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The Role of the National Gas Policy on the Nigerian Electricity Supply Industry and Economic Growth

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ABSTRACT

This study examined the relationship between real GDP, electricity supply, and the National Gas Policy (NGP) in Nigeria, using annual time series data from 1981 to 2019. To achieve its aim, the study explores how the NGP might influence future economic growth, natural gas reserves and electricity supply. Econometric techniques are employed for analysis, where real GDP is dependent variable, and the NGP is the dummy explanatory variable alongside other explanatory variables. The Augmented Dickey-Fuller and Phillip Perron Methods were used for unit root tests. The ARDL bounds tests indicated evidence of co-integration and long-run relationships among the variables. From the results, electricity supply and the NGP have a positive and significant relationship with real GDP. Consumer Price Index (CPI), a control variable, had a negative and significant relationship with real GDP in the short run. Also, the Error Correction Term is -0.2228. Consequently, the speed of adjustment for the model to return to long-run equilibrium after a shock is 22.28%. The study also found that the current two (2) percent annual growth rate of proven NG reserves is inadequate to cater for the rapid growth in the NG sector considering the positive effect of the NGP. The study, therefore, recommends that policymakers should continue to promote the NGP programme because it contributes positively to real GDP. In addition, consideration should be given to a diverse energy mix policy to reduce the over-reliance of electricity generation on NG-fired power plants, consequently, policymakers should promote policies that will lead to the diversification of the energy source for power generation.

INTRODUCTION

Nigeria's current power deficit is seen as a bottleneck to economic progress by many researchers; for example, the World Bank estimates a staggering \$26 billion annual loss due to inadequate electricity supply; this amount exceeds half the national budget. This energy shortfall stifles progress, impacting tax revenue and hindering the well-being of millions. Despite a population of over 200 million and an annual growth rate of 2.5%, Nigeria's recent economic track record paints a grim picture. A World Bank report reveals a decline in GDP per capita from \$2,280.47 in 2010 to \$2,097.09 in 2020, translating to a negative 0.08% growth over a decade. This stagnation does not help remove Nigeria's classification as one of the world's poverty capitals, a stark contrast to its potential. The government, aware of this crisis, has formulated multiple policies aiming for rapid economic growth. Among these, the National Gas Policy (NGP) of 2017 stands out as a potential catalyst for a brighter future. Building upon the 2008 Nigerian Gas Master Plan (NGMP), the NGP emerges as a strategic response to this energy challenge. It emphasizes gas-to-power initiatives for improved electricity supply. This strategy also seeks to boost local value addition to natural gas (NG) through increased domestic usage, while maintaining foreign exchange income from exports. The power sector becomes a catalyst for this transformation, as gas-fired power plants promise are being planned for the expansion of the Nigerian Electricity Supply Industry (NESI) to contribute to economic growth. Ayado (2019)

highlights the stark comparison with Brazil, a nation of similar size concerning power generation. While Brazil generates an average of 101,363 MW from its installed capacity, Nigeria manages only 4,000 MW from its 12,500 MW capacity for similar populations, consequently, the Nigerian energy gap forces businesses and households to resort to individual inefficient and costly self-generation with diesel or petrol generators, undermining the benefits of economies of scale and hindering sustainable development.

The intricate relationship between energy and economic growth has long captivated scholars. Is increased energy generation always a catalyst for prosperity? Different studies paint a mixed picture. Wolde-Rufael (2005) and Akinlo (2009) found complex causal patterns across various African countries. In some cases, energy consumption drives economic growth, while in others, it's the other way around. Even bi-directional causality exists, highlighting the intricate interplay of factors. Studies usually link rising economic activity to increased electricity consumption, but realities in OECD countries seem to challenge this assumption. Research on OECD countries like Japan, the UK, and the US reveals a surprising disconnect: their GDPs climb, yet their electricity use remains stagnant. In contrast, emerging economies like Brazil, China, Egypt, and India show growth patterns in GDP when electricity consumption increases. This divergence stems from contrasting manufacturing or industrial landscapes. OECD nations typically rely on less energy-intensive, more efficient manufacturing

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processes compared to their non-OECD counterparts, who often employ low-skilled labor and outdated, high-energy consuming methods. The service sector's growth in many developed economies means GDP can rise even with decreasing electricity demand due to efficient power generation. Additionally, technological advancements can lead to more efficient production processes, further decoupling intensive energy use from economic output. Therefore, a one-size-fits-all approach to analyzing this relationship may not suffice. Each nation's unique economic structure, resource mix, and technological adoption need to be factored in. As Peterson (2017) suggests, econometric tests accounting for the uniqueness of each country are crucial to accurately quantifying their intertwined effects.

