more needs to be learn on how revenue from the recent oil production in Ghana affect economic growth to help contribute to designing effective economic policies to promote economic growth and development. The present study contributes to literature by examine the effect of oil revenue on economic growth of Ghana. In contributing to literature, we also provide sound empirical grounds for policy formulation regarding oil production in Ghana. Our study departs from existing study and measure oil revenue with Oil resource rent which is measured as the deviation between total costs of production and value of crude oil production at world market prices which are shared between government and the producing firm (World Bank, 2019). Additionally, contrary to existing studies, we include non-oil revenue, interest rate and capital in our regression model as control variables to contributes to the literature that seeks to find the determinants of economic growth. Thus, the present study contributes to unearthing new factors that influences economic growth of an

economy. Therefore, our study is unique this strand of literature because we utilized new control variables.

The rest of the paper is organized as follows: Literature review section discusses an overview of crude oil production as well as empirical literature review. Section three presents the data, the model, and the estimation strategy employed in this paper. Econometric findings and diagnostic tests were presented and discussed in section four. Finally, section five provides conclusion and policy recommendation.

2. Literature review

2.1. Overview of crude oil production in Ghana

Crude Oil production started in Ghana after a discovery by Kosmos Energy and Tullow oil in July 2007 in the Western Region. However, the location was named jubilee field based on historical facts and the sudden discovery of oil. Development towards jubilee field officially began in December 2010. Aside the jubilee field, other locations were discovered such as the Tweneboa field in the Western Region (Annan, 2008). The jubilee field is located 60 km off the Coast of Ghana sharing border with the Côte d' Ivoire. On the other hand, Tweneboa field is 6 km off Jubilee Field and produces significant amount of crude oil in Ghana. Jubilee Field produces an average 1 and 2 billion barrels of crude oil per day whiles Tweneboa field produces about 1.4 billion barrels of oil per day (Annan, 2008). These two fields are the major source of Ghana's oil and gas production. In relation to the quality, jubilee field produces light oil indicating its quality, hence, draws foreign direct investment into the country. Ghana currently operates one oil refinery. Thus, Tema oil refinery which has a refinery capacity of about 45.000 barrels p/d (Ministry of Energy, 2010). It was operating at 28,000 barrels per day on average, however, due to technical and financial challenges, the refinery is grounded and producing at zero barrel per day. Within the first quarter of production, government was able to secure about Ghc445 million equivalents to US$ 316 million (Ministry of Energy, 2010).

2.2. Literature review

The relationship between oil revenue and economic growth in developing countries has received far less attention in the literature. Studies in this strand o literature are often conducted in developed countries. Few studies conducted in developing countries have produced varying outcomes. For instance, Acquah-Andoh *et al*. (2018) investigated the effect of the production of oil and gas on Ghana's GDP growth using ordinary least squares (OLS) regression as estimation strategy. The study revealed that recent production of oil does not contribute significantly to GDP growth of Ghana. Uwakonye *et al*. (2006) et al. studied the production of oil and gas on growth of Nigeria's economy. This research work paid much attention to the share of production of oil and gas to Nigeria's rural areas growth using an econometric

model. The study found that poverty rate and unemployment rate are still high despite a huge oil export revenue Nigeria earns. Further, Cantah (2014) did a similar work on the price of oil and Ghana's GDP growth. The study used annual time series data spanning from 1967 to 2011 and was source from World Bank Development. The study found a long run association between GDP growth and oil price. Using fixed effect model as an estimation strategy, Wang (2020) examined the economic effect of Oil and Natural Gas production on development in some selected countries. The data used was a panel data spanning 1998-2016 covering 62 countries. The results from the study revealed that oil industries contribute approximately one million dollar per years towards development.

Akinlo and Apanisile (2015) investigated the effect of volatility of oil price on GDP growth in Sub-Sahara Africa using panel data spanning from 1986 to 2012. The study employed different estimation strategies including fixed effect model, Panel pooled OLS and others. Their results revealed that volatility of oil price positively and significantly affects GDP growth for oil exporting countries.

Employing the Granger causality test as estimation strategy, Parvin Hosseini and Tang (2014) assessed the effect of non-oil and oil export on GDP growth of Iran. The study used annual data which covered the period of 1970 to 2008. The results from the study revealed a unidirectional causality running from oil and non-oil export to GDP growth. This finding implies that export-led growth hypothesis is valid in Iran.

In a related study, Appiah Appiah *et al*. (2020) examined the nexuses among oil consumption, oil price volatility and GDP growth. Annual time series data spanning from 1980 to 2013 used in this study was source from World Development Indicators. The study employed the vector error correction model and the GARCH model as an estimation technique and found that crude oil price has a negative and significant effect on GDP growth in the short run. However, the long run association was found to be positive.

A closely related study by Olayungbo (2019) used ARDL model as an estimation strategy to study the effect of oil revenue and institutional quality Nigeria's economic growth. Using data from World Development Indicators, the study found that oil revenue exerts a positive and significant effect on gross domestic product, signifying that oil revenue contributes significantly to economic growth of Nigeria.

Manu (2011) examined the benefits associated with oil and gas production at Cape Three Points using correlation analysis and descriptive statistics. Using qualitative research technique, the study found that oil and gas production create jobs, improves the living standard of people, increases revenues and improves in the distribution of electricity in the country. The study used purposive sampling technique to sample 25 households.

