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Original Article

Effect of Liquefied Natural Gas Exports on the Nigeria Economy: An ARDL Model Approach

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Abstract *- This study examines the effect of Liquefied Natural Gas (LNG) export on the economy of Nigeria from 2000-2021 using biannual data in an Autoregressive Distributed Lag model. The model incorporates Liquefied Natural Gas (LNG) exports, crude oil prices, natural gas prices, and Gross Domestic Product (GDP). The study activity included the collection and use of secondary data and the performance of a unit root test on such data to validate their stationarity and co-integration test to investigate the variables' long-run and short-run relationships. The findings indicate a significant and favourable correlation between LNG exports and the Nigerian economy (proxied by GDP). In the long run, LNG exports have a positive and significant influence on the economy at the 1% significance level, and a 1% rise in LNG export from Nigeria would result in a 0.72% gain in GDP. In the short run, there is a positive and strong association between LNG and the Nigerian economy, such that a 1% rise in LNG exports would result in a 0.23% gain in GDP. As a result, the Nigerian government should enhance investments in the natural gas sub-sector to assure a consistent and continuous supply of natural gas to the country's LNG facilities it is recommended that a proactive strategy should be implemented to encourage investment in floating LNG plants in regions and locations where laying a pipeline is uneconomical. This can convert stranded gas reserves to LNG for export and transform these regions/areas into gas development hubs.*

Keywords *- ARDL, GDP, LNG exports, Natural gas price, Nigerian economy.*

1. Introduction

Nigeria houses the largest natural gas reserves in the African continent, nearly 200 trillion cubic feet, as reported by Statista in 2022. This figure represents approximately 3% of the global natural gas reserves that have been verified. The competition between producers in Africa and Europe has led to a notable decrease in natural gas prices, instigating price wars and shifting import-export routes. This has been documented in various studies [41]. The instability resulting from fluctuations in the natural gas market has negatively impacted the Nigerian economy's growth. This is particularly significant given that the country's oil and gas sector contributes to more than 95% of its foreign exchange earnings and 80% of its budgetary revenues [28]. At present, the non-oil sector accounts for the majority of the Gross Domestic Product (GDP), comprising approximately 93.67% of the total GDP, while the oil sector represents only 6.33% of the total GDP.

The non-oil sector encompasses a range of economic activities, including but not limited to extraction and excavation, information and communication, agriculture, manufacturing, trade, as well as financial and insurance services. The category of extracting and digging is significant and encompasses activities such as coal extraction, exploration and exploitation of natural gas, excavation of metal ores, and other mining-related endeavours. The National Bureau of Statistics has reported that natural gas accounted for approximately 91.74% of the category in the second quarter of 2022. This is a noteworthy observation.

In recent years, the utilisation of natural gas as a primary energy source and supply has been deemed indispensable. There has been a deployment of advanced technologies in the exploitation, conveyance, and retrieval of these resources [48]. The transportation of natural gas has encountered significant limitations, including challenges related to pipeline transmission, pressure regulation, environmental impact assessment, and community issues arising from the terrain characteristics surrounding these factors. Consequently, there exists a necessity for technological advancements, such as the process of liquefying natural gas, which is commonly denoted as Liquefied Natural Gas (LNG), to facilitate its transportation. According to [48], utilising LNG to transport natural gas is considered the most cost-effective and efficient approach, thereby enhancing the capacity to deliver the product for exportation. LNG finds application in residential settings for the purposes of space heating and culinary activities.

Likewise, LNG is employed as a substitute for traditional fuels in automobiles [8]. It has been found to emit lower levels of carbon dioxide in comparison to other fossil fuels, thus presenting a promising prospect as the

global community transitions towards sustainable, efficient, and eco-friendly energy sources [43], [26], [50]. Hence, global economies are transitioning towards the utilisation of natural gas as a substitute for fossil fuels in order to comply with the Kyoto Protocol's mandate of reducing CO2 emissions [21]. Nigeria is confronted with a multitude of obstacles, including but not limited to gas flaring, which places the country in the second position globally after Russia, insufficient domestic demand for gas, gas pipeline vandalism, deficient gas infrastructure, and a dearth of incentives for development, among other issues [4]. Moreover, inadequate planning for domestic gas consumption led to the decision to export LNG. According to [17], it can be argued that there is a steady rise in population and the establishment of small and medium-sized enterprises within the nation. This trend has resulted in a heightened demand for energy resources, which has not been met with a corresponding increase in energy supply—consequently, the persistent reduction in economic growth and escalating reliance on petroleum as an energy source.

It is noteworthy that, in conceptual terms, the expansion of an economy is linked to the increase in the level of output or the increase in income, to state it more accurately [1]. The measurement of economic growth is based on various standards such as productivity level, trade statistics, and investments in physical and human capital [32]. According to reference [9], economic growth can be defined as a gradual improvement in a nation's capacity to produce goods and services that enhance the quality of life for its citizens as population indicators and diversity increase. According to [24], economic growth is characterised by a rise in a nation's output as measured by its Gross Domestic Product (GDP) or Gross National Product (GNP). Additionally, it pertains to the advancement in the standard of living of the population, which is gauged by the GNP per capita.