The Energy Commission of Nigeria's Reference and Optimistic Growth Scenarios projections assessed Nigeria's energy needs under different GDP growth scenarios where NG power plants played significant roles. Considering these scenarios, existing power plants and future construction plans portrayed NG-fired plants to still dominate a large chunk of the energy mix. In addition, the development of the NLNG train 7 project indicate Nigeria government's interest to expand the liquefied NG (LNG) export sector, thereby creating more revenue opportunities from Nigeria's NG resources, Udouo *et al.*(2023) suggested that expanding the liquefied NG (NG) export sector provides steady revenue opportunities for the government, all these will impact economic activity in the NG sector, consequently, NG's impact on both GDP growth and electricity consumption needs thorough investigation. This information will be vital in shaping effective policies aligned with the NGP's domestic NG utilization aspirations for economic growth. As government policies prioritize the NESI and NG sectors as engines of economic growth, understanding their impact on the lives of Nigeria's 83 million (almost 40% of the population) impoverished citizens is critical. Unpacking their potential to alleviate poverty should be a central focus.

This study delves into the NGP's potential to influence positive real GDP growth in Nigeria. Using econometric tools like the Augmented Dicker Fuller (ADF) and Autoregressive Distributed Lag (ARDL) tests, it will analyze the policy's impact on Real GDP growth, domestic NG consumption, and electricity supply within NESI. Time series data (1981-2019) will be employed, with real GDP as the independent variable and NESI's electricity supply and domestic NG consumption serving as dependent variables.

The Nigerian Electricity Supply Industry

Up until 2006, NESI was under the monopoly of the government-owned National Electrical Power Authority (NEPA), which managed all aspects of electricity generation, distribution, and transmission. The transformation of NEPA into the Power Holding Company of Nigeria (PHCN) marked the beginning of

its unbundling, facilitated by the Electric Power Sector Reform (EPSR) Act of 2005. The enactment of the EPSR Act not only paved the way for PHCN's unbundling but also led to the establishment of key regulatory bodies, namely the Nigerian Electricity Regulatory Commission (NERC) and the Nigerian Bulk Electricity Trader (NBET) in 2010. Following the aspirations of this act, the successful unbundling and privatization of PHCN in 2014 resulted in 18 successor companies, consisting of 6 generation companies (GENCOs), 11 distribution companies (DISCOs), and a wholly government-owned transmission company (TCN). This marked a significant shift from the historical government monopoly in the Nigerian Electricity Industry, opening the door for private sector participation.

Expectations accompanying the privatization aimed at addressing the sector's historical capacity inadequacies and inefficiencies. However, as of the study's timeframe, substantial financial investments in Nigeria's electricity sector have not yielded the anticipated positive impact. Many Nigerians continue to rely on privately generated electricity from diesel and petrol generators, incurring high operational costs, contributing to environmental pollution, and requiring regular maintenance.

Guided by the EPSR Act of 2005 and NESI roadmaps, the Federal Ministry of Power is the governmental body responsible for crafting policies pertaining to the country's electricity supply. By overseeing various agencies within the Nigerian Electricity Supply Industry (NESI), the Federal Ministry of Power shapes the regulatory landscape and operational framework for the industry. Furthermore, an effective framework was needed, considering that the current daily power generation of around 4,000 MW for a population exceeding 200 million citizens is precarious, therefor a situation where Nigeria's industrial sector copes with power shortfalls by using diesel and gas generators, highlighting the country's heavy reliance on inefficient, high pollutant alternative power sources. The ability of Brazil to generate a higher power per capita reveals Nigeria's inadequate daily generation, suggesting a power need of 50,000 MW or 75,000 MW to match 50% or 75% of Brazil's current generation. Despite Nigeria's increase in power plant installed capacity over the decades, electricity supply has not improved proportionately to population growth. Generation was 14,730 GWh (1990 - 2000), 27,030 GWh (2000 - 2010), and 35,029 GWh (2010-2020).