EKPERIWARE and Olomu (2015) employed the VAR as estimation strategy to examine the impact of oil and gas production on GDP growth in Nigeria. Findings from the study revealed a significant and positive association between oil production and growth in Nigeria.

From the above empirical review, few studies have examined the effect of oil production on economic growth in different countries. Further, most of these few empirical studies focused on how macroeconomic variables such as oil price and oil production affect growth. Such studies are limited in Ghana. Much more need to be learned on how oil revenue affects GDP growth, especially in Ghana since Ghana's is among the developing countries with young oil industry. This work has become necessary to fill this gab in literature as well as provide empirical ground to help improve Ghana's oil industry. This study is differentiated from other studies by employing recent data (2011-2020) to analyze the effect of crude oil revenue on economic growth of Ghana in a more contemporary era.

3. Methodology

In this section we present the methods employed by the study to achieve objective of the study. First, we present the type as well as the source of data followed by model specification and finally, the estimation strategy.

3.1. Data type and source

The study utilized quarterly time series data covering the time period of 2011 to 2020. The data was obtained from three sources which includes Bank of Ghana, World development Indicator, and Ministry of Finance. Data on oil receipts (or oil revenue) and non-oil revenue were sourced from the Ministry of Finance Annual Petroleum Report and Bank of Ghana annual report whiles that of GDP, interest rate capital and foreign direct investment were sourced from World Development Indicators (WDI). We used 2011 as a starting point because that is the period where Ghana began the production of oil in significant large quantities.

3.2. Brief description of variables

This subsection presents a brief description of the variables used in our regression model.

Economic growth

Growth or output is commonly measured in an economy using GDP. GDP is defined as the sum of services and goods an economy produced during a given time period, normally a year. Real GDP on the other hand is defined as total good and services an economy produced at a given time period which adjust for inflation. Thus, it a GDP adjusted for inflation. The study makes use of real GDP growth as a measure

of economic growth following studies such as Nketiah-Amponsah (2009) and Romp and De Haan (2005).

Capital

Capital is defined as money or wealth needed to produce goods and services for consumption. A proxy for capital stock in this study is Gross fixed capital formation. This variable was employed by Fosu and Aryeetey (2008) in their study. Gross fixed capital formation is measured by fixed domestic assets less the part consumed in that year and added to the non-produced assets (Baafi Antwi, 2010). Capital is anticipated to have a positive relationship with economic growth. By employing linear regression analysis with fixed effect model, a study conducted by Sari *et al*. (2018) found that capital has a significant and positive impact on South Sumatra's economic growth. We expect the finding of our study to be consistent with the findings from Sari *et al*. (2018) since both studies were conducted in a developing country though some conditions may differ between these two countries.

Foreign direct investment (FDI)

FDI is defined as a category of cross border investment made by non-resident in the economy. FDI includes the total value of reinvested earnings, value of affiliated equity and net inter-company loans (Alfaro and Chauvin, 2016). In this study, we measured FDI as net inflows expressed as a share of the gross domestic product (GDP). The study expects positive association between FDI and Ghana's economic growth following existing studies (Adabor and Buabeng, 2020; Alfaro *et al*., 2007; Alfaro and Chauvin, 2016).

Interest rate

Interest is the price paid for the use of capital or money. Specifically, Auld *et al*. (1983) defined interest rate as the price borrowers pay which turn out to be the return lenders enjoy for deferring consumption pattern with liquidity. According to the classical economists, interest rate is ascertained by interaction between the demand for investment capital and supply of savings. Interest is also related to liquidity preference theory. Interest rate is the percentage charged on the total amount lent, deposited or borrowed within a specified period. Quarterly interest rate is referred to the interest rate in Ghana given for deposits once in every three months measured in percentage. We followed previous studies and measured interest rate with commercial banks' base rate in Ghana (Ladime *et al*., 2013; Matemilola *et al*., 2015; Kinyuru, 2011). Interest rate is expected to have a long-term negative association with economic growth.

Oil revenue

The present study defines oil revenue as the sum of income or earning made from oil sales. Specifically, it is the income earned from crude oil sold on the international

market. In this study, oil rent is use as a proxy for oil revenue, where oil rent is the deviation between total costs of production and value of crude oil production on the world market prices. The study expects a significant positive association between oil revenue and economic growth of Ghana. Oil revenue is the total oil rent received from Ghana's oil production, which is the income earned from sale of crude oil less cost of oil producing crude oil measured in Ghana cedi. Data on oil revenue was obtained from the Ministry of Finance Annual Petroleum Reports.

Non-oil revenue

Non-oil revenue measures sum of income or earning made in Ghana from all sectors except the oil sector. Significant proportion of this income or earning comes from taxation. Hence, taxation is the major source of non-oil revenue. This is the total income or revenue received by government which is measured in Ghana cedi. The study expects positive association between non-oil GDP and Ghana's GDP growth because it is the major source of government expenditure on developmental projects.

3.3. Model specification

The study examines the impact of oil revenue on Ghana's economic growth by following previous empirical studies (Mwasya, 2016; Adabor *et al*., 2022) and adopted general model as shown below:

$$\mathrm{GDP}_t = f(\mathrm{OR}, \mathrm{NOR}, \mathrm{K}, \mathrm{INTR}, \mathrm{FDI}) \quad (1)$$

Where GDP is gross domestic product, NOR is non-oil revenue, K is capital, INTR is interest rate and FDI is foreign direct investment.

