Oil Prices and Economic Growth Nexus in Ghana: New Empirical Evidence

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Abstract

The study aims to contribute to the oil price-economic growth nexus in Ghana by assessing the short- and long-run relationships with annual data that covers the period from 1987 to 2020. The study contributes to the literature by accounting for developments in the Ghanaian oil industry post-2012, including the discovery of the Tweneboa-Enyenra-Ntomme (TEN) and Sankofa Gye-Nyame (SGN) oil fields in 2016 and 2017, respectively, thus filling a massive deficiency in the literature. The Autoregressive Distributed Lag (ARDL) and the bounds cointegration test are used because they are appropriate for analyzing short- and long-run dynamics on a theoretical basis when time series are mixed-integrated, i.e., I(1) and I(0). The bounds test results indicated a cointegration relation between economic growth as proxied by real gross domestic product per capita and physical capital, labor force, oil prices, population growth, and government expenditure. The findings provide convincing evidence that the oil price is a significant driver of economic growth in Ghana. Both long-run and short-run impacts of the oil price are positive, statistically significant, and robust for the oil price proxy. The results suggest that because of the recent volatility of oil prices, economic policies should be concentrated on reducing overreliance on oil revenue to avoid the Dutch disease phenomenon. Nonetheless, policymakers should strategize well enough by encouraging more local participation in the oil sector to avoid the risk of falling victim to the Dutch disease.

Keywords: ARDL, Bounds Test, Economic Growth, Ghana, Oil Prices.

JEL Classifications: C22, N97, O40

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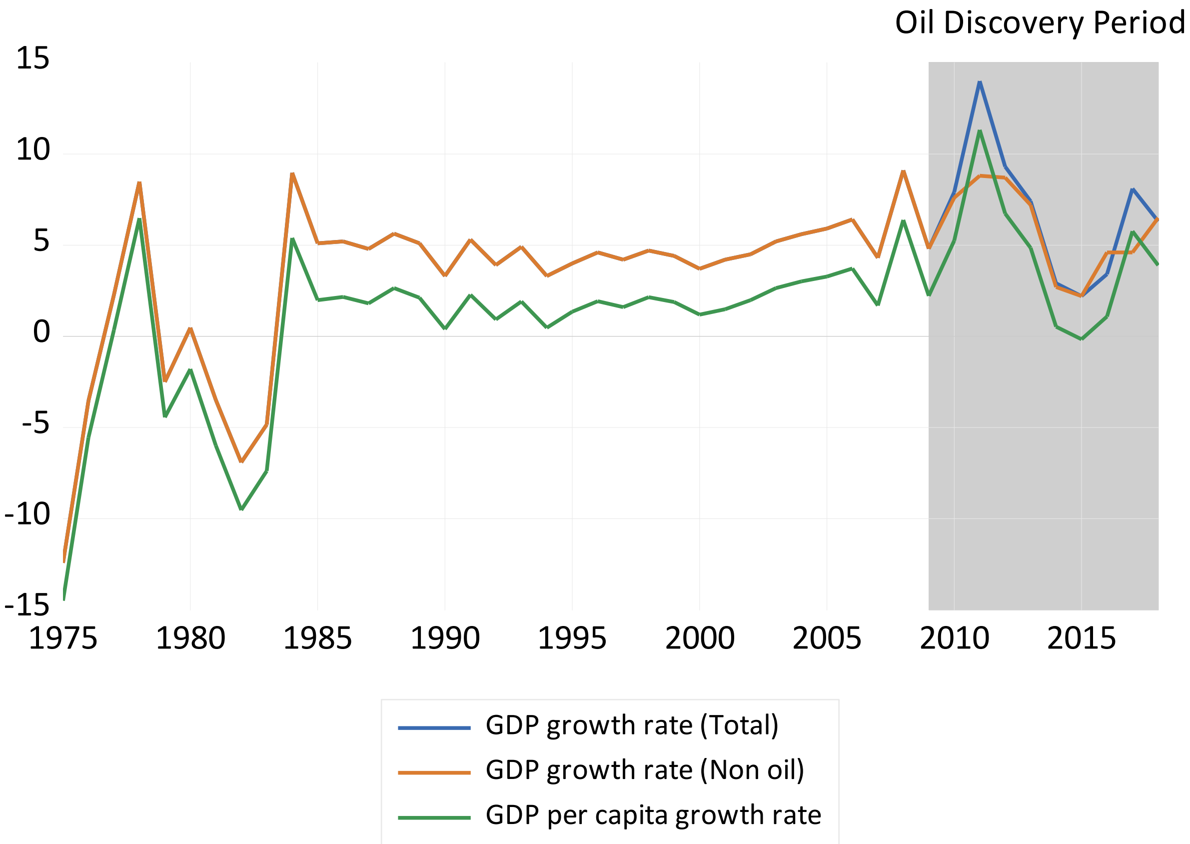
1. Introduction

In an integrated world, with energy increasingly becoming a key driver of the global economy, the effect of changes in oil prices on economic growth cannot be overemphasized. This is true not just for developed economies but also for developing economies such as Ghana. After gaining independence in 1957, Ghanaians had grand expectations for steering their affairs. They had hoped for rapid industrialization, universal employment, higher salaries, a more democratic style of governance, improved access to education and healthcare, and general welfare improvements (Aryeetey and Kanbur, 2017). Unfortunately, many Ghanaians believed that the lofty expectations that surrounded the independence celebrations had not been met. The unrealized expectations were a result of prolonged economic uncertainty and weak economic performance. For instance, by the end of 2015, gross domestic product (GDP) growth had fallen to 3.5 percent from 8 percent in 2012 (IMF, 2016). By the end of March 2016, headline inflation (YoY) stood at 19.2 percent, and unemployment closed the year at 5.45 percent (Statista, 2021). At about the same time, the country was struggling to recover from its erratic power supply due to the energy supply shock caused by a breakdown in the West African gas pipeline, economically costing between $320 million and $920 million per annum, as reported by the Institute for Statistical, Social, and Economic Research (ISSER), Ghana (Adom, 2016). Commercial production of crude oil in Ghana started in 2011, with the Jubilee field being the first, but two more fields—Tweneboa-Enyenra-Ntomme (TEN) and Sankofa Gye-Nyame (SGN)—have been added in 2016, and 2017, respectively, increasing Ghana's oil reserve capacity.