Scholars have reached a consensus that emerging economies rely on the exportation of their natural resources to generate revenue and foster economic development. Authors have endeavoured to establish correlations between the instability of natural resource prices and GDP growth [12]. According to his assertion, fluctuations in the prices of natural resources lead to a reduction in a nation's economic growth. The scholarly work of [45] demonstrates a lucid depiction of the negative impact of LNG exportation on the economy of the United States of America in the event of price instability. Additionally, the research emphasises that this could result in unemployment and excessive reliance on revenue generated from exporting natural resources. The study suggests diversifying the economy as a potential solution for the phenomenon commonly referred to as the "resource curse" or the "Dutch disease".

Numerous studies have been conducted in the academic literature, wherein empirical correlations have been utilised to establish connections between the export of natural resources, such as crude oil, and economic growth. Additionally, some studies have analysed the effects of gas production on a nation's gross domestic product. Nevertheless, the findings of this study exhibit contrasting characteristics. Thus, a comprehensive investigation is necessary to address the deficiencies in this field of study. The study conducted by [19] examined the relationship between oil trading and economic growth in Nigeria, with a particular emphasis on a disaggregated case. This study employed annual data spanning from 1986 to 2019 to evaluate the impact of crude oil trading on the economic development of Nigeria. The study employed error correction methodology (ECM) to model the relationship between the importation of diesel and economic growth. The findings revealed a statistically significant negative impact of diesel importation on the economy. The importation of premium motor spirit has had a significant and advantageous impact on the economic advancement of Nigeria. The study's results emphasised that oil export substantially influenced the economy's advancement. The authors have suggested that the restoration of local refineries would lead to an increase in production, specifically for domestic consumption. The study conducted by [22] utilised the Auto-Regressive Distributive Lag (ARDL) method to examine the short-term and long-term relationships between natural gas consumption and economic growth in Nigeria. The findings of the study suggest that the utilisation of natural gas for domestic purposes had a favourable effect on the Nigerian economy in both the short and long-term periods. However, statistical significance was observed only in the long-term runs. Therefore, enhancing the development of natural gas infrastructure for domestic consumption has the potential to stimulate economic growth.

A study was conducted by [49] to evaluate the impact of macroeconomic factors on the management of natural gas exports. The study employed Indonesia and South Korea as its primary case study, integrating secondary data sources spanning from 1995 to 2017. The analysis was conducted using the ARDL method. The findings of the study indicate that natural gas export was influenced by GDP per capita, natural gas prices, and domestic consumption in the short-term and long-term periods, with each variable having a significant impact in its respective time frame. The study conducted by [20] investigated the economic implications of gas production in Nigeria. The Ordinary Least Squares (OLS) technique was employed, along with the Augmented Dickey-Fuller test, to assess stationarity and the Johansen co-integration method to analyse long and short-term relationships. The study utilised data spanning from 1985 to 2020. The findings of the study revealed that there exists a positive correlation between economic growth and both the utilisation of gas and the flaring of gas. The challenge that the nation is currently encountering pertains to its incapacity to govern the domestic generation of gas. A study was conducted by [5] to examine the impact of oil rents on the economic productivity of Brunei Darussalam. The study utilised time series data spanning from 1990 to 2017. The study employed the ARDL and ECM models to examine the

relationship between oil exports and economic productivity over the short and long term. The findings indicate that the ECM model suggests a short-term relationship, while the ARDL model suggests a long-term relationship. The study's recommendation suggests that augmenting investments in the oil sector of Brunei Darussalam's economy would foster additional growth in its GDP.

The impact of crude oil, natural gas, and LNG prices on Malaysia's GDP was investigated [42]. The authors employed the ARDL method to conduct an analysis based on data spanning from 1987 to 2017. The study's results indicate that fluctuations in energy prices significantly impact both the short-term and long-term Gross Domestic Product (GDP), thereby exerting an influence on the overall economic stability. In a similar vein, the impact of oil revenue on economic growth was investigated by [13], with a specific focus on providing empirical evidence from Nigeria. The research employed Gross Domestic Product (GDP) information spanning from 1980 to 2017, and the analytical method of Autoregressive Distributed Lag (ARDL) was employed for the investigation. The research report revealed that the influence of oil revenue and oil rent on the Gross Domestic Product (GDP) was relatively weak in both the short and long term. Subsequent findings revealed that the variables had a diminishing effect on the economy's expansion. Therefore, it is recommended that diversification of the various sectors of the economy be pursued as a pragmatic approach towards improving the nation's overall economic performance.

The impact of imports and exports on the Gross Domestic Product (GDP) of Egypt was examined by [47]. The study employed the autoregressive distributed lag (ARDL) approach, utilising gross domestic product (GDP) data spanning from 1980 to 2010. The study revealed the presence of a sustained correlation between the economic expansion in Egypt and the fluctuations in market prices. Consequently, the impact of the export and import of commodities and services on Egypt's Gross Domestic Product (GDP) is affirmative. In a similar vein, a study was carried out by [29] to evaluate the significant economic outcomes of the international market prices of U.S. LNG exports. The study's results indicate that the economic consequences of LNG exportation in the United States are multifaceted. These include heightened natural gas prices, wealth redistribution resulting from exportation fees, diminished production and supply for domestic use, amplified production curtailment to satisfy elevated demand and environmental deterioration. Therefore, it necessitates meticulous examination as the impacts are twofold, comprising favourable and unfavourable outcomes. Another study examined the impact of petrol prices and demand on the productivity of Nigeria [51]. The investigation employed the structural vector auto-regressive (SVAR) model to conduct the analysis, utilising monthly time series data collected between 1996 and 2016. The findings of the research indicate that the global market price of natural gas exerted a significant impact on the dynamics of gas demand and supply. Consequently, there is an impact on the Gross Domestic Product (GDP) of Nigeria. Additionally, the research suggested that providing adequate infrastructure and incentives is necessary to stimulate both domestic and foreign investors to expedite the production process and increase profits, thereby enhancing the nation's economic growth.