The empirically estimable form of equation (1) is given as:

$$ln\mathrm{GDP}_t = \beta_0(\mathrm{OR}_t)^{\beta_1}(\mathrm{NOR}_t)^{\beta_2}(\mathrm{K}_t)^{\beta_3}(\mathrm{INTR}_t)^{\beta_4}(\mathrm{FDI}_t)^{\beta_5} + (e_t)^{\mu_t} \quad (2)$$

The study then took natural log of equation (2) to make it linear. Hence the general form is transformed to obtain an empirical and estimable form below;

$$ln\mathrm{GDP}_t = \beta_0 + \beta_1 ln\mathrm{OR}_t + \beta_2 ln\mathrm{NOR}_t + \beta_3 \mathrm{K}_t + \beta_4 ln\mathrm{INTR}_t + \beta_6 ln\mathrm{FDI}_t + \mu_t \quad (3)$$

From equation (3), all the βi in the model were estimated. All the βi's become elasticities once the natural log of the variables has been taken. Hence the coefficient could be interpreted as their long-run and short-run elasticities. For instance, β_2 which is coefficient of $ln\mathrm{OR}_t$ can be explained as the elasticity of GDP_t with respect to OR. In particular, it measures the degree at which GDP respond to changes in oil revenue, *ceteris paribus*. β_1, β_3, β_4 and β_5 represent their respective coefficient and elasticities and thus show the same behaviour as β_2.

3.3. Estimation strategy

To achieve the objective of the study, the study employed the autoregressive distributed lag model by Pesaran *et al.* (2001) as an estimation strategy. First, to use

time series data there is the need to test whether the series are integrated or not. This is so because using non-stationary series can generate spurious regression results, hence, drawing conclusion based on these results would be invalid (Granger and Newbold, 1974). Based on this reason, the study employed the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) test by Phillips and Perron (1988) to test for stationarity of the variables. The PP and ADF test have a regression augmented with lagged of the dependent variable with degree of freedom test used to test stationarity of all the variables used in this study.

3. The study then proceeds with ARDL estimation technique to estimate the five parameters in equation (3). The ARDL estimation technique is adopted in this study for its simplicity as compared to other estimators. Further, this approach has been shown to be more efficient and reliable with small sample size and able to account for endogeneity among the variables. Pesaran *et al.* (2001) explained that the ARDL co-integration approach is the best approach when the sample size is relatively small compared to some other multivariate and single co-integration techniques. This is so because ARDL model can produce much more reliable results compared to the other conventional time series models. The ARDL bound test specifies the functional relationship between economic growth, oil revenue, non-oil revenue, interest rate, capital and foreign direct investment as shown below:

$$\begin{aligned}\Delta \ln GDP_t = {} & \alpha_0 \\ & + \sum_{t=1}^{p} \beta_1 \Delta \ln GDP_{t-1} + \sum_{t=1}^{q} \pi_1 \Delta \ln OR_{t-1} + \sum_{t=1}^{r} \eta_1 \Delta \ln NOR_{t-1} \\ & + \sum_{t=1}^{s} \gamma_1 \Delta \ln INTR_{t-1} \\ & + \sum_{t=1}^{t} \lambda_1 \Delta \ln \mathrm{OR}_{t-1} + \sum_{t=1}^{u} \tau_1 \Delta \ln K_{t-1} + \delta_1 \ln INTR_{t-1} + \delta_2 \ln OR_{t-1} \\ & + \delta_3 \ln NOR_{t-1} + \delta_4 \ln FDI_{t-1} + \delta_5 \ln \mathrm{OR}_{t-1} + \delta_6 \ln \mathrm{K}_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

In the ARDL equations the Δ is the first difference operator of the models. The parameters β, π, η, λ and τ in the ARDL model denote the short run dynamic while δ_1 to δ_6 represent the multipliers in the long run, the number of lags is represented by p, q, r, s, t, and u whiles ε_t is white noise disturbance term which is independent and identically distributed.

The ARDL co-integration is examined by testing the following hypotheses:

H0 = $\delta 1 = \delta 2 = \delta 3 = \delta 4 = \delta 5 = \delta 6 = 0$; (there is no co-integration. Thus, no long run association between the variables).

H1 = $\delta 1 \neq \delta 2 \neq \delta 3 \neq \delta 4 \neq \delta 5 \neq \delta 6 \neq 0$ *(there is co-integration or association between the variables in the long run).*

The above hypothesis is tested using the F-statistic. It primarily tests for the hypothesis of no long-run relationship by comparing the F-statistic with the upper bound critical value. If the F-stats value is greater than the upper critical value implies that the null hypothesis is rejected. Thus, there is no long run association between the variables. Otherwise, the result is accepted. F-statistic between the upper and lower limit means the result is inconclusive.

Finally, the error correction model was used to estimate the speed of adjustment. The error correction model helps in reconciling the economic variables under consideration when there is a deviation in their behavior in the short run. The model is specified as;

$$\Delta Y_t = a_0 + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{q} \gamma_i \Delta X_{t-i} + \delta ECM_{t-i} + \varepsilon_t \quad (5)$$

Where Y in the model denotes the regressand and it lag, and X denotes the regressors and its lag, Δ is an operator representing first difference, whiles the dynamic coefficients in the short run are represented by β and γ. The ECM_{t-i} is the error correction term and stand for the long run which by theory must be statistically significant and negative, δ represents the spend in which the model will return to long run equilibrium when the is a shock.