Like any other country, Ghana is not free from economic shocks. The recent economic stagnation triggered by supply-side bottlenecks that accompanied the COVID-19 pandemic is a critical example. However, despite the effects of changes in oil prices, the economy was relatively stable, with growth broadly in the positive territory. The economy is projected to remain relatively strong and broad-based over the medium term, supported by higher prices for key exports, including oil, and strong domestic demand (The World Bank, 2022). Indeed, since the Structural Adjustment Program (SAP) of the 1980s, otherwise termed the Economic Recovery Program (ERP), the economy has emerged strongly, following a series of political uncertainties in some cases, and maintained relative stability over the years. More so was when oil was discovered in 2007 and produced in commercial quantities in 2011, shooting the GDP growth to an all-time high. While growth had staggered on the back of a market failure in 2015, coupled with erratic power supply, the coming on board of the TEN and SG-N oil fields in 2016 and 2017, respectively, further boosted the growth potentials, as shown in Figure 1.



Source: Bank of Ghana data

Figure 1. The Trend of Ghana's GDP (Per Capita) Growth Rate

Studies differ on the association between oil prices and economic growth. Darby (1982) and Hamilton (1983), two of the earliest studies, stated that most economic recessions were historically followed by a fast increase in crude oil prices. In Ghana, Aryeetey and Harrigan (2000) partly attributed the crude oil price shocks of 1974 and 1981 to the preceding economic downturn. Hence, growth rates weakened during periods of crude oil price hikes (Fosu and Aryeetey, 2008). On the contrary, Awunyo-Vitor et al. (2018) contend that this period of economic adversity and crude oil price shocks was preceded by economic restructuring and low crude oil prices. Killick (2010), for instance, added that this development made the country experience stable growth, with GDP growth averaging 5 percent per annum since 1993, marking the birth of democracy. The decline in economic growth from an average of 10-15 percent in 2011–2012 to below 5 percent in 2014–2015 was partly due to the lingering effects of the external and domestic macroeconomic shocks since 2012 (Skaten, 2018).

As of 2018, local crude oil production accounted for 5 percent of the final energy demand, excluding biomass, with the share of imports constituting 95 percent (Abudu and Sai, 2020). Awunyo-Vitor et al. (2018), for instance, using yearly data from 1970 to 2012, found an inverse relationship between oil prices and economic growth, suggesting that a high rate of oil prices feeds into high general price levels and, consequently, leads to slow economic activity in the long run. This was based on the empirical work of Jiménez-Rodrguez and Sánchez (2005), who concluded that the consequences of oil price fluctuations should differ in oil-exporting and oil-importing countries, especially the Organization for Economic Cooperation and Development (OECD) countries, as increased should be considered good news in the former and bad news in the latter. It is important, however, to note that this only largely explains the demand-side effect. On the supply side, a high rate of oil prices shores up the international reserve, which consequently helps to provide resilience in times of economic downturns or shocks, streamlining economic activities in the long run. Again, Awunyo-Vitor et al. (2018) do not consider the effects of developments in the Ghanaian oil industry post-2012, including the discovery of the TEN and SG-N oil fields in 2016 and 2017, respectively, creating a massive deficiency in the literature. Therefore, this study fills this gap by extending the sample to 2020. The results of the study indicate a positive short- and long-run robust impact of oil prices on economic growth in Ghana.

In this respect, the current study contributes to the literature in the following ways: Firstly, the ARDL is suitable for investigating short and long-run relationships simultaneously with a limited sample size on a theoretical basis, unlike Awunyo-Vitor et al. (2018), where theoretical vector autoregressive/vector error correction models and lag-sensitive greater causality techniques were used. This paper, therefore, augments the study of Awunyo-Vitor et al. (2018) by employing the ARDL approach to delve into the short- and long-run dynamics of the oil price-economic growth nexus. Secondly, the current study extends the sample range beyond 2012 to capture the developments (including the discovery of the TEN and SG-N oil fields in 2016 and 2017) in the Ghanaian oil industry that were not accounted for by the previous literature, such as Awunyo-Vitor et al. (2018). This also captures the period of oil production in commercial quantities. Finally, the current study uses Brent-Europe and West Texas Intermediate (WTI) oil price proxies to show that the effect of oil prices on growth is independent of an oil proxy. Thus, overcoming the use of a single dimension or inadequate measures of oil price in the literature

The rest of the paper is divided as follows: Section two (2) discusses the relevant literature. Section three (3) dwells on the data and methodology. Section four (4) discusses the results. Section five (5) concludes the paper and offers recommendations for policy considerations.

2. Literature Review

GDP has been used since 1937 to measure economic growth (Masterson, 2022). Therefore, there has been a vast literature explaining economic growth across different countries. However, the literature review focuses on relevant studies related to the Ghanaian economy.

Physical capital and labor force are the growth model’s endogenous variables. Hence, every economic growth model incorporates them. Capital stock and the labor force generally have a positive effect on economic growth (Havi et al., 2013; Anthony et al., 2016; Bonga-Bonga and Ahiakpor, 2016; Adu, 2019). But Darko (2015) discovered a negative influence of capital stock on economic growth in Ghana. Also, Ho and Iyke (2020) documented a negative impact of labor on growth in Ghana. Studies, including Anthony et al. (2016), Ho and Iyke (2020), Havi et al. (2013), and Sakyi (2011), found that growth in Ghana is dependent significantly on foreign aid flowing into the country. They found foreign aid to have a significant positive impact on economic growth.

Foreign direct investment (FDI) is demonstrated by a few studies to have a growth-enhancing effect. Joseph Magnus and Eric Fosu (2006) documented evidence that indicated no causality between FDI and economic development in Ghana during pre-SAP, while they reported causality between FDI and economic growth during the post-SAP period. Antwi et al. (2013)'s and Anthony et al. (2016)'s studies presented similar conclusions, showing that the FDI is a positive driver of economic growth in Ghana in both the short and long run. Havi et al. (2013) also indicated FDI is a significant driver of economic growth.

Another strand of the literature discussed financial development's growth effect in Ghana. Adu et al. (2013) indicated that the effect of financial development on growth depends on the choice of financial development proxy. Using the ratio of credit to private sector GDP, or total domestic credit, as a proxy of financial development led to a positive and statistically significant impact. But when the ratio of the broad money supply to GDP was used to proxy financial development, a significant negative impact emerged. Asuamah and Ohene-Manu (2015) also found a negative effect when financial development was measured by money supply. Idun and Aboagye (2014) found similar results that financial innovation is positively (negatively) related to economic growth in the short run (long run). Idun and Aboagye (2014) also found that bank competition only impacts growth positively in the long run. The Granger causality test results indicated a bidirectional causality between financial development and growth, and a unidirectional causality running from bank competition to economic growth. On the contrary, Ho and Iyke (2020) found a negative impact of financial development on economic growth in the short and long run.