The electricity industry comprises a value chain. Nigeria's electricity value chain comprising the generation, transmission, and distribution networks within a national grid system has had its fair share of challenges. With an installed capacity of 13,324 MW for electrical power generation, only 38% is utilized, emphasizing the need for improved utilization to meet growing demand. The EPSR Act facilitated private participation in the generation and distribution sectors, while the government retained ownership of the transmission sector, as a result, Independent Power Producers (IPPs) contributed to

the grid, an arrangement that was difficult to achieve pre-ESPR Act, and the Niger Delta Power Holding Company (NDPHC), a special purpose vehicle of the government invested in critical infrastructure as a partner. Irrespective, improvement in electricity supply to citizens is still challenged, despite 27 power-generating facilities with a total capacity of 13,324 MW, the available installed capacity is still 8,140 MW, the Transmission Company of Nigeria (TCN) which manages the central national grid, through a 132 KV and 330 KV system can only transmit a portion of this power. Regardless of a total transmission length of over 20,000 km and a theoretical installed capacity of 7,500 MW, the highest wheeled out is around 5,500 MW. Frequent system collapses and low reliability therefore call for improvements. A partnership with Siemens aims to enhance transmission reliability. The ESPR Act encouraged privatization to instill an efficient market, privatization of the distribution sector under the EPSR Act resulted in Distribution Companies (DISCOs), 40% owned by the government and 60% by private investors. Eleven DISCOs handle electricity distribution across the country. The distribution sector still faces inefficiencies, with Aggregate Technical Commercial Collection (ATC&C) losses averaging 46% (2015) and worsening to 49.16% (Q1 2021). Nigeria imports most of its machinery and equipment, therefore, the DISCOs struggle with exchange rate (naira-dollar conversion) issues when buying equipment such as transformers. According to Udouo *et al.*(2024), the exchange rate needs effective monitoring to be stable. To mitigate the impact of exchange rate, the Multi-Year Tariff Order (MYTO) was introduced. The MYTO seeks to address pricing issues, categorizing customers for effective cost recovery. MYTO components include generation, transmission, distribution, taxes, and profit mark-ups.

The Nigerian Gas Master Plan (NGMP)

The NGMP, the precursor to the National instated by the FGN, aimed to promote in-country value addition to natural gas (NG) and encourage investments in gas infrastructure through appropriate pricing, commercialization of the gas value chain, and the development of public infrastructure to bolster natural gas consumption in Nigeria. The NGMP outlined three main objectives:

- The Commercial Framework - Gas Pricing Policy (GPP).
- The Domestic Gas Supply Obligations (DGSO).
- The Gas Infrastructure Blueprint (GIP).

The GPP aimed to establish suitable gas pricing to attract private investments domestically, while the DGSO aimed to ensure the development of the local gas market. The Nigeria NLNG Limited (NLNG) company set up through the NLNG Act of 1989, is designed for LNG export, and couldn't serve local demand because it operates primarily as a private company, although the government has a 49% stake in the organization. DGSO

therefore aimed to create opportunities for domestic natural gas utilization without hindering commercial exports, primarily from NLNG Limited. The GIP's goal was to invest in essential gas infrastructure, facilitating connections between buyers and sellers and ensuring the availability of pipelines to transport natural gas to local destinations.

Nigeria's Ministry of Petroleum Resources in 2017 reported that a review of the NGMP presented a poor result achievement necessitating a review of strategy and the policy. This prompted the introduction of the New National Gas Policy (NGP) in 2017. The NGP acknowledged Nigeria's abundant gas resources but noted the persistent energy crises and the shortfall in achieving the planned critical gas infrastructure of 2,500 km outlined in the NGMP. The NGP aimed to address these challenges and set new targets to further enhance the gas sector in Nigeria.