3.4. Reliability and diagnostic checks

Finally, the study conducted a series of diagnostic test to ensure that the results obtained are reliable. Specifically, the study conducted normality test, serial correlation test, heteroskedasticity test, functional test and the stability test. The normality and serial correlation test were conducted using the Jarque-Bera test and the Breusch-Godfrey LM test respectively. Heteroskedasticity and functional test were conducted using Breusch-Pagan-Godfrey test and Ramsey reset test respectively. Finally, the stability of the model over the sample period is ascertained from the plots of CUSUM and CUSUMSQ.

4. Empirical results and discussion

This section presents empirical results of our study. The empirical results are presented in the following sequential order. First, we begin by presenting a summary of descriptive statistics of all the variables, followed by the stationarity test results and the co-integration bound test. Next, we present the ARDL long- and short-run results and the diagnostic test results.

4.1. Descriptive statistics

This section presents the descriptive statistics of all the variables used in the study. The results are presented in Table 1.

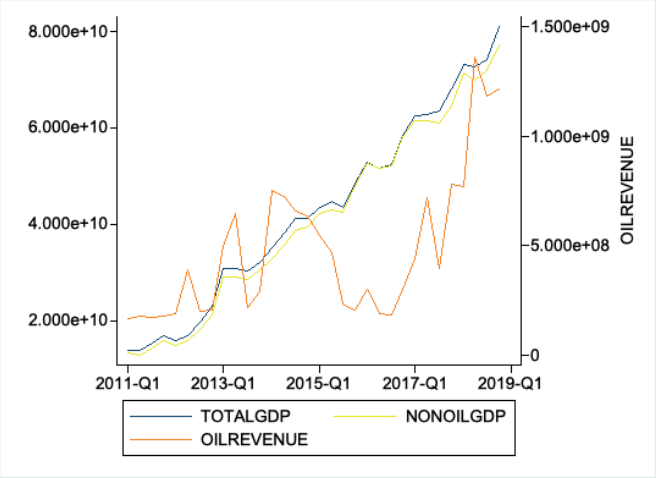
Table 1: Descriptive statistics

Variable	Observation	Mean	Std dev	Min	Max
LnGDP	38	12.5555	13.5790	0.3262	4.8533
LnOR	38	7.7738	1.8267	4.3501	10.2011
LnNOR	38	1.9703	1.1926	0.7126	5.9085
LnINTR	38	4.7985	3.5619	1.2874	11.6311
LnK	38	2.4511	0.9903	1.2501	4.5066
LnFDI	38	2.0960	0.5322	1.1764	2.9246

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

From Table 1, the average gross domestic product is 12.5 and ranges between 0.32615 and 4.85325. From a public policy stand point, the maximum shows that Ghana's highest level of growth within the period of 2011 to 2020 is about 4.85%. The standard deviation of gross domestic product is 13.579. Oil revenue averaged 7.77 and peaked at 10.2 with 4.35 as minimum value. The maximum value of oil revenue implies that over the 38-years period, oil revenue highest average increment is 10.2 percent. The standard deviation of oil revenue was 1.82. The average of the non-oil revenue variable is 1.9703 and falls between 0.7126 and 5.9085. Its deviation from the mean was 1.1926. In addition, interest rate had an average of 4.8 and ranges from 1.28 and 11.63, with 3.56 standard deviation. The maximum value of interest rate implies that the highest cost of borrowing within the period of 2011 to 2020 was about 11.63%. Capital had 4.51 and 1.25 as maximum and minimum values respectively. Its standard deviation was 0.99 and with an average of 2.451. Finally, foreign direct investment averaged 2.09 with 2.92 and 1.17 as its maximum and minimum value. FDI had 0.53 as its standard deviation.

Figure 1: Trend analysis



4.2. Trend analysis

Figure 1 help presents the behavior of the three main variables employed in the study. Figure 1 depicts that from the beginning of first quarter of 2011 to fourth quarter 2019 oil revenue has experienced some random shocks over the study period. However, a persistent growth path has been achieved over the period of 2011 to 2019. Oil revenue consistently increases from the first quarter of 2011 until it sharply falls in the fourth quarter of 2013. It then reaches the lowest point in the fourth quarter of 2017 and sharply increased until peaked at the fourth quarter of 2018. For gross domestic product and non-oil revenue, they have both consistently increased over the fourth quarter of 2011 to the fourth quarter of 2019.

4.3. Unit root and co-integration test results

Table 2: ADF and PP unit root test results

	ADF				PP			
Variables	**Levels**		**1st difference**		**Levels**		**1st difference**	
	Constant	Constant with trend	Constant	Constant with trend	Constant	Constant with trend	Constant	Constant with trend
LnGDP	-3.018**	-3.475*	-3.921***	-6.825***	-2.968**	-3.229*	-5.881***	-5.447***
LnOR	1.306	0.421	1.1501	-3.661**	3.054	0.421	-2.768*	-6.675***
LnNOR	0.613	-1.147	-4.317**	-4.626***	0.291	-1.146	-4.324***	-6.710***
LnINR	-2.389	-2.117	-4.994***	-5.336***	-2.329	-2.122	-5.294***	-5.204***
LnFDI	-1.100*	-2.922	-3.265**	-3.214***	-7.268**	-1.384	-1.936**	-4.531***
LnK	-3.037**	-2.925	-4.619***	-5.320***	-4.667**	-2.652	-4.708***	-4.545**

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

Note: **, **, and *** denotes 10%, 5% and 1% level of significance respectively.*

From Table 2, the results from both ADF and PP shows oil revenue, non-oil revenue and interest rate variables at level are not stationary. However, they become stationary at the first difference. For gross domestic product, FDI and investment, the variables were stationary at both levels and first difference. Thus, gross domestic product, FDI and capital in equation (3) are integrated of order zero [I (0)] and order one [(1)] and the remaining variables: oil revenue, non-oil GDP and interest rate are integrated of order one [(I (1)].