Economic Growth may depend on the expenditure of the government fiscal policy measures. A significant positive growth effect of the gross government expenditure was recorded by Havi et al. (2013), Anthony et al. (2016), Ho and Iyke (2020), Asuamah and Ohene-Manu (2015), and Sakyi and Adams (2012), whilst a negative effect was discovered by Alhassan et al. (2012) and Darko (2015) in their studies.

The literature also shows inflation might encourage or hinder economic growth in the Ghanaian economy. Havi et al. (2013) reported that in the long run, military rule and consumer price index are significant negative drivers of economic growth in Ghana. Bonga-Bonga and Ahiakpor (2016)'s findings showed inflation is a significant driver of economic growth in Ghana. Ho and Iyke (2020) and Alhassan et al. (2012) discovered inflation negatively affects the growth of output. Contrarily, Asuamah and Ohene-Manu (2015) demonstrated that inflation benefited the growth of the Ghanaian economy.

Additionally, Moral-Benito (2012) discovered that the price of investment goods, political rights, and globalization are the most robust determinants of growth for seventy-three countries. Abrams and Lewis (1995) used a similar panel approach to reveal that culture, political and economic arrangements, and personal freedoms are statistically significant determinants of economic growth. They found convergence for their hypothesis, thus, other things being equal, lower-income countries grow more rapidly than higher-income countries. In the same panel approach, Raggl (2014) indicated that between 2005 and 2009, there was no improvement in the determinants of economic growth. Again, GDP per capita was projected to stagnate at approximately 4.5% for the next three decades after 2009.

Barro (2003) revealed that disparities in per capita growth rates are systematically related to a set of quantitative explanatory variables, and further showed that the growth rate exhibits a conditional convergence effect. The study concluded that growth is boosted by favorable changes in trade conditions and increased international openness, albeit the latter effect is limited. Sakyi (2011)'s study also obtained evidence showing that economic growth, in the considered post-liberalization period, depended significantly on openness, and the interactions between foreign aid and openness in both the short run and long run had an impact. Ho and Iyke (2020) revealed that in the long run human capital has a significant positive influence on economic growth in Ghana. Contrarily, the study reported a significant negative correlation between debt servicing on output growth. Asuamah and Ohene-Manu (2015) demonstrated that trade liberalization policies benefited the Ghanaian economy, but investment did not. Alhassan et al. (2012) empirically found that export and human resources development affected growth positively.

Bonga-Bonga and Ahiakpor (2016) found that population growth, current account balance, population density, and crop rotation are significant drivers of economic growth in Ghana. Adu (2019) obtained evidence that shows terms of trade and investment rate have a robust significant positive impact on economic growth. Mends-Brew et al. (2012) modeled economic growth in Ghana between the period 1991 and 2011 in the framework of the Augmented Cobb-Douglas production function. They reported that the average simulated growth rate within the period was 4.21% as against the actual growth rate of 4.5%. They also reported a weak correlation of 0.298 between the actual and the simulated growth rate, which indicated an economic relationship between actual and calculated rates of economic growth.

Darko (2015) found that variables such as mineral rent, oil, and exports drive output growth in Ghana. The study also noted that economic growth in Ghana depends on the uncertainties associated with the volatilities in the prices of primary exports of the country. Thus, the volatility in commodity prices may hinder economic growth because of the so-called Dutch disease. Czech and Imbeah (2019) found that oil exports in Ghana significantly affect macroeconomic indicators (exchange rate, government expenditure, rural population, and total reserves minus gold), and economic sectors (agricultural and industry). However, they found no significant relationship between crude oil exports and real GDP growth. Likewise, Awunyo-Vitor et al. (2018) discovered that oil prices negatively affect economic growth in the long run, but insignificantly. They further reported a unidirectional causality between oil prices and economic growth. Only Darko (2015) and Awunyo-Vitor et al. (2018) discussed the oil price-economic growth nexus in Ghana, but for periods that do not capture some important developments in the oil industry. This study, therefore, adds new insights into short and long-run relationships between oil prices and economic growth by extending the data to cut across the important developments in the oil industry of Ghana, thus filling a huge deficiency in the literature.

3. Data and Methodology

3.1. Data Description

The study employs annual data, covering the period from 1987 to 2020. After 1983, fiscal discipline had restored, following the structural adjustment package or the ERP instituted with International Monetary Fund (IMF) financing (Overseas Development Institute, 1993). The study, therefore, focuses on the post-ERP era, but the upper and lower limits are constrained by data accessibility. The oil price (OP) is proxied by Brent-Europe in dollars per barrel which is the unweighted average of the daily closing spot prices. The dependent variable is the real gross domestic product (GDP) per capita at constant prices in local currency (Ghana Cedis). The control variables include, for instance, physical capital (K), which is the gross fixed capital formation as a share of GDP; labor force (L); government expenditure (GE), measured as a share of GDP; population growth (POP) is in annual growth rate. Data are collected from World Development Indicators (WDI) and Federal Reserve Economic Data (FRED). The summary statistics and correlation matrix are reported in Tables 1 and 2.

Table 1. Time Series Summary Statistics

Time Series	**lnGDP**	**lnK**	**lnL**	**lnOP**	**lnPOP**	**lnGE**
Mean	8.087796	2.942539	3.797958	3.600128	0.922462	2.289433
Median	7.995975	3.014695	3.639076	3.503257	0.910596	2.280687
Maximum	8.600533	3.367370	4.313205	4.715190	1.064232	2.728386
Minimum	7.715052	2.337983	3.505504	2.546315	0.756480	1.939756
Std. Dev.	0.289825	0.289093	0.287090	0.694432	0.091979	0.222126
Skewness	0.476408	-0.476082	0.670144	0.198212	0.090094	0.131440
Kurtosis	1.758706	2.157778	1.796859	1.601684	2.100629	2.064011
Jarque-Bera	3.468948	2.289269	4.595554	2.992622	1.191893	1.339009
Probability	0.176493	0.318340	0.100482	0.223955	0.551041	0.511962
Sum	274.9851	100.0463	129.1306	122.4044	31.36371	77.84072
Sum Sq. Dev.	2.771961	2.757973	2.719878	15.91377	0.279182	1.628219
Observations	34	34	34	34	34	34

Table 2. Time Series Correlation Matrix

Time Series	lnGDP	lnK	lnL	lnOP	lnPOP	lnGE
lnGDP	1					
lnK	0.03793	1				
lnL	0.36594	0.01002	1			
lnOP	0.37865	-0.09060	0.03003	1		
lnPOP	-0.16533	-0.14007	0.04480	0.22776	1	
lnGE	0.32521	0.15757	0.04408	0.24684	-0.07050	1