The National Gas Policy

Attempts to recover from the 2016 recession and address the challenges of a mono-economy resulted in the development of a Strategic Implementation Work Plan (SIWP) by the FGN to support the national budget of 2016. Nigeria's economic reliance on crude oil revenues has hindered diversification, exposing the nation to the impacts of global crude oil price fluctuations. The decline in crude oil prices, such as in the first half of 2014, led to a recession in 2016, highlighting the vulnerability of Nigeria's economy. The Economic Recovery & Growth Plan (ERGP) 2017 emerged from the SIWP, and subsequently, the NGP evolved from the ERGP (Ministry of Budget & National Planning, 2017).

Preceded by the NGMP, the NGP acknowledges areas for improvement in its predecessor, noting the slow growth of the gas market over the years. During the NGMP period, the local gas market experienced a growth rate of 3.1%, slightly above the national growth rate of 2.8%. However, this growth was insufficient to meet the per capita requirements of Nigerians, contributing to a significant energy crisis given Nigeria's abundant natural gas resources (Ministry of Budget & National Planning, 2017). As per (Ministry of Budget & National Planning, 2017), the NGP builds upon the FGN's policy goals outlined in the 7 Big Wins initiative within the ERGP. It delineates the FGN's vision, objectives, plans, and strategies for Nigeria's gas sector. The NGP introduces an institutional, legal, regulatory, and commercial framework for the gas sector, emphasizing stakeholder engagement. Its primary goals include eliminating barriers hindering sector growth and investment, with provisions for periodic reviews and modifications to align with governmental objectives.

The NGP categorizes the gas value chain into upstream, midstream, and downstream sectors for effective monitoring, fiscal application, market entry terms, and regulatory clarity. A key objective is to stimulate electric power generation by domestically utilizing natural gas

for gas-fired power plants. Major NGP aspects cover governance, industry structure, gas source development, infrastructure, gas market establishment, local capacity, and content development, roadmap, and action plans (Banwo & Ighodalo, 2017). The NGP establishes short-term (0-1 years), medium-term (1 to 2 years), and long-term (over 2 years) targets, encompassing legislative drafting, stakeholder consultations, infrastructure development, and regulatory capacity building.

LITERATURE REVIEW

In Alawiye's (2011) investigation into the correlation between Nigeria's power sector and industrial development, qualitative research methods and detailed structured interviews were employed. The study found a positive impact of power sector growth on industrial development in Nigeria. The focus was on improving PHCN's efficiency in supplying electric power to propel the country's economy to greater heights. Identified obstacles to PHCN's efficiency included poor maintenance planning, insufficient funding, high prices, PHCN's monopoly hindering private investments, reliance on fossil fuels, vandalization of power facilities, and a deficient inventory and accounting system. The study suggested that the Nigerian government should promote alternative energy sources (renewable energy) and introduce subsidies to encourage power generation through these means, considering the positive environmental impact of renewable energy. Observations from the study included the need for post-PHCN privatization investigations and the discrepancy between high pricing affecting PHCN's performance and NERC's MYTO template.

Iyke (2015) explored the causal relationship between electricity consumption and economic growth in Nigeria, utilizing the Vector Error Correction Model (VECM) with time series data from 1971-2011. The findings suggested that electricity consumption stimulates economic growth, advocating for policymakers to use electricity consumption to drive economic growth in Nigeria. Observations included the study's focus on Nigeria's specific context and the absence of an examination of NG power plant's impact on the power supply.

Foye and Benjamin (2021) investigated how natural gas influenced economic performance in six sub-Saharan African countries from 1998-2017, using Toda and Yamamoto's Lag Augmented Vector Autoregressive (LA-VAR) model. The study indicated that natural gas consumption can lead to economic growth in sub-Saharan Africa. Observations included the need to assess the sustainability of gas resources, given the non-renewable nature of natural gas.

Nwatu & Ezenwa (2020) examined the connection between the Nigerian economy and the energy sector, emphasizing the dynamics of the energy mix, including oil, natural gas, and electricity sub-sectors. The study suggested that population growth significantly influences energy demand, highlighting factors affecting the Nigerian energy market such as crude oil dynamics, poor

gas infrastructure, electricity pricing issues, infrastructural security challenges, and poor policy implementation. Recommendations included building gas infrastructure, promoting renewable energy, and ensuring the security of oil and gas infrastructure.