The ARDL co-integration test was employed by [4] to investigate the correlation between the economic expansion of Nigeria and its domestic natural gas consumption. The study's results indicate a noteworthy correlation between domestic petrol consumption and economic growth. The authors propose the immediate cessation of gas flaring and the provision of incentives to small-scale enterprises to enhance energy availability for household use. A study conducted by [3] examined the economic benefits of utilising natural gas as a source of domestic energy. The study employed the ARDL methodology and found that the nation's economic growth cannot be attributed to domestic gas usage. Instead, the study suggests that development and productivity can be achieved through the cessation of gas flaring and increased investment in the gas sector's infrastructure. A study conducted by researchers [31] investigated the empirical analysis of the factors that influence natural gas flaring in Nigeria, utilising the ARDL method. The study utilised information obtained from secondary sources. The research findings suggest that gas flaring in Nigeria can be attributed to various factors, including crude oil production, natural gas prices, and inadequate gas infrastructure, among others. Consequently, the adoption of rigorous measures to curtail gas flaring has the potential to propel Nigeria towards significant developmental progress and enable the country to meet the World Bank's Vision 2030 target for gas flaring.

The study conducted by [18] focused on empirically investigating the impact of crude oil export on the growth of the Nigerian economy. The research employed various statistical methods, including ordinary least squares regression, co-integration test, short-run dynamics, and the Augmented Dickey-Fuller unit root test. The study's results indicate that the exportation of crude oil plays a crucial role in the country's economic development. The study yielded a coefficient of -2.115947 and a t-value of 3.623380. In contrast to the research conducted by [18], the study conducted by [25] utilised the Ordinary Least Squares (OLS) regression methodology to evaluate the influence of the oil sector on the economic growth performance of Nigeria. A time series was utilised as the repressor to regress gross domestic product (GDP) and oil revenue. According to the report, following the implementation of a tailed test at a 5% significance level, the parameters did not exhibit any significant impact on the nation's economic growth during the investigated period. The individual suggested that a transition away from excessive reliance on revenue generated from oil exports would lead to enhanced economic stability and expansion.

In addition, a study conducted by [11] examined the influence of petroleum on the economic growth of Nigeria. The study utilised data sourced from Nigeria's Central Bank for the period spanning from 1980 to 2011. The study's results indicate that foreign direct investment (FDI) has a significant positive impact, as evidenced by a GDP coefficient 50.15043. The adverse effects of oil revenue on the Nigerian economy were attributed to corruption and other irregularities. The authors have proposed the enactment of the petroleum industry bill as a viable and sustainable measure to mitigate the adverse effects on the economy. In a separate investigation, the impact of gas production, utilisation, and flaring on Nigeria's economic growth was examined by [16] through the implementation of the OLS methodology. The study's results indicate a negative correlation between gas flaring and gas production and economic growth. The correlation between the utilisation of petrol and economic growth was found to be positive. Thus, advocating for the necessity of allocating resources towards the development of infrastructure within the industry. The results obtained from the research contradict the stance put forth by [20]. The study evaluated the supply of petroleum products in the downstream sector of Nigeria, considering both short-term and long-term impacts of exports, imports, prices, refinery outputs, and domestic distribution. This study utilised the Ordinary Least Square (OLS) and Vector Auto Regression (VAR) models to analyse monthly data from 2005 to 2010. The study results suggest that the economy was sustained by the distribution quantity of imports and exports, while other parameters had a lower impact on the dependent variable. In a similar vein, the empirical evidence on the Nigerian economy regarding petroleum income was examined by [34]. The findings of this study indicate that the Nigerian economy, as measured by GDP and per capita index (PCI), was significantly influenced by revenue generated between 2000 and 2009. The significance of oil in the development of the Nigerian economy was investigated by [7] through the utilisation of a multivariate VAR model. Consistent with the research conducted by [25], the results of this study indicate that excessive reliance has minimally impacted the Nigerian economy in the oil and gas sector.

A 2011 study was conducted to evaluate the effects of LNG exports from the United States. The study's findings indicate that the exportation of LNG has a negative impact on the production and availability of gas for domestic use. In contrast to the findings of [25], [53] discovered a favourable correlation between the oil industry and the Nigerian economy by utilising the OLS regression method to establish a linkage between the crude oil sector and the Nigerian economy's performance. As posited by [53], enhancing the economy necessitates a surge in exports, coupled with heightened investments in local content and smaller enterprises in the oil and gas industry. In contrast, it has been argued by some scholars [40] that the Nigerian economy is experiencing a significant downturn as a result of various factors, including heightened levels of poverty, the breakdown of domestic infrastructure, limited availability of natural gas due to exportation requirements, and the importation of refined products due to the inoperability of local refineries. The author suggests that a viable solution would involve promoting domestic consumption and incentivising small-scale businesses to enhance state-of-the-art facilities, thereby augmenting growth and production for local consumption. Therefore, consistent with the claims made by sources [44] and [25].