3.2. Theoretic and Econometric Model

This sub-section describes both the empirical model and the estimation strategy. The Autoregressive Distributed Lag (ARDL) method and bounds test are more suitable for studying the long-run and short-run relationships between variables, especially when the variables are not strictly stationary (Sakyi, 2011; Sakyi and Adams, 2012; Alhassan et al., 2012; Abdul-Rahman et al., 2020). This is because the ARDL approach not only assumes a mixed order of integration between the variables when the stationarity test results show the combination of the I(0) and I(1) series, but it also provides a quite straightforward interpretation in a single equation (Abdul-Rahman et al. 2020). Besides, the method is asymptotically efficient in finite and small sample studies, and applicable even when the regressors are endogenous (Sakyi, 2011), with the current study involving only thirty-three observations. In an augmented production function, this study follows the country-level empirical growth model formulation, as alluded to by Sakyi and Adams (2012) and Alhassan et al. (2012), of the following specification:

$$Y_t = f(A_t, K_t, L_t) \quad (1)$$

where Y_t is the GDP per capita, K_t is the physical capital, L_t is the force, and A_t measures the total factor productivity (i.e., the growth in GDP per capita) not captured by growth in capital and labor. In this model, all factors of production can be accumulated, implying that long-run growth effects are due to the overall incentive to accumulate capital and the distortion of resource allocation (Alhassan et al., 2012). The approach also makes it easier to simultaneously study the roles of various variables that some of the new growth theories have identified as important growth determinants (Alhassan et al., 2012). Here, it is assumed that total factor productivity (A_t) in Ghana is determined by several policy variables, including oil prices (OP_t), population (POP_t) and government expenditure (GE_t), From equation (1), substituting for (A_t) yields,

$$Y_t = g(K_t, L_t, OP_t, POP_t, GE_t) \quad (2)$$

Therefore, we estimate a long-run growth model of the following form:

$$lnGDP_t = \alpha_0 + \alpha_1 lnK_t + \alpha_2 lnL_t + \alpha_3 lnOP_t + \alpha_4 lnPOP_t + \alpha_5 lnGE_t + \varepsilon_t \quad (3)$$

where ln symbolizes the natural logarithm, all variables are as previously defined, with the real GDP_t per capita, representing economic growth. α_1, α_2, α_3, α_4, and α_5 are long-run economic growth elasticities, corresponding to physical capital, labor force, oil prices, population growth, and government expenditure, respectively. ε_t is the error term. α_0 is the intercept. Though the literature for Ghana has obtained mixed signs for α_1 and α_2, the theoretically expected signs are positive—and negative for α_4. α_3 and α_5 are unknown for Ghana as their growth effect depends on several factors, given the uncertainty of Ghana's position in the oil market. To achieve the objective of the study, introducing the short-run and long-run dynamics into equation (3) yields an ARDL representation of equation (3) in the following specification:

$$\Delta lnGDP_t = \beta_0 + \beta_1 lnGDP_{t-1} + \beta_2 lnK_{t-1} + \beta_3 lnL_{t-1} + \beta_4 lnOP_{t-1} + \beta_5 lnPOP_{t-1} + \beta_6 lnGE_{t-1} + \sum_{i=1}^{p} \beta_7 \Delta lnGDP_{t-i} + \sum_{i=1}^{q_1} \beta_8 \Delta lnK_{t-i} + \sum_{i=1}^{q_2} \beta_9 \Delta lnL_{t-i} + \sum_{i=1}^{q_3} \beta_{10} \Delta lnOP_{t-i} + \sum_{i=1}^{q_4} \beta_{11} \Delta lnPOP_{t-i} + \sum_{i=1}^{q_5} \beta_{12} \Delta lnGE_{t-i} + \varepsilon_t \quad (4)$$

where β_0 is the intercept term; β_1, β_2, β_3, β_4, β_5, and β_6 denote long-run elasticities; β_7, β_8, β_9, β_{10}, β_{11}, and β_{12} denote short-term elasticities; Δ is the first difference operator. Next, by estimating equation (4) the bounds test is used to test the null hypothesis of no cointegration by restricting the coefficients of the lagged level variables equal to zero, H_0; $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, which implies no long-run relationship, and it is tested against the alternative H_1; $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$ which implies a cointegration relationship exists among the series. The decision is guided by the Wald test-based F-statistic for cointegration, comparing the asymptotic critical value of the F-statistic with a set of I(0) and I(1) table values (Pesaran et al., 2001). The H_0 cannot be rejected if the computed F-statistics value is lower than the I(0) bound critical value; therefore, the outcome will be no long-run relationships among the time series. On the contrary, if the computed F-statistics value exceeds the upper bound [I(1)] critical value, H_0 will be rejected, indicating a long-run relationship. The decision, however, is inconclusive if the computed value falls between I(0) and I(1) bounds table values, where additional information will be needed to make a conclusive inference (Pesaran et al., 2001). Finally, the unrestricted error correction model will be estimated to obtain the short-run dynamics and the speed of adjustment coefficient in the case of a cointegration relationship.

4. Results and Discussions

4.1. Unit Root Test

To assess the order of integration of the time series, Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and the Phillip-Perron (PP) (Phillips and Perron, 1988) unit root tests are conducted, and Table 3 reports the results obtained from the ADF and PP tests, respectively. The results reported in Table 3 show all the time series are integrated of the first order except the government expenditure, which is level-stationary. Thus, both tests are unable to reject the unit root null hypothesis for all the time series except the log of government expenditure (lnGE). This implies the analysis comprises a mixture of I(0) and I(1) time series.

Table 3. Augmented Dickey-Fuller (ADF) and Phillips-Perron(PP) unit root test results.