4.4. Co-integration test results

To ascertain the long run relationship between all the variables, the study employed the bound test for co-integration and the result is presented in the Table 3.

Table 3: ARDL Bounds test for long run relationship

F-statistic	K	Lower bound critical value	Upper bound critical value
3.527 ***	5	2.29	3.37

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

Note: *K represent the number of regressand in the equation (3), *** denotes 1% level of significance.*

In Table 3, the F-stats of 3.527 is higher than the upper critical value of 3.37 at 1% level of significance. Therefore, the null hypothesis is rejected indicating long run association between the independent variables and the dependent variable in equation (3). Specifically, our results suggest the existence of a long run association or co-integration between the gross domestic product and oil revenue, non-oil revenue, interest rate, capital as well as foreign direct investment. Hence, we can proceed to estimate the short and long run effect of oil revenue on economic growth of Ghana.

4.5. ARDL estimates for long-run and short-run

Table 4: Estimated ARDL long-run coefficient

Regressor	Coefficient	Standard Error	T-Statistic
LNOR	0.8413***	0.1612	5.2189
LNNOR	0.3547**	0.0811	4.3736
LNINTR	-0.7371**	0.1814	-4.0634
LNK	1.0323*	0.2841	3.6336
LNFDI	0.2587**	0.0631	4.0998

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

Note: ****, ** and * denotes1%, 5% and 10% level of significance respectively.*

From Table 4 oil revenue has positive and significant effects on Ghana's GDP at the 5% significance levels in the long run, all else equal. The magnitude and the sign of the oil revenue imply that 1 percent increase in oil revenue causes gross domestic product to increase by 0.84 percent. The economic implication of this result is that the extraction of crude oil generates income (revenue) to both the producing firm and government which are shared among the two parties based on law. The firm can reinvest earned income generated from oil production to increase its scale of production thereby increasing oil revenue to boost economic growth of Ghana. Increase in income accruing to firms results in an increase in wages or improved working conditions of workers which improves the standard of living of the workers. Improved standard of living of workers increases workers productivity which subsequently increases oil production to promote economic growth of Ghana.

Government on the other hand, uses the revenue in implementing its developmental project and policies to promote sustained economic growth. Thus, government uses income or revenue earned from crude oil exportation for developmental projects such as infrastructure development, agricultural, schools, rural electrification, payment of wages and unemployment as well as labor programs. For instance, in Ghana, part of the oil fund is used to support the free senior high. Our finding is consistent with findings from Olayungbo (2019), EKPERIWARE and Olomu (2015) and Manu (2011) but contradicts that Uwakonye *et al*. (2006).

Regarding the control variables, non-oil revenue had significant and a positive impact on gross domestic product at the 5% level of significance in the long run in Ghana. Its sign and magnitude show that 1 percent increase in non-oil revenue increases gross domestic product by about 0.35% percent in Ghana in the long run. The intuition behind this result is that revenue from other sector of the economy is channeled to vital areas of the economy including employment, infrastructure development, agricultural, education, health and industrialization to promote economic growth of Ghana. This finding is in line with existing studies (Olayungbo and Olayemi, 2018; Ojong *et al*., 2016). Additionally, the results reveal that interest rate has significant negative effect on Ghana's long-run economic growth. The coefficient of interest rate signifies that one percent increase in interest rate reduces gross domestic product by 1.02% in the long run. As explained earlier, interest rate is one of the components of the cost of production of firms since firms borrow to invest to expand their productive capacity. Therefore, high interest implies high cost of securing fund to acquire capital for further production since firms are required to pay interest on the money borrowed. Besides this, firms that have funds for investment may divert their funds into the purchasing of treasury bills since return on such portfolio investment is profitable compared to the internal rate of return of the investment, thus, deterring the firms from investing their funds into production. This thereby reduces economic growth of Ghana. Our finding conforms that of previous studies (Njie and Badjie, 2021; Saymeh and Orabi, 2013). Furthermore, capital had a significant and positive relationship with Ghana's economic growth. Specifically, 1% increase in domestic capital generates 1.03 percent increase in gross domestic product, all other things being equal. This implies that domestic investment plays a vital role in promoting economic growth of Ghana. This result is consistent with existing studies (Changyuan, 2007; Omri, 2014). Lastly, FDI had a significant and positive impact on Ghana's economic growth. Thus 1% increase in FDI leads to 0.25% increase in Ghana's economic growth. This implies that inflows of FDI is an important factor that contributes to economic growth of Ghana. This finding is consistent with findings from Chang (2010), Alfaro *et al*. (2004) and Chakraborty and Nunnenkamp (2008).