In brief, the research conducted by authors [44] and [40] indicated that the presence of natural resources does not serve as a catalyst for economic progress but instead results in a decrease in growth due to various factors. Nevertheless, there exist various factors that exert both positive and negative effects on the export of LNG with respect to the Nigerian economy. However, current research has not been specifically focused on exploring this aspect. This study aims to evaluate the impact of LNG exports on the gross domestic product (GDP) of Nigeria. The primary aim of this investigation is to employ the Auto-regressive Distributed Lag Model (ARDL) technique, an econometric model, to assess the impact of LNG exportation on the Nigerian economy. The significance of this research lies in the shift of global attention from fossil fuels towards more environmentally friendly and sustainable energy sources for power generation in response to escalating climate change concerns.

2. Methodology

2.1. Data Source

The present investigation utilised secondary data. The data employed in this study consist of biannual time series spanning from 2000 to 2021. It is worth noting that the data was gathered on an annual basis but was subsequently disaggregated into a biannual (semi-annual) format through the utilisation of Eviews-10. The present investigation draws upon data from various sources, including BP, Statista, EIA, and World Development Indicators. The statistical analyses were conducted utilising the Eviews 10.0 software package.

2.2. Model Specification

The primary aim of this research is to investigate the impact of liquefied natural gas (LNG) exports on the economy of Nigeria. The functional form of the econometric model used is:

$$GDP = (LNG, COP, NGP) \quad (1)$$

In order to enhance the efficacy of the assessment and mitigate potential heteroskedasticity in the specified model, a logarithmic function was employed to transform the model, as demonstrated in equation (2) presented underneath. As per [23], it has been suggested that utilising the double-logged model for estimation yields outcomes that are readily comparable and relatively straightforward to comprehend. Research conducted by [38] and [6] provides evidence supporting the dependability and uniformity of a double-logged model.

$$LGDP = \beta_0 + \beta_1 LLNG + \beta_2 LCOP + \beta_3 LNGP + \mu_t \quad (2)$$

Where LGDP is the natural log of nominal Gross Domestic Product proxy for Nigeria's economy measured in USA Dollars, LLNG is the natural log of Nigeria's LNG export in Billion cubic metres per annum, LCOP is the natural log of Brent crude oil price measured in USA Dollar per Barrel, and LNGP is the natural log of Henry hub prices of natural gas measured in USA dollar per million Btu. $\beta_{0\ is}$ the intercept, $\beta_1 - \beta_3$ is the coefficient, and μ_t is the stochastic error term.

2.3. Estimation Techniques

2.3.1. Auto-Regressive Distributed Lagged (ARDL) Model

Co-integration was examined using the Autoregressive Distributed Lag (ARDL) bounds testing method suggested by [35] and [36]. [30] asserts that, in contrast to earlier co-integration methods, ARDL assists in identifying cointegrating vectors. To put it another way, the model's underlying variables are all represented by a single co-integration equation. Comparing this co-integration testing method to other single equation estimating methods offers certain benefits. This includes the following: (i) it can distinguish between dependent and independent variables when there is only one co-integration equation; (ii) it can identify co-integration vectors when there are multiple co-integration equations; (iii) it is the most efficient single equation estimation strategy when the sample size is small or finite; (iv) Each variable may have a variety of optimum delays, and the approach can be used to variables of order I(0), I(1), or a mix of both, as long as they are not I(2) or higher. (vi) It is possible to concurrently acquire long- and short-run estimates of the explained variables with regard to the explanatory variables in a regression. These benefits led to the selection of this constrained co-integration test strategy. The following is the general form of an ARDL (p, q) model:

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \ldots + \delta_p Y_{t-p} + \beta_0 X_t + \beta_1 X_{t-1} + \ldots + \beta_q X_{t-q} + \mu_t \quad (3)$$

$$Y_t = \delta_0 + \sum_{i=1}^{p} \delta_i Y_{t-i} + \sum_{j=0}^{q} \beta_j Y X_{t-j} + \mu_t \quad (4)$$

Where μ_t is a disturbance term. The p is the maximum lag for the dependent variable, while q is the maximum lag for exogenous variables. The dependent variable is a function of its lagged values, and the current and lagged independent variables as regressors in the model. Thus, the ARDL model formulation for this investigation is provided by equation (5).

$$\Delta \mathrm{GDP}_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \triangle LGDP_{t-1} + \sum_{i=0}^{q1} \alpha_{2i} \triangle \mathrm{LLNG}_{t-1} + \sum_{i=0}^{q2} \alpha_{3i} \triangle \mathrm{LCOP}_{t-1} + \sum_{i=0}^{q3} \alpha_{4i} \triangle \mathrm{LNGP}_{t-1} + \beta_1 \mathrm{LGDP}_{t-1} + \beta_2 \mathrm{LLNG}_{t-1} + \beta_3 \mathrm{LCOP}_{t-1} + \beta_4 \mathrm{LNGP}_{t-1} + \mu_t \quad (5)$$

Where $\triangle$ is the first difference operator, p is the optimal lag lengths of the dependent variable and q_1, q_2, and q_3 are the optimal lag lengths of the independent variables, α_0 is the constant, α_1 - α_4 are the coefficients of the differenced variables, β_1 - β_4 are the coefficients of the lagged variables. The ARDL co-integration method consists of three phases for estimating the long-run connection among the variables [31, 28, 2]. The first phase uses the bound F-statistic to test for the presence of a long-run relationship between the variables under consideration. In the ARDL model, the bound co-integration test leads to hypothesis testing. The null hypothesis thus presumes that there is no long-run link. Thus, the null and alternative