ADF unit root test results					
Time series	ADF at level		ADF at first difference		Decision
	Constant	Linear time trend	Constant	Linear time trend	
lnGDP	1.256452	-1.256371	3.2888**	-3.7748**	I(1)
lnK	-2.9464*	-2.6173	-5.8565***	-5.9010***	I(1)
lnL	1.4154	-1.3111	-1.8193	-7.8812***	I(1)
lnOP	-1.0823	-1.8586	-5.0457***	-4.9727***	I(1)
lnPOP	-0.805127	-2.946296	-3.2427**	-3.1666	I(1)
lnGE	-3.7722***	-3.9626**			I(0)
PP unit root test results					
Time series	PP at level		PP at first difference		Decision
	constant	Linear time trend	constant	Linear time trend	
lnGDP	2.4414	-0.7008	-3.2888**	-3.7542**	I(1)
lnK	-2.7695*	-2.6703	-5.6901***	-5.7327***	I(1)
lnL	1.432524	-1.268151	-6.5778***	-7.6016***	I(1)
lnOP	-1.2525	-1.4601	-4.6537***	-4.6576***	I(1)
lnPOP	-0.7518	-1.9662	-4.2457***	-4.2065**	I(1)
lnGE	-3.8289***	-3.9521**			I(0)

Note: “*” “**” and “***” indicate the rejection of the null hypothesis at 10%, 5%, and 1%

The unit root tests are complemented by a stationary test for robustness. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test is, therefore, considered a suitable complement for unit root tests not only because it directly tests the stationarity, but especially because it can be used for shorter time series (Arltová and Fedorová, 2016). Table 4 presents the KPSS stationarity test results. For GDP per capita (lnGDP), physical capital (lnK), the labor force (lnL), and oil price (lnOP), the null hypothesis of stationarity was rejected at a 5% level of significance. For Government expenditure (lnGE), we failed to reject the null of stationarity at a 5% significance level, which confirms that our analysis involves I(0) and I(1) time series. As a result, using the ARDL approach in conducting the estimations leads to a robust outcome since it accounts for both I(0) and I(1) time series in the cointegration testing. Further, to account for the existence of structural changes in the time series, the breakpoint unit root test is applied (see the results in the lower panel of Table 4), and the results are similar to the results of the ADF, PP, and KPSS tests, indicating no presence of structural changes within the sample period.

Table 4. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and Structural Break Unit Root Test Results

Time series	KPSS at level		KPSS at first difference		Decision
	constant	Linear time trend	Constant	Linear time trend	
lnGDP	0.701465**	0.176857**	0.322279	0.102166	I(1)
lnK	0.481702**	0.204695**	0.239818	0.062469	I(1)
lnL	0.816353***	0.246861***	0.447818	0.089968	I(1)
lnOP	0.746946***	0.147908**	0.163771	0.106293	I(1)
lnPOP	0.670959**	0.159928**	0.071513	0.071760	I(1)
lnGE	0.404926*	0.034371			I(0)
Structural break unit root test					
Time series	At level		At difference		Decision
	constant	Linear time trend	Constant	Linear time trend	
lnGDP	-1.548731	-3.619248	-7.683900***	-7.616329***	I(1)
lnK	-3.309412	-4.197132	-6.902963***	-7.218094***	I(1)
lnL	-2.549420	-2.831074	-9.623598***	-10.27581***	I(1)
lnOP	-1.223942	-2.516689	-6.136279***	-6.311982***	I(1)
lnPOP	-4.189319	-1.310229	-6.099041***	-8.252855***	I(1)
lnGE	-5.044956***	-4.905460***			I(0)

Note: “*”, “**”, and “***” indicate the rejection of null hypothesis at 10%, 5%, and 1%

4.2. *The ARDL Bounds Cointegration Test*

The bounds test is used to assess the existence of a long-run cointegration relationship between economic growth proxy and independent variables because the time series is a blend of I(0) and I(1). The Schwarz Information Criterion (SIC) is applied to determine the lag length for the variables in the model, where an ARDL (1, 1, 1, 0, 2, 1) model is selected. By estimating Equation 4, the bounds test is conducted as the results are displayed in Table 5. Then the null hypothesis H_0; $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ is tested against the alternative H_1; $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$. The null hypothesis is rejected because the F-statistic (9.570) is above the I(1) of Pesaran et al. (2001) table critical values. Hence, the results indicate a long-run cointegration relationship between economic growth and lnK, lnL, lnOP, lnPOP, and lnGE, implying there exists a common stochastic trend of the time series in the long run.

Table 5. Bounds Test Results

Model	F-statistic	5% Bounds critical values Lower Bound [I(0)]	Upper Bound [I(1)]	Outcome
ARDL(1, 1, 1, 0, 2, 1) k=5	9.569853	2.62	3.79	Cointegration

Note: I(0) and I(1) are F-bounds critical values at a 5% significance level computed by Pesaran et al. (2001) for Case III.

As a long-run relationship exists between economic growth and the independent variables in the model, the long-run coefficients are obtained and reported in Table 6. The relevant diagnostic tests show the validity of the model. According to the results, the labor force (lnL), oil prices (lnOP), and gross government expenditure (lnGE) are positively and significantly related to economic growth. The results imply that a percentage increase in the labor force instigates about a 0.60% increase in economic growth in Ghana in the long run. Accordingly, since the labor force is a direct input in the aggregate production function, and since aggregate production is assumed to be monotonic, an increase in the labor force leads to an increase in production, all other things remaining equal. Sakyi and Adams (2012) and Anthony et al. (2016) reported a similar positive influence of the labor force on growth in Ghana. However, the findings documented by Havi et al. (2013) and Bonga-Bonga and Ahiakpor (2016) that shows the negative influence of the labor force on economic growth contradict our results. Further, a 1% increase in government spending boosts the economy by 0.22%. Havi et al. (2013), Anthony et al. (2016), Ho and Iyke (2020), and Sakyi and Adams (2012) reported similar findings in their studies. However, Alhassan et al. (2012) and Darko (2015) contradict the current results.

Additionally, oil prices exert a significant long-run impact on economic growth in Ghana. A 1% increase in oil prices causes the GDP to increase by 0.07% in the long run, statistically significant at 1%. Per the prior expectation, the impact of oil prices depends on the position of the country in the oil market, which is whether the country is a net exporter or importer. For net oil exporters, a positive effect is expected while a negative effect is expected for net oil importers. The positive impact on Ghana is not surprising, given that oil extraction in Ghana started in commercial quantities after 2010. This is evidenced in the growth trends of GDP with oil and GDP without oil in Figure 1. The positive impact of the oil price might have emerged due to the discovery of the TEN and SG-N oil fields in 2016 and 2017, respectively. The statistical significance of the effect of oil price change on GDP per capita suggests the government should reduce over-reliance on oil revenues to avoid the Dutch disease phenomena. Bercement et al. (2009) discovered that in the Middle East and North Africa (MENA) countries an increase in oil prices had a statistically significant and positive impact on the output of Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria, and the UAE. Aliyu (2009) also found oil price shocks to have both linear and non-linear effects on real GDP. Bercement et al. (2009) and Aliyu (2009)'s results support the findings of this study. Additionally, Darko (2015)'s findings, which show oil rent drives economic growth in Ghana positively, support our current results. On the contrary, Awunyo-Vitor et al. (2018) findings contradict our findings. They documented a negative and insignificant impact of oil prices on economic growth in Ghana, however, with a sample (1970-2012) period that covered only the period before the discovery of oil in commercial quantities.