Table 5: Short run coefficients and the error correction estimate

Regressor	Coefficient	Standard Error	T-Statistic
ΔLnOR	0.0747**	0.0136	5.4926
ΔLnNOR	0.0315**	0.0065	4.8462
ΔLnINTR	-1.8871***	0.3301	-5.7167
ΔLnK	0.0917*	0.0321	2.8567
ΔLnFDI	0.0669**	0.0142	4.7113
ECM(-1)	-0.0911***	0.0141	-6.2836

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

Note: ****, ** and * denotes1%, 5% and 10% level of significance respectively.*

Table 5 shows that empirical results of the short run association between GDP growth and oil revenue (OR) as well as GDP growth and the other explanatory variables. The empirical results revealed that oil revenue had a significant positive impact on GDP at the 5% level of significance in the short run in Ghana. The sign and magnitude signify that 1% increase in oil revenue increases gross domestic product by 0.07% percent in the short run, *ceteris paribus*. The intuition behind this result is that oil revenue is another relevant source of government revenue for government expenditure. Government expenses on infrastructure development such as roads, electricity, schools and hospitals help promote economic growth. Government spends on wages and salaries which improve standard of living of individuals working in the public sector and thus increases worker's productivity to increase economic growth. Our finding is coherent with that of the long run and findings from Olayungbo and Adediran (2017).

Regarding the control variables, non-oil revenue exerts a significant positive effect on GDP in the short run in Ghana. The result implies that a percentage increase in non-oil revenue corresponds to 0.03 percentage increase in the GDP of Ghana in the short run. Additionally, the results revealed that interest rate exert significant negative effects on GDP at 1% significance level. Therefore, a 1% increase in interest rate generates a decrease of about 1.88 % in GDP. Additionally, the study found that, FDI exerts significant positive impact on gross domestic product. Thus, a percentage increase in foreign direct investment causes a 0.07% increase in gross domestic product. These results demonstrate that, an increase in interest rate and foreign direct investment has the tendency to increase output of firms thereby increasing their contribution to gross domestic product, ceteris paribus. On the issue of FDI, the results made it clear that it has a significant positive effect on gross domestic product. Specifically, 1 percent increase in FDI causes gross domestic product to increase by 0.066.

Regarding the error correction model, it is significant and negative which support the long run relationship between oil revenue, non-oil revenue, capital, FDI, interest rate, and GDP and there is a long run equilibrium restoration when there is a shock to any of the regressors. Specifically, ECM (-1) of -0.09 shows 9% speed of adjustment in the long run equilibrium when there is a shock. This implies that the speed of convergence to long-run equilibrium after a shock occurs is very low, hence, it will take a while for equilibrium to be restored in the ARDL model.

Table 6: Diagnostic test result

Diagnostic test	Test approach	Test Statistics	Prob. Value
Normality	Jarque-Bera test	0.3211	0.2561
Serial correlation	Breusch- Godfrey LM test	1.2658	0.3073
Heteroskedasticity	Breusch-Pagan-Godfrey test	0.4997	0.8232
Functional form	Ramsey reset test	0.3892	0.3214
Stability of the model	CUSUM test	Stable	
Stability test	CUSUMQ test	Stable	

Source: *Author's estimation based on data from WDI and Bank of Ghana.*

In this section, our goal is to conduct various diagnostic test to ensure that our results are robust and reliable. The results are reported in Table 5. It is observed that the ARDL model does not suffer from statistical and econometric problems mentioned above since all the probability values are greater than 0.05. Thus, the estimated results from the ARDL model are free from heteroskedasticity, serial correlation and it is normally distributed. From the CUSUMQ and CUSUM graph (see the Appendix) reveals that economic growth in the exact time period is stable. This is because Cumulative sum of square and Cumulative sum (CUSUMQ and CUSUM) plots lie within the 5 percent critical limit.

5. Conclusions and policy recommendations

The aim of the study was to assess the effect of oil revenue on Ghana's GDP growth using quarterly data spanning from 2011-2018. To do this, the study employed bounds testing approach to co-integration within the framework of an autoregressive distributed lag model (ARDL) and error correction model as an estimation strategy to ascertain both the short run and the long run association between oil revenue and Ghana's GDP growth. The study includes non-oil revenue, interest rate, foreign direct investment and domestic capital as control variables to examine how these economic indicators affect economic growth of Ghana.

The results from the ARDL estimates revealed that oil revenue exerts positive impact on Ghana's GDP growth in both the long-run and short-run. 4. This, however, means that when there is an increase in oil revenue in the economy, we should expect an increase in Ghana's economic growth as depicted in the trend analysis. Regarding the other macroeconomic variables used as control variables, we found that non-oil revenue, capital, FDI and interest rate had a significant influence on economic growth of Ghana in both the short run and long-run. Thus, our study contributes to the literature in determinant of economic growth by finding that FDI, capital and non-oil revenue exert a positive and significant effect on Ghana's GDP while interest rate exerts a negative and significant impact on economic growth of Ghana.