Table 1. Descriptive Statistic of Variables

	LGDP	LLNG	LNGP	LCOP
Mean	4.913441	2.243379	0.708675	3.356965
Median	5.2338	2.4431	0.6941	3.4007
Maximum	5.6157	2.6772	1.5303	4.0542
Minimum	3.5337	1.0207	-0.0706	2.4860
Std. Dev.	0.6529	0.4715	0.4066	0.4814
Skewness	-0.9702	-1.1349	0.3511	-0.3269
Kurtosis	2.5067	3.0535	2.3380	2.0536
Jarque-Bera	7.3484	9.4500	1.7076	2.4254
Probability	0.0254	0.0090	0.4258	0.2974
Sum	216.1914	98.70867	31.1817	147.7065
Sum Sq. Dev.	18.3326	9.5580	7.1084	9.9639
Observations	44	44	44	44

Source: Author's computation using Eviews 10 (2023)

hypotheses are:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$; no long run relationship exists (no cointegration).
H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$; long run relationship exists (cointegration).

The Wald test, also known as F-statistics, is employed to examine a hypothesis, resulting in the derivation of two critical values or p-values. In the context of statistical analysis, it is customary to accept the null hypothesis when the F-statistic is less than the critical value of the lower bound. This outcome suggests that no enduring correlation exists between the variables under consideration. In contrast, the null hypothesis is deemed invalid when the F-statistic surpasses the critical value upper bound, signifying the presence of a long-term relationship between the variables. Therefore, the alternate hypothesis is deemed to be valid. When the F-statistic is within the range of the lower and upper bound critical value, it suggests an indeterminate outcome. Equation (6) is utilised to estimate the long-run model in the event that there is proof of co-integration among the variables. The aforementioned statement pertains to the second stage of the ARDL estimation approach.

$$\text{GDP}_t = \beta_0 + \sum_{i=1}^{p} \beta_1 LGDP_{t-1} + \sum_{i=0}^{q1} \beta_2 \text{LLNG}_{t-1} + \sum_{i=0}^{q2} \beta_3 \text{LCOP}_{t-1} + \sum_{i=0}^{q3} \beta_4 \text{LNGP}_{t-1} \quad (6)$$

If the variables have a long-run connection, the Error Correction Model (ECM) is used to calculate the short-run dynamics of the coefficients, represented by $\text{ECM}_{(t-1)}$ and illustrate the speed of correction of disequilibrium in the model. Consequently, equation (7) determines the model's short-run coefficients. This is the third phase in the ARDL estimation technique.

$$\Delta\text{GDP}_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \triangle LGDP_{t-1} + \sum_{i=0}^{q1} \alpha_{2i} \triangle \text{LLNG}_{t-1} + \sum_{i=0}^{q2} \alpha_{3i} \triangle \text{LCOP}_{t-1} + \sum_{i=0}^{q3} \alpha_{4i} \triangle \text{LNGP}_{t-1} + \varphi \text{ECM}_{(t-1)} + \mu_t \quad (7)$$

Where φ is the speed of the adjustment coefficient, α_1-α_4 are the coefficients of the short-run dynamic.

To determine the quality of fit of the ARDL model, a series of diagnostic tests, including Serial correlation, Ramsey Reset, normality, heteroscedasticity, and stability tests, were conducted.

3. Results and Discussion

3.1. Descriptive Analysis

The result of the descriptive statistics in Table 1 shows that there is a significant disparity between the series' lowest and maximum values. This demonstrates that the variables for the time period under consideration exhibit substantial fluctuation. Apart from LNGP, which is favourably skewed, the result also demonstrates that the series is negatively biased.

Furthermore, LGDP has a maximum, minimum, mean, and median of 5.6157, 3.5337, 4.913441 and 5.2338, respectively, for the period considered. Also, LGDP has a standard deviation and Jarque-Bera statistic value of 0.6529 and 7.3484, respectively, with a p-value of 0.0254. LLNG has maximum, minimum, mean, and median of 2.677161, 1.020651, 2.243379 and 2.443149, respectively, for the period considered. Also, LLNG has a standard deviation and Jarque-Bera statistic value of 0.471463 and 9.449971, respectively, with a p-value of 0.008871.