Etukudor *et al.* (2015) explored challenges facing Nigeria's electricity supply industry (NESI), noting positive outlooks due to recent leadership changes and tariff increases. The study revealed that insufficient generating capacity and an inefficient transmission network contributed to frequent power failures. Observations included the study's theoretical nature and the absence of economic or statistical tests on NESI variables.

Aladejare (2014) studied Nigeria's electricity sector, focusing on energy, growth, and the economy. Descriptive and statistical analyses were employed to examine factors influencing Nigeria's electricity sector performance. The study projected scenarios for electricity demand based on different GDP growth rates and manufacturing sector contributions. Observations included the study's focus on the period when PHCN operated as a monopoly and the absence of projections on natural gas reserves supporting increased gas-fired plant power generation.

Solarin & Ozturk (2016) investigated the relationship between natural gas consumption and economic growth in 12 OPEC member countries from 1980-2012. The study used panel Granger causality tests and found mixed causality relationships among countries. Observations included the study's absence of natural gas reserves in the analysis.

Akinlo (2009) explored the causal link between energy consumption and economic growth in Nigeria from 1980-2006, using time series data. The study found a one-way causal link and suggested increased investment in the electricity sector to enhance economic expansion. Observations included caution in interpreting results due to a small sample size and potential omitted variable bias. Ojjiagwo *et al.* (2018) studied eliminating gas flaring by increasing domestic natural gas utilization in Nigeria. The study suggested Nigeria could generate an extra 7,500MW of electricity by utilizing flared gas. Observations included variations in gas flare estimates and the need for further investigation.

Nwaoha and Wood (2014) examined Nigeria's natural gas resources and their utilization, highlighting technologies, reserves, and incentives for growth. The study projected an increase in gas demand for power generation and identified sources of NG for the domestic market. Observations included policy changes in Nigeria's gas sector post-study.

Fayomi *et al.* (2021) focused on energy systems in Nigeria, emphasizing the pillars supporting effective systems. The study identified electricity as the most valuable form of energy and outlined pillars such as effective regulation, strengthened regulators, and policies on renewable energy. The study emphasized the role of energy in economic success and the increasing demand for electricity supply in Nigeria.

Gbadebo and Okonkwo (2009) investigated the relationship between energy use and the Nigerian economy from 1970-2005, considering crude oil, electricity, and coal. The study explored the potential diversification of Nigeria's energy mix by reintroducing coal. Observations included the dominance of crude oil in Nigeria's commercial energy sources and the need to consider other resources as the population and economy evolve.

Overall, these studies provide valuable insights into the complex relationships between energy sectors, economic growth, and development in Nigeria. They also highlight the need for ongoing research to address changes in policies, technologies, and the evolving energy landscape.

METHODOLOGY

The research aimed to assess the role of the NGP on NESI and Economic Growth. Secondary data from the World Bank, Central Bank of Nigeria (CBN), U.S. Energy Information Administration, Organisation of the Petroleum Exporting Countries (OPEC), Nigerian National Petroleum Company (NNPC) Limited, Nigerian Upstream Petroleum Regulatory Commission (NUPRC) and Nigerian Electricity Regulatory Commission (NERC) were utilized, consequently, the study uses the ex-post facto research design, that is, observations were made from time series data spanning from 1981 to 2019. The variables consist of dependent and independent variables, explained variable and explanatory variable, respectively. Data for the study were subjected to appropriate tests to check for errors. To make the study's outcome reliable, the data were tested for regression analysis suitability, consequently, violation of regression analysis assumptions: linearity, stationarity, homoscedasticity, independence, and normality assumptions were avoided. The study focused on reviewing, analyzing, and investigating the relationship between domestic natural gas use, power, and economic development in Nigeria. Iyke (2015) drew researchers' attention to the omission of variable bias which could limit the results of tests carried out, that is, consideration should be given to important economic factors when modeling. Consumer Price Index (CPI) which accounts for inflation as a significant contributor to economic growth is added as an explanatory variable to avoid omission bias, additionally, government expenditure and exchange rate are added as explanatory variables. The ADF test, ARDL Bounds Tests, and Error Correction Model (ECM) econometric modeling approach were used for the study. Variables in the model were logged to linearize the non-linear relationships, linearizing was to improve model fit and for ease of interpretation as percentages (elasticities). The comparative analysis examined the relationship between national gas consumption and future natural gas supply for Nigeria's industrialization, considering several policies of the Nigerian government on natural gas. The hypothesis for the study is given below:

Ho: There is a relationship between real GDP, electricity supply in Nigeria, and the National Gas Policy.