Table 6. Long-run results

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	2.489186	0.810319	3.071860	0.0058
lnK	-0.191327	0.092056	-2.078380	0.0501
lnL	0.599431	0.064574	9.282798	0.0000
lnOP	0.069769	0.024070	2.898640	0.0086
lnPOP	-1.845556	0.369731	-4.991614	0.0001
lnGE	0.215442	0.095698	2.251272	0.0352

Despite Ghana supposedly being a net importer of oil, on the supply side, a high rate of oil prices shores up the international reserve, which consequently helps to provide resilience in times of economic downturns or shocks, streamlining economic activities in the long run. This is broadly consistent with the long-run results of the study, which show that the impact of oil prices is positive and statistically significant. Therefore, it is expected that a windfall from the petroleum sector can be used to significantly make up for revenue shortfalls, which will help cushion the economy, as recently corroborated by the finance minister in the mid-year budget statement (Business & Financial Times, 2022).

On the contrary, population growth (lnPOP) and physical capital (lnK) are negatively, and statistically significantly, related to economic growth in Ghana. It is revealed that a percentage increase in the population of the country results in about a 1.85% decrease in the GDP per capita growth in Ghana. This finding implies that higher population growth reduces capital per capita growth while maintaining the same level of human and physical capital, thereby lowering output per capita (Ho and Iyke, 2020). Additionally, physical capital significantly reduces economic growth by a 0.19% per unit increase. Darko (2015) finds a similar negative impact of physical capital on economic growth in Ghana. This result contradicts Ho and Iyke (2020)’s, Havi et al. (2013)’s and Anthony et al. (2016)’s findings.

4.3. The Short-run and Error Correction Model

Now the short run and the error correction model (ECM) results are analyzed as reported in Table 7. The relevant diagnostics tests including serial correlation test, heteroscedasticity test, stability test, and normality test are conducted on the ECM to ensure the validity of our results. The ECM results in Table 7 indicate a significant model and a high explanatory power of 78% of the time series included in the model. In the short run, oil price (lnOP), the labor force (lnL), and government expenditure (lnGE) are positively related to economic growth in a significant way. The results show that a 1% increase in lnL, lnOP, and lnGE induce about 0.25, 0.03, and 0.03 percent increase in the growth of the GDP per capita in the short run, respectively. Concerning labor, Ho and Iyke (2020) find a negative influence of labor on growth in the short run, which contradicts the current results. However, our short-run results of a significant impact of government expenditure on growth are supported by Ho and Iyke (2020)’s findings. On the contrary, physical capital (lnK) and population growth (lnPOP) are negatively influencing economic growth in the short run but insignificantly.

Additionally, the error correction term (ECT) coefficient is negative as shown in Table 7. The negative of the error correction term implies adjustment of errors in the long run. It measures how much short-run deviations are corrected in the long run. It thus implies a 44% of short-run errors are corrected in the long run.

Table 7. Short-run and Error Correction Results

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	0.011825	0.005194	2.276442	0.0346
D(lnGDP(-1))	0.240576	0.143560	1.675785	0.1102
D(lnK)	-0.014399	0.013706	-1.050581	0.3066
D(lnK(-1))	-0.022134	0.014001	-1.580857	0.1304
D(lnL)	0.252333	0.063712	3.960534	0.0008
D(lnL(-1))	0.048269	0.076123	0.634087	0.5336
D(lnOP)	0.030898	0.011998	2.575358	0.0185
D(lnPOP)	-0.752110	0.973688	-0.772434	0.4494
D(lnPOP(-1))	0.215183	1.712489	0.125655	0.9013
D(lnPOP(-2))	0.217673	1.061742	0.205015	0.8397
D(lnGE)	0.033076	0.014253	2.320706	0.0316
D(lnGE(-1))	0.042144	0.015736	2.678164	0.0149
ECT(-1)	-0.435644	0.171754	-2.536434	0.0201
Diagnostics test and regression statistics				
Test	**F-statistics**	**Prob.**		
Serial correlation LM	4.218539	0.1213	CUSUM	State
Heteroscedasticity	7.507409	0.8223	CUSUMSQ	State
Normality	1.3817	0.501	R-squared	0.780294
F-statistic	5.623261	0.000457	Adj. R-squared	0.635266

Also in Table 7, the diagnostic tests that are conducted to make sure the assumptions made about the error term hold are reported. The uncorrelated errors assumption is verified by using the serial correlation LM test. The no serial correlation null hypothesis could not be rejected at all levels of significance. Hence the random errors are free from serial correlation. Additionally, the Breusch-Pagan-Godfrey heteroscedasticity test indicates a rejection of the null hypothesis of heteroscedasticity that indicates homoscedastic error terms. The normality test also confirms the errors are normally distributed. Nevertheless, the cumulative sums (CUSUM) and the cumulative sum of squares (CUSUMSQ) test as in Figure 2 and Figure 3, respectively, show the estimated parameters are stable.