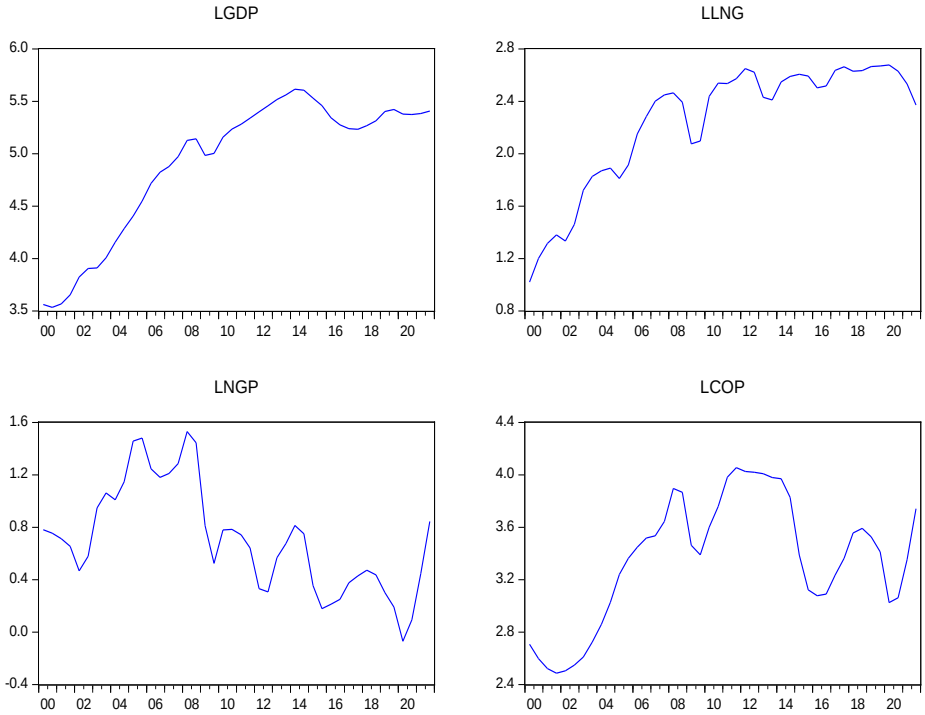

Fig. 1 Graphic plots of LGDP, LLNG and LNGP, AND LCOP at level

Source: Author's compilation using Eview 10 (2023)

LNGP has a maximum, minimum, mean, and median of 1.530259, -0.070557, 0.708675, and 0.694079, respectively, for the period considered. Also, LNGP has a standard deviation and Jarque-Bera statistic value of 0.406584 and 1.707581, respectively, with a p-value of 0.425798. LCOP has a maximum, minimum, mean, and median of 4.054217, 2.486000, 3.356965, and 3.400700, respectively, for the period considered. Also, LCOP has a standard deviation and Jarque-Bera statistic value of 0.481371 and 2.425416, respectively, with a p-value of 0.297391. The Jarque-Bera test result from the descriptive statistics table confirms abnormality for LGDP and LLNG variables at a 5% level of significance, and we cannot reject the null hypothesis for these time series variables. However, the Jarque-Bera for LNGP and LCOP shows normality at a 5% significance level, and we reject the null hypothesis for these time series variables. This outcome suggests non-stationary of the variables. Figure 1 shows the time series plots of the series at level, and Figure 2 shows the time series plots of the series at their first difference.

4.2. Empirical Analysis

4.2.1. Unit Root Test

Table 2 shows the result of the unit-root test conducted for all the time series variables with Intercept and Trend employing Phillips-Parron (PP).

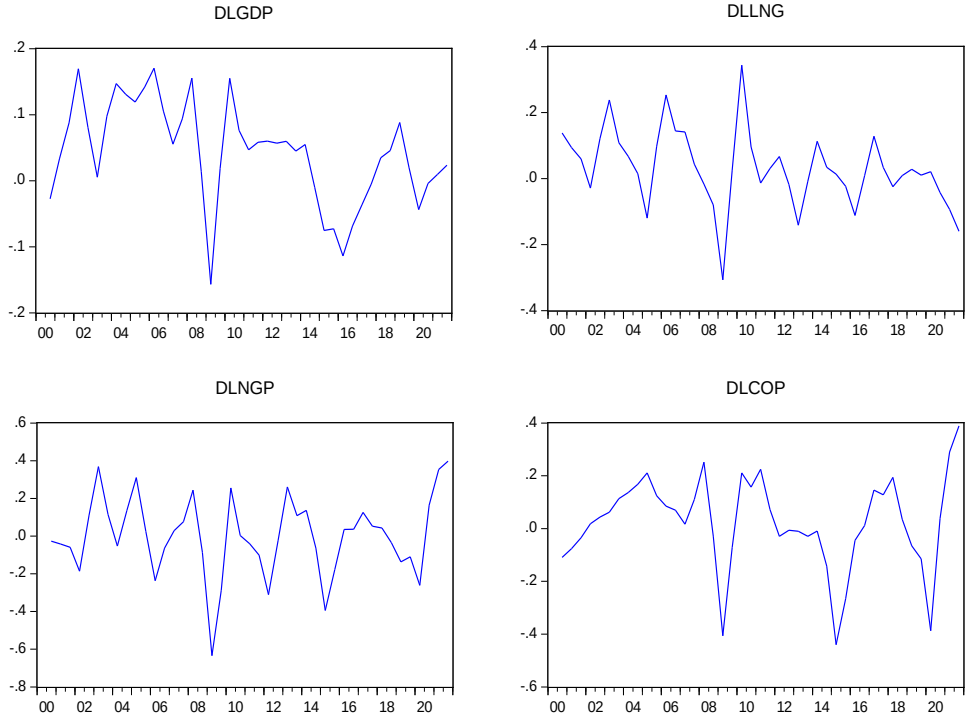

Fig. 2 Graphic plots of LGDP, LLNG and LNGP, AND LCOP at first difference

Source: Author's compilation using Eview 10 (2023)

Table 2. Unit root test result

PP					
	LEVEL I(0)		FIRST DIFFERENCE I(1)		
VARIABLE	INTERCEPT	TREND & INTERCEPT	INTERCEPT	TREND & INTERCEPT	ORDER OF INTEGRATION
LGDP	-2.6424	-0.6860	-3.1746	-3.7893	**I(1)**
	(0.0926)	(0.9678)	**(0.0287)****	**(0.0270)****	
LLNG	-4.7402	-0.9334	-3.8702	**-6.8796**	**I(0); I(1)**
	(0.0004)***	(0.9425)	**(0.0048)*****	**(0.0000)*****	
LNGP	-1.7042	-1.8971	-3.2250	-3.1603	**I(1)**
	(0.4220)	(0.6387)	**(0.0254)****	(0.1063)	
LCOP	-1.56892	-1.59693	-3.209681	-3.1492	**I(1)**
	(0.4895)	(0.7778)	**(0.0264)** **	(0.1087)	

Notes: (*)Significant at 10%; (**)Significant at 5%; (***) Significant at 1%. Using Schwarz Information Criteria.