H1: There is no relationship between real GDP, electricity supply in Nigeria, and the National Gas Policy.

Model Specifications and Equations

The model for the study is represented in the functional form in Equation (1)

$$RGDP = f(ELEC, EXR, CPI, GE, DUM) \quad (1)$$

Regression form in Equation (2)

$$RGDP = \gamma + \beta_1 ELEC + \beta_2 EXR + \beta_3 CPI + \beta_4 GE + \beta_5 DUM + \epsilon_t \quad (2)$$

Where RGDP is real GDP, ELEC is Electricity Generation, EXR represents exchange Rate, CPI represents Consumer Price Index, GE is government expenditure, DUM is the dummy variable and represents the NGP, and ϵ_t is the error term.

Pre-Analysis Tests

The success of any survey analysis hinges on two key factors: the quality of data collected and the appropriateness of the chosen analytical model. Before diving into full-fledged analysis, a descriptive analysis of the raw data is crucial. This analysis, like a data x-ray, unveils its properties and characteristics, uncovering potential issues and guiding model selection. By examining descriptive statistics like standard deviation, kurtosis, and Jarque-Bera tests, diagnoses can be made of data quality and model suitability. Some of the analyses are presented as follows: Standard deviation vs. mean ratio: a value less than 1 suggests relatively low variability and minimal fluctuations in the data. This signals a more stable dataset. Kurtosis: A value of three (3) indicates a "normal" distribution, where data points are evenly spread around the average, <3 (Platykurtic), data is "flat" with fewer extreme values than a normal distribution, >3 (Leptokurtic), data has "peaky" tails with more extreme values than normal. Jarque-Bera test: A p-value above 5% suggests the data likely follows a normal distribution, lower values suggest otherwise. The decision criteria for the Jarque-Bera probability test are H0: normally distributed (P-Value > 0.05):H1: not normally distributed. (P-value < 0.05). The goal is to find a model that aligns with the characteristics revealed by these tests. Passing most of the tests by the data suggests better data quality, consequently, a more dependable analysis.

Unit Root Test and Optimal Lag Selection

Unit root tests are essential for assessing data stationarity, a crucial prerequisite for reliable regression analysis. These tests determine whether a time series mean and variance remain constant over time, indicating data health and suitability for further modeling. In this study, the joint unit root tests using the ADF and Phillips-Perron (PP) methods to assess the variable's stationarity.

To ensure unbiased results, optimal lag length selection was done by comparing the Akaike Information Criterion

(AIC) and Schwarz Criterion (SC) within EViews. This approach to lag selection supports the validity of subsequent ARDL tests.

ARDL Bounds Test

The ARDL bounds test is a statistical method used to examine the long-run relationship between variables in time series data. It tests for cointegration to determine whether the variables have a long-run relationship, even if they might have short-term deviations. The key steps include model specification with appropriate lag length, bounds testing, interpretation of the F-statistics value to determine co-integration, and then estimate the ECM for short-run dynamics and long-run adjustments if co-integration exists.