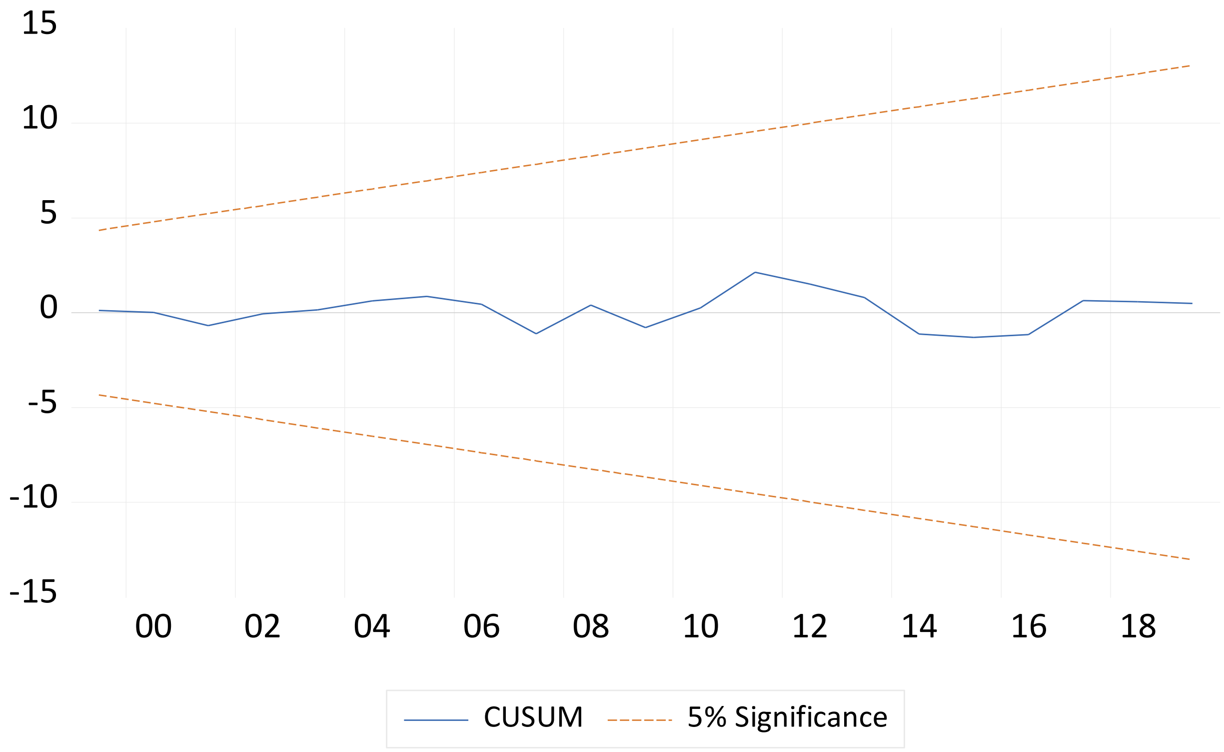


Figure 2. CUSUM Graph

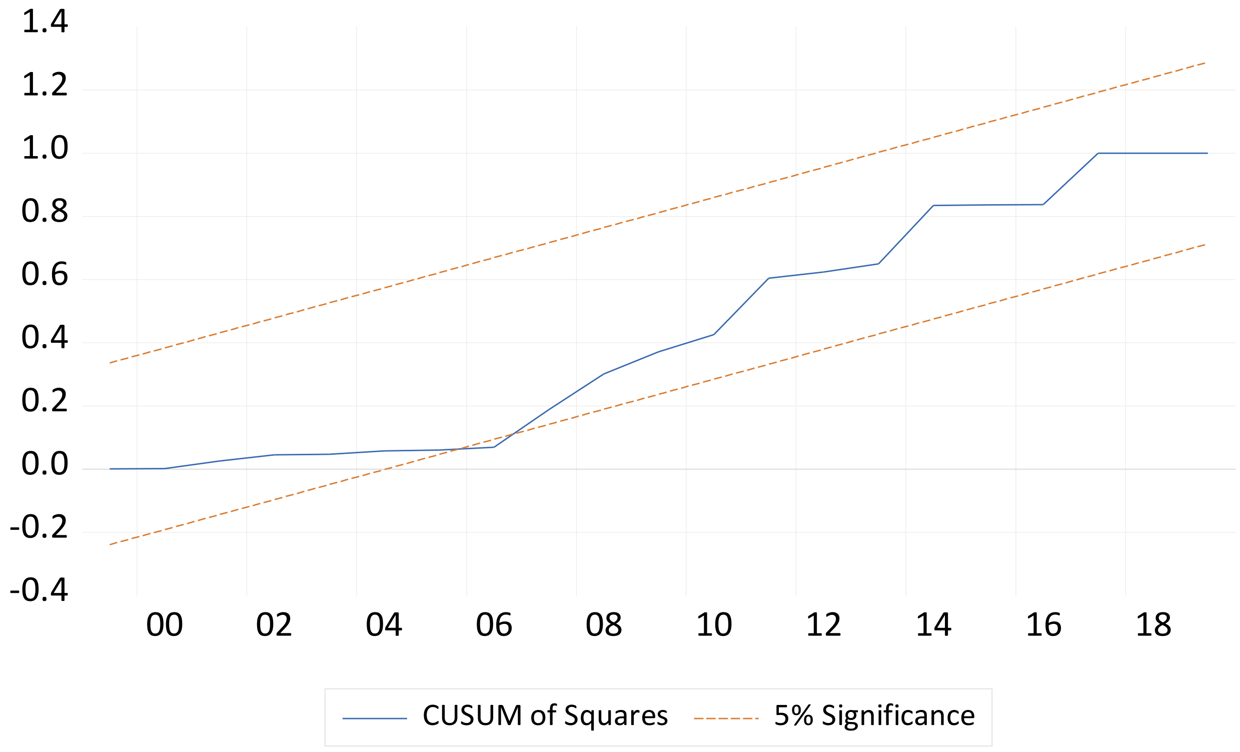


Figure 3. CUSUMSQ Graph

Besides the CUSUM and CUSUM square structural stability test, the study introduces a structural dummy as an exogenous regressor since the ARDL approach accommodates exogenous regressors in the cointegration testing (Pahlavani et al., 2005; Pesaran and Smith, 1998). The dummy variable takes a value of zero before commercial production of oil began in 2011 and one afterward. After introducing the dummy variable into the baseline model, the cointegration relationship between the variables persists and there is not any significant change in the main findings of the study as presented in Table 8. The long and short-run impact multipliers are 0.07 and 0.03, respectively, which are approximately equal to the impact multipliers reported from the primary model.

Table 8. Long run, Short run, and Error Correction Model Results with Structural Dummy Variable as a Fixed Regressor

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long run results				
Constant	3.281681	0.969507	3.384896	0.0033
lnK	-0.089588	0.074759	-1.198357	0.2463
lnL	0.410757	0.131626	3.120641	0.0059
lnOP	0.074305	0.022209	3.345690	0.0036
lnPOP	-1.469255	0.306129	-4.799456	0.0001
lnGE	0.026058	0.113506	0.229574	0.8210
Short run and error correction model results				
Constant	0.012640	0.005587	2.262279	0.0371
D(lnGDP(-1))	0.245728	0.168393	1.459257	0.1627
D(lnK)	-0.017988	0.014843	-1.211863	0.2421
D(lnK(-1))	-0.025271	0.016959	-1.490125	0.1545
D(lnL)	0.260981	0.076307	3.420158	0.0033
D(lnL(-1))	0.037148	0.086363	0.430132	0.6725
D(lnL(-2))	-0.026932	0.072174	-0.373153	0.7136
D(lnOP)	0.034064	0.013177	2.585032	0.0193
D(lnPOP)	-0.804767	1.019045	-0.789727	0.4406
D(lnPOP(-1))	0.078020	1.805717	0.043207	0.9660
D(lnPOP(-2))	0.429033	1.146858	0.374095	0.7130
D(lnGE)	0.035350	0.016076	2.198945	0.0420
D(lnGE(-1))	0.047641	0.017952	2.653851	0.0167
D(lnGE(-2))	0.009724	0.020381	0.477123	0.6394
ECT(-1)	-0.537531	0.213031	-2.523250	0.0219

4.4. Sensitivity Analysis

The validity of the ARDL approach depends on the lag order selected for each of the variables in the model. The SIC was used to select the lag order since it gives the most parsimonious model by avoiding the inclusion of unnecessary lags in the baseline model. But we control for the sensitivity of the estimated model by again using the Hannan-Quinn criterion (HQ) and Akaike Information Criterion (AIC) for the lag selection procedure for robustness. The long-run results are reported in Table 9. Again, the results from HQ and AIC criteria confirm the existence of a long-run cointegration relationship between the GDP per capita and independence variables with unchanged signs of elasticities. All the long-run coefficients remain statistically significant at a given level of significance, thus confirming the benchmark results.