Source: Author's computation Using Eviews 10 (2023).

Table 3. ARDL Bound Test of Co-integration

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.9557	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Table 4. The Long run Estimates of the ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LLNG	0.716058	0.134461	5.325405	0.0000
LNGP	-0.118509	0.087374	-1.356346	0.1858
LCOP	0.572406	0.102803	5.567980	0.0000
C	1.573084	0.182094	8.638874	0.0000

The data presented in Table 2 reveal that LLNG was stationary at the level I(0) while LGDP, LNGP and LCOP were stationary at the first difference I(1). Due to the distinct order of integration exhibited by the series, Engle-Granger and Johansen co-integration tests are unsuitable for analysis. Instead, the ARDL Bound co-integration test is deemed more appropriate. The Bound co-integration test is deemed appropriate when the co-integration of variables occurs in a distinct order, as per sources [37], [39], and [30]. The study utilises an ARDL model-bound test methodology to demonstrate the enduring association between LGDP and its corresponding predictors.

From the result in Table 3, K represents the number of parameters estimated from the ARDL model, F is calculated F-statistics, I(0) is the lower bound value, and I(1) is the upper bound value. Akaike Information Criterion automatically selected ARDL (3, 2, 2, 2) as the optimal lag length for the series.

4.3. ARDL Bound Test of Co-integration

[30] and [39] assert that: i) If the calculated value of F statistics is greater than the upper bound I(1) of critical values, then the presence of co-integration is confirmed among the variables. ii) If the calculated value of F statistics is less than the lower bound I(0) of the critical values, then no co-integration exists among the variables. iii) If the calculated value of the F statistics lies between the lower bound I(0) and upper bound I(1), then the test is inconclusive.

The result of the bound test in Table 3 shows that the F-statistic value is greater than the upper bound I(1) critical value at all levels of significance. Therefore, the null hypothesis is rejected, and we accept that there is strong evidence of a Long-run relationship among the variables.

4.4. ARDL Long-Run Estimates

As shown in Table 4, all independent variables are statistically significant except LNGP. In the long run, LNG export (LLNG) has a positive and significant effect at a 1% level of significance on the Nigerian economy. That means keeping all other variables constant, a 1% increase in LNG export from Nigeria will cause a 0.72% increase in Nigeria's GDP. This is so because, of total natural gas exported from Nigeria in the fourth quarter of 2021, LNG accounts for over 95% of gross natural gas export. In the fourth quarter of 2021, according to the CBN economic report, natural gas export accounted for 10.6% of total export earnings. In the long run, the price of natural gas (LNGP) has a negative and insignificant effect on the Nigerian economy (GDP). When all other variables are kept constant, a 1% increase in the price of natural gas will result in a 0.12% decrease in Nigeria's GDP, but this effect is not significant, and it agrees with the findings of [42] on the Malaysian economy. Crude oil price (LCOP), in the long run, has a positive coefficient, and it is highly significant at a 1% level of significance. That means keeping all other variables constant, a 1% rise in crude oil price will cause a 0.57% increase Nigeria's GDP. This is so because Nigeria's budget is based on crude oil export, and a rise in crude oil prices causes an increase in the foreign exchange earnings to Nigeria and an increase in GDP. For example, crude oil export accounted for about 77% of Nigeria's export earnings in the 4th quarter of the year 2021 [14]. It is also in agreement with the findings of [52].

Since there is a long-run relationship among the variables, it is, therefore, appropriate to estimate the short-run coefficient of the model.

4.5. ARDL Short-Run Estimates

The result in Table 6 shows a positive and significant relationship between GDP and LNG in the short run. Other variables remaining constant, a 1% increase in LNG export will cause an increase in GDP by 0.23% biannually in the short run. This finding is consistent with the long-run finding. Natural gas price has a negative relationship with GDP in the short run and is not significant at the 5% level of significance. When all other variables remain constant, a 1% rise in natural gas price will cause a 0.08% decrease in the GDP of Nigeria biannually in the short run, but this effect is not statistically significant. This agrees with the findings in the long run. In the short run, the crude oil price has a positive and significant relationship with GDP.

All other variables remaining constant, a 1% rise in crude oil price will cause a 0.3% increase Nigeria's GDP biannually. Also, ECT_{t-1} shows the short-run speed of adjustment of LGDP to its long-run equilibrium after a shock has occurred. The coefficient of the error correction term, $ECT_{t-1,}$ is -0. 263862, and it is statically significant at a 1% significance level.

The value, as expected, is negative, less than 1, and significant. The coefficient, being negative, shows the speed of adjustment of any disequilibrium or deviation from the previous half-year toward the long-run equilibrium. The speed of the disequilibrium adjustment is 26.38% biannually. A significant ECT_{t-1} shows evidence of stable long-run equilibrium between the regressand (LGDP) and the regressors (LLNG, LNGP, LCOP). The calculated R^2 is 0.865030, which means that 87% of all variations in LGDP are traceable to LLNG, LNGP, and LCOP, and the remaining 13% of variations are ascribed to some other exogenous agents in the model but covered by the error term. This observation is strengthened by an Adjusted R2 of 83%. D.W value of 2.062303 suggests the absence of serial autocorrelation for this model.