Following the findings from the study, the study makes the following vital policy recommendations for developing countries especially countries in sub-Sahara Africa with similar socioeconomic and demographic features like Ghana. Since the study found that oil revenue promotes economic growth, the study recommends that government should work with investors and monetary authorities to design policies that will boost the performance of the oil industry in Ghana to increase oil production which will consequently increase oil revenue to promote economic growth. Such policies include directing more foreign direct investment to the oil industry, increasing access to capital and investment in the oil industry through lowering cost of borrowing and reinvesting profit made from oil production into the oil industry, respectively. Further, providing a stable macroeconomic environment to boost investors' confidence will increase total domestic investment of which some will be directed to the oil industry to increase their scale of production. Hence, ensuring macroeconomic stability should be given much attention when devising policies aim at increasing oil production in order to promote economic growth. Lowering the interest rate is another strategy to promote economic growth of Ghana. This so because lowering interest rate reduces cost of borrowing and increases investment in Ghana to accelerate economic growth. Lastly, stabilizing macroeconomic indicators to boost foreign investors' confidence will help increase inflow of foreign direct investment to significantly promote economic growth of Ghana.

About the authors

Opoku Adabor holds a Bachelor of Art and Masters in economics both from Kwame Nkrumah University of Science. He worked as graduate research assistant at KNUST after his first degree and during his master's studies. He is currently a PhD student at RMIT University, Australia. His research interest includes macroeconomics, monetary, health, energy economics and economic policy analysis.

The late **Dr. Emmanuel Buabeng** was a Senior Lecturer at the Department of Economics, Kwame Nkrumah University of Science and Technology (KNUST),

Kumasi-Ghana. He received B.A degree, Master's and PhD degree in economics from Kwame Nkrumah University of Science and Technology (KNUST). He had professional experience in finance and teaching field for over 10 years. His research interest included microeconomics, macroeconomics economic analysis and financial economics.

Acknowledgements

This manuscript benefited from the valuable comments the anonymous reviewer and the editor. We thank the anonymous reviewer and the editor for their time and effort.

References

Acquah-Andoh, E., Gyeyir, D. M., Aanye, D. M. & Ifelebuegu, A. (2018). Oil and Gas Production and the Growth of Ghana's Economy: An Initial Assessment. *International Journal of Economics & Financial Research*, 4, 303-312.

Adabor, O. & Buabeng, E. (2020). Does Monetary Policy and Foreign Direct Investment Have an Influence on the Performance of Stock Market: Further Empirical Evidence from Ghana. *Economics Literature*, 2, 161-176.

Adabor, O., Buabeng, E. & Dunyo, J. F. (2022). The causative relationship between natural resource rent and economic growth: evidence from Ghana's crude oil resource extraction. *International Journal of Energy Sector Management*.

Akinlo, T. & Apanisile, O. T. (2015). The impact of volatility of oil price on the economic growth in sub-Saharan Africa. *Journal of Economics, Management and Trade*, 338-349.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S. & Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of International Economics*, 64, 89-112.

Alfaro, L. & Chauvin, J. (2016). *Foreign direct investment, finance, and economic development*. World Scientific Singapore.

Alfaro, L., Kalemli-Ozcan, S. & Volosovych, V. (2007). Capital flows in a globalized world: The role of policies and institutions. In *Capital controls and capital flows in emerging economies: Policies, practices, and consequences*. University of Chicago Press.

Annan, B. (2008). *Oil Discovery in Ghana: A blessing or a curse?* Thesis.

Appiah, G. K., Oduro, E. & Benn, S. (2020). Empirical analysis of crude oil consumption and price on Ghana's economic growth. *Open Science Journal*, 5.

Auld, D. A. L., Bannock, G. & Baxter, R. E. (1983). *The American Dictionary of Economics*, New York: Facts on File.

Baafi Antwi, J. (2010). Ghana's Economic Growth in perspective: A time series approach to Convergence and Growth Determinants.

Breisinger, C., Diao, X., Schweickert, R. & Wiebelt, M. (2010). Managing future oil revenues in Ghana: An assessment of alternative allocation options. *African Development Review*, 22, 303-315.

Cantah, W. (2014). *Crude oil price and economic growth: the case of Ghana*. Centre for Study of Africa Economies Conference, Economic Development in Africa. St Catherine's College, University of Oxford, 2014. 23-25.

Chakraborty, C. & Nunnenkamp, P. (2008). Economic reforms, FDI, and economic growth in India: a sector level analysis. *World Development*, 36, 1192-1212.

Chang, S.-C. (2010). Estimating relationships among FDI inflow, domestic capital, and economic growth using the threshold error correction approach. *Emerging Markets Finance and Trade*, 46, 6-15.

Changyuan, L. (2007). FDI, domestic capital and economic growth: Evidence from panel data at China's provincial level. *Frontiers of Economics in China*, 2, 92-113.

Cologni, A. & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30, 856-888.

Dubinina, E. (2008). Impact of the oil and gas industry on human security: relation between the national and the human: case study: the Nenets Autonomous Okrug, Russia. Universitetet i Troms.

Ekperiware, M. C. & Olomu, M. O. (2015). Effect of oil and agriculture on economic growth in Nigeria. *Journal of Global Economics, Management and Business Research*, 3, 75-86.

Fosu, A. & Aryeetey, E. (2008). Ghana's post-independence economic growth. In *The economy of Ghana: analytical perspectives on stability, growth, and poverty*. Oxford: James Currey, 36-77.

Gonzalez, D. J., Francis, C. K., Shaw, G. M., Cullen, M. R., Baiocchi, M. & Burke, M. (2022). Upstream oil and gas production and ambient air pollution in California. *Science of The Total Environment*, 806, 150298.

Hooker, M. A. (1996). What happened to the oil price-macroeconomy relationship? *Journal of Monetary Economics*, 38, 195-213.