Table 9. Long-run Sensitivity Analysis Results

Variable	HQ	AIC
Constant	2.489186 (3.071860)**	1.906918 (1.971564)*
lnK	-0.191327 (-2.078380)*	-0.338456 (-1.902687)*
lnL	0.599431 (9.282798)***	0.579625 (7.462393)***
lnOP	0.069769 (2.898640)***	0.101918 (2.094548)**
lnPOP	-1.845556 (-4.991614)***	-2.349211 (-4.031505)***
lnGE	0.215442 (2.251272)**	0.367898 (2.026229)**

Note: Numbers in brackets are the t-statistics. "*" "**" and "***" indicates the significance of coefficients at 10% 5%, and 1%, respectively.

Additionally, the sensitivity results for the short-run and error correction model are like the benchmark error correction model estimation results as shown in Table 10. The results from both lag selection criteria are similar and consistent with the main results with the same signs of elasticities. Again, oil price exerts a significant short rum influence on economic growth according to the results from both HQ and AIC procedures. The ECT coefficients have the right signs and are statistically significant. This implies that our results are not sensitive to the lag selection procedure used in the benchmark model estimation.

Table 10. Short-run and Error Correction Sensitivity Analysis Results

Variable	HQ	AIC
Constant	0.011825** (2.276442)	0.009839* (1.810070)
D(lnGDP(-1))	0.240576 (1.675785)	0.196226 (1.329890)
D(lnGDP(-2))		0.213728 (1.146303)
D(lnK)	-0.014399 (1.050581)	-0.020924 (-1.419792)
D(lnK(-1))	-0.022134 (-1.580857)	-0.026073* (-1.822558)
D(lnL)	0.252333*** (3.960534)	0.206380** (2.757803)
D(lnL(-1))	0.048269 (0.634087)	0.019615 (0.246623)
D(lnOP)	0.030898** (2.575358)	0.031399** (2.636883)
D(lnPOP)	-0.752110 (-0.772434)	-0.751876 (-0.778549)
D(lnPOP(-1))	0.215183 (0.125655)	0.218086 (0.128398)
D(lnPOP(-2))	0.217673 (0.205015)	0.259179 (0.245971)
D(lnGE)	0.033076** (2.320706)	0.040097** (2.602673)
D(lnGE(-1))	0.042144** (2.678164)	0.048479*** (2.927962)
ECT(-1)	-0.435644** (-2.536434)	-0.446961** (-2.619348)

Note: AIC-based ARDL (2, 1, 1, 0, 2, 1), HQ-based ARDL (1, 1, 1, 0, 2, 1). Numbers in (.) denote the t-statistics. "*" "**" and "***" indicate the significance of coefficients at 10% 5% and 1%, respectively

Are the results sensitive to the oil price measure? This question is answered by estimating the model, using the West Texas Intermediate (WTI) oil price proxy, as reported in Table 11. The long-run coefficients are consistent with the baseline estimation results. In the long run, oil price significantly derives economic growth by 0.21% per unit increase. The short-run estimated coefficient is also significant and positive. About 0.03% variation in economic growth is caused by oil price per 1%-unit increase. This implies our results are robust for oil price proxy.

Table 11. Long-run and Short-run Estimation Results with WTI Proxy

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Long-run estimation results				
Constant	0.905239	0.567205	1.595965	0.1221
lnK	-0.340568	0.304626	-1.117987	0.2734
lnL	0.572637	0.149146	3.839427	0.0007
lnOP_WTI	0.211080	0.122570	1.722116	0.0965
lnPOP	-2.079408	0.997456	-2.084712	0.0467
lnGE	0.407663	0.337412	1.208204	0.2374
Short-run and ECT estimation results				
Constant	0.007914	0.004980	1.589129	0.1246
D(lnGDP(-1))	0.406138	0.142783	2.844446	0.0087
D(lnK)	-0.008761	0.013910	-0.629824	0.5345
D(lnL)	0.202851	0.072110	2.813055	0.0094
D(lnOP_WTI)	0.029685	0.012720	2.333812	0.0279
D(lnPOP)	-0.363931	0.228487	-1.592791	0.1238
D(lnGE)	0.040182	0.015920	2.523977	0.0183
ECT(-1)	-0.290887	0.135841	-2.141371	0.0422
Diagnostic test and regression statistics				
Test	**F-statistics**	**Prob.**		
Serial correlation LM test	2.899980	0.088	CUSUM test	stable
Heteroscedasticity test	5.480257	0.4838	CUSUMSQ test	Stable
Normality test	0.317	0.853	R-squared	0.576
f-statistics	4.860	0.001	Adj. R-squared	0.459

5. Conclusion

The study aimed to employ the ARDL and the bounds test approaches to investigate the short- and long-run relationships between economic growth and oil prices in Ghana, using physical capital, labor force, population growth, and government expenditure as control variables, with yearly data that ranges from 1987 to 2020. The bounds cointegration test results show a long-run cointegration relationship between economic growth and indicators such as physical capital, labor force, oil prices, population growth, and government expenditure. The study discovered convincing evidence of a positive and significant impact of oil prices on economic growth in Ghana in the short and long runs. The robustness-test results confirm that the oil price effect on economic growth is independent of the oil price proxy. Additionally, the labor force and government spending are significant positive determinants of economic growth in the short and long runs. Whereas physical capital and population growth significantly retard economic growth in the short and long runs, the coefficient of the error correction term is negative and statistically significant, implying that short-run shocks are corrected and equilibrium in the system is re-established in the long run. Conducting sensitivity analysis enforces the robustness of the findings; thus, the findings are not accidental. The considerable positive influence of oil prices on economic growth has policy implications. The results imply that economic growth policies could be geared towards reducing the over-reliance on oil revenues to avoid the Dutch disease phenomenon due to the volatile nature of oil prices. Nevertheless, policymakers should strategize well enough by encouraging more local participation in the oil sector to avoid the risk of falling victim to the Dutch disease.

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