Table 5. The Short-run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	0.5846	0.11838	4.938332	0.0000
D(LGDP(-2))	-0.236596	0.094237	-2.510641	0.0181
D(LLNG)	0.230035	0.049952	4.605122	0.0001
D(LLNG(-1))	-0.187765	0.056038	-3.35068	0.0023
D(LNGP)	-0.076091	0.043181	-1.76214	0.0890
D(LNGP(-1))	0.108853	0.044361	2.453789	0.0206
D(LCOP)	0.296517	0.057695	5.139414	0.0000
D(LCOP(-1))	-0.291695	0.068727	-4.244224	0.0002
CointEq(-1)*	-0.263862	0.04523	-5.833731	0.0000

R^2 = 0.865030; Adjusted R^2 = 0. 0.831287; Durbin-Watson (D.W) = 2.062303

Source: Source: Author's computation from Eview 10 (2023)

Table 6. Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test:	F-statistic	0.327306	Prob. F(2,26)	0.7238
	Obs*R-squared	1.006920	Prob. Chi-Square(2)	0.6044
Heteroskedasticity Test: Breusch-Pagan-Godfrey	F-statistic	1.030215	Prob. F(12,28)	0.4499
	Obs*R-squared	12.55781	Prob. Chi-Square(12)	0.4020
Normality Test	Jarque-Bera	0.843896	Prob.	0.6558
Ramsey RESET Test		Value	df	Probability
	t-statistic	0.221612	27	0.8263
	F-statistic	0.049112	(1, 27)	0.8263

4.6. Diagnostic Tests

Table 6 displays the diagnostic test outcome conducted for the Breusch-Godfrey serial correlation and Breusch-Pagan-Godfrey. The model was subjected to tests for heteroscedasticity, normality, and the Ramsey RESET test. The findings indicate that the residual series exhibit homoscedasticity, lack of serial correlation, and normal distribution. This is supported by the observed R2 probabilities exceeding 0.05 and the Jarque-Bera probability exceeding 0.05, leading to the rejection of their respective null hypotheses. The Ramsey Reset test yields a probability of 0.83, indicating statistical significance at a level greater than 0.05. This validates the linear correlation between the dependent and independent variables.

4.7. Stability Test

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) graphs, as shown in Figure 3 is employed for the evaluation of model stability. The graphical representation illustrates that the CUSUM and CUSUMSQ plots are contained within the critical bound of a 5% level of significance.

The findings validate the lack of instability in the coefficients and indicate that the estimates of the parameter coefficients remain stable throughout the studied period.

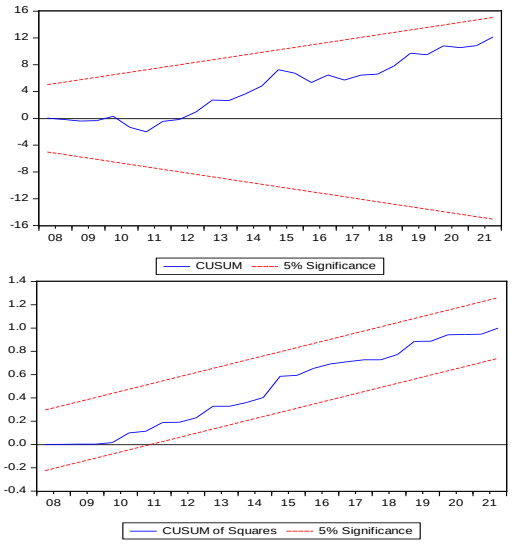

Fig. 3 CUSUM Test and CUSUM of Square Test

Source: Author's computation from Eview 10 (2023)

5. Conclusion

The present study utilised the ARDL co-integration modelling approach to examine the effect of LNG exports on the Nigerian economy during the period spanning from 2000 to 2021. In order to ensure the reliability of the outcome, the ADF and Philips Parron unit root tests were utilised. The bounds co-integration test was employed to ascertain the collective characteristics of the model. The bounds-testing approach to co-integration was utilised to examine the long-term and short-term effects among the variables.

The study's empirical findings have uncovered results that are both impactful and compelling. The gross domestic product (GDP) of Nigeria, exports of LNG, prices of crude oil, and prices of natural gas exhibited co-integration and co-movement over an extended period. The findings of the research indicate that the export of LNG and the prices of crude oil have a noteworthy and favourable impact on the GDP of Nigeria. Conversely, the price of natural gas has a detrimental and inconsequential effect on the country's GDP. Consequently, it is recommended that the Nigerian government augment its investments in natural gas development initiatives to guarantee a consistent and uninterrupted provision of natural gas to the LNG facilities. It is recommended that the Nigerian government implement policies aimed at enhancing international market access for LNG exports to augment its export revenues.

Moreover, it is recommended that the government implement policies, such as tax exemptions, to incentivise increased investment in the LNG value chain. This measure is expected to enhance the liquefaction capacity of LNG and minimise the practice of gas flaring to a significant extent, thereby augmenting the export of LNG. It is recommended that a proactive policy be implemented to incentivise investment in floating LNG plants in regions and areas where the cost of laying a pipeline to an onshore LNG plant has become economically unfeasible. The proposed approach holds promise for the conversion of stranded gas reserves into LNG suitable for overseas shipment, thereby facilitating the emergence of gas development hubs in these regions.

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