Kadafa, A. A., Zakaria, M. P. & Othman, F. (2012). Oil spillage and pollution in Nigeria: organizational management and institutional framework. *Journal of Environment and Earth Science*, 2, 22-30.

Kinyuru, F. G. (2011). *Determinants of Lending Rate of Commercial Banks in Kenya*. University of Nairobi.

Ladime, J., Sarpong-Kumankoma, E. & Osei, K. (2013). Determinants of bank lending behaviour in Ghana. *Journal of Economics and Sustainable Development*, 4, 42-47.

Manu, D. A. K. (2011). *The emerging oil industry in Ghana: Socio-economic and environmental impact on the people of Cape Three Points*. Norwegian University of Life Sciencess.

Matemilola, B., Bany-Ariffin, A. & Muhtar, F. E. (2015). The impact of monetary policy on bank lending rate in South Africa. *Borsa Istanbul Review*, 15, 53-59.

Mork, K. A. (1989). Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. *Journal of Political Economy*, 97, 740-744.

Mwasya, G. N. (2016). *The Effect of the Central Bank Rate on Stock Market Performance at the Nairobi Securities Exchange*. University Of Nairobi.

Njie, M. & Badjie, M. (2021). The effects of interest rate on economic growth: Further insights from the Gambia. *Journal of Economics and International Finance*, 13, 100-105.

Nketiah-Amponsah, E. (2009). Public spending and economic growth: evidence from Ghana (1970–2004). *Development Southern Africa*, 26, 477-497.

Ojong, C. M., Anthony, O. & Arikpo, O. F. (2016). The impact of tax revenue on economic growth: Evidence from Nigeria. *IOSR Journal of Economics and Finance*, 7, 32-38.

Olanyungbo, D. (2019). Effects of oil export revenue on economic growth in Nigeria: A time varying analysis of resource curse. *Resources Policy*, 64, 101469.

Olanyungbo, D. & Olayemi, O. (2018). Dynamic relationships among non-oil revenue, governmentspending and economic growth in an oil producing country: Evidence from Nigeria. *Future Business Journal*, 4, 246-260.

Olanyungbo, D. O. & Adediran, K. A. (2017). Effects of oil revenue and institutional quality on economic growth with an ARDL approach. *Energy and Policy Research*, 4, 44-54.

Olusegun, A. O. (2009). Gender, sustainable peace, and development in the Niger Delta region of Nigeria. *Journal of Sustainable Development in Africa*, 11.

Omri, A. (2014). The nexus among foreign investment, domestic capital and economic growth: Empirical evidence from the MENA region. *Research in Economics*, 68, 257-263.

Parvin Hosseini, S. M. & Tang, C. F. (2014). The effects of oil and non-oil exports on economic growth: a case study of the Iranian economy. *Economic research-Ekonomska istraživanja*, 27, 427-441.

Peach, J. & Starbuck, C. M. (2011). Oil and gas production and economic growth in New Mexico. *Journal of Economic Issues*, 45, 511-526.

Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16, 289-326.

Phillips, P. C. & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75, 335- 346.

Plänitz, E. & Kuzu, D. (2015). *Oil production and the transformation of livelihoods of communities in Ghana.*

Romp, W. E. & De Haan, J. (2005). Public capital and economic growth: a critical survey. *EIB papers*, 10, 41-70.

Sari, N., Syamsurijal, A. & Widiyanti, M. (2018). The impact of Islamic capital market development on economic growth: The case of Indonesia. *Journal of Smart Economic Growth*, 3, 21-30.

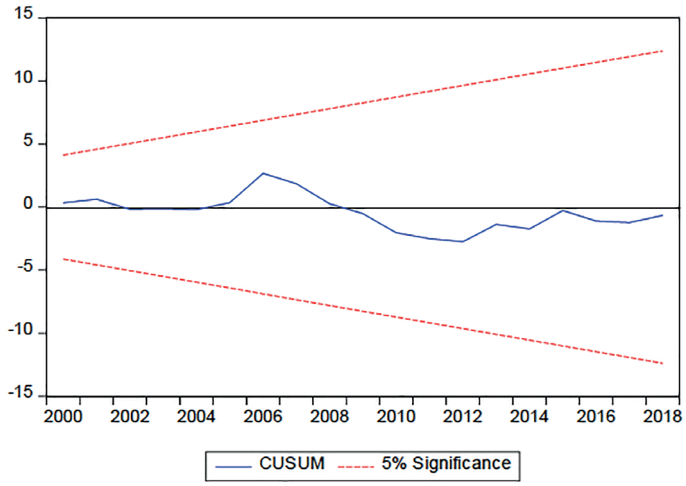
Saymeh, A. A. F. & Orabi, M. M. A. (2013). The effect of interest rate, inflation rate, GDP, on real economic growth rate in Jordan. *Asian Economic and Financial Review*, 3, 341.

Uwakonye, M. N., Osho, G. S. & Anucha, H. (2006). The impact of oil and gas production on the Nigerian economy: A rural sector econometric model. *International Business & Economics Research Journal* (IBER), 5.

Wang, H. (2020). The economic impact of oil and gas development in the Permian Basin: Local and spillover effects. *Resources Policy*, 66, 101599.

World Bank (2019). *World development indicators 2019*, World Bank.

Appendix Figure 1: CUSUM and CUSUMQ graph



Appendix Figure 2: Plots of CUSUM and CUSUM