The ARDL equation for the model in compact form is shown in equation (3)

$$\text{ARDL}(p, q_1, q_2) = \alpha_0 + \sum_{i=1}^p \mu_i \text{RGDP}_{(t-i)} + \sum_{j=0}^{q_1} \gamma_1 \text{ELEC}_{(t-j)} + \sum_{j=0}^{q_2} \gamma_2 \text{EXR}_{(t-j)} + \sum_{j=0}^{q_3} \gamma_3 \text{CPI}_{(t-j)} + \sum_{j=0}^{q_4} \gamma_4 \text{GE}_{(t-j)} + \sum_{j=0}^{q_5} \gamma_5 \text{DUM}_{(t-j)} + \varepsilon_t \quad (3)$$

The bounds test model of the equation is captured as follows:

$$\Delta \text{RGDP}_t = \alpha_0 + \alpha_1 \text{RGDP}_{(t-1)} + \alpha_2 \text{ELEC}_{(t-1)} + \alpha_3 \text{EXR}_{(t-1)} + \alpha_4 \text{CPI}_{(t-1)} + \alpha_5 \text{GE}_{(t-1)} + \alpha_6 \text{DUM}_{(t-1)} + \sum_{i=1}^p \mu_i \text{RGDP}_{(t-i)} + \sum_{j=0}^{q_1} \gamma_1 \text{ELEC}_{(t-j)} + \sum_{j=0}^{q_2} \gamma_2 \text{EXR}_{(t-j)} + \sum_{j=0}^{q_3} \gamma_3 \text{CPI}_{(t-j)} + \sum_{j=0}^{q_4} \gamma_4 \text{GE}_{(t-j)} + \varepsilon_t \quad (4)$$

The General form of the error correction model is captured as follows:

$$\Delta \text{RGDP}_t = \alpha_0 + \sum_{i=1}^p \mu_i \text{RGDP}_{(t-i)} + \sum_{j=0}^{q_1} \gamma_1 \text{ELEC}_{(t-j)} + \sum_{j=0}^{q_2} \gamma_2 \text{EXR}_{(t-j)} + \sum_{j=0}^{q_3} \gamma_3 \text{CPI}_{(t-j)} + \sum_{j=0}^{q_4} \gamma_4 \text{GE}_{(t-j)} + \sum_{j=0}^{q_5} \gamma_5 \text{DUM}_{(t-j)} + \delta \text{ECT}_{(t-1)} + \varepsilon_t \quad (5)$$

RESULTS AND DISCUSSION

Descriptive Analysis

Table 1 contains the descriptive analysis of the model. From the analysis, the standard deviation of all the data sets is lower than the mean values indicating that there is no wide variation among the data set. The Kurtosis values of the data indicate that the data sets are platykurtic, this is because all the Kurtosis values are less than 3. The Jarque-Bera Statistics value suggests that the data sets are normally distributed, considering that most probability values are greater than 0.05 (5%).

Table 1: Descriptive Statistics

	LNRGDP	LNELEC	LNEXR	LNCPI	LNGE
Mean	10.36827	9.412152	3.480754	2.957174	1.027707
Median	10.1437	9.321882	4.626004	3.447871	0.737803
Maximum	11.18573	10.23853	5.726589	5.620401	2.245839
Minimum	9.693476	8.646466	-0.494255	-0.665532	-0.09296
Std. Dev.	0.516486	0.534162	1.981023	2.003201	0.769021
Skewness	0.364199	0.16344	-0.783041	-0.487147	0.258523
Kurtosis	1.601547	1.464508	2.319139	1.835508	1.605488
Jarque-Bera	4.040133	4.00495	4.738797	3.746095	3.5945
Probability	0.132647	0.135001	0.093537	0.153655	0.165754

Source: Author's analysis using Eviews 10

Unit Root Test

The result summary of the unit root (stationarity) test is presented in table 2. The ADF and PP unit root test produced similar outcomes, that is, all variables were not stationary at levels, but all were found to be statistically significant at a 5% level of confidence at first difference. Some researchers suggest that unit root pre-testing is not required for the ARDL cointegration technique, however,

Nkoro & Uko (2016) suggested that the unit root test can save the model from errors because of ARDL model crash. This crash could occur due to second differencing caused by an integrated stochastic trend. Consequently, the ARDL cointegrating technique can be applied when the variables are of mixed order of integration (I (0) and I (1)), or all variables are stationary at first difference, in both cases, the results derived are valid and acceptable.

Table 2: Unit Root (Stationarity) Test Result

Variable	Levels		1st Difference		Status - I(d)
	ADF	PP	ADF	PP	
	P-value	P-value	P-value	P-value	
LNRGDP	0.8081	0.1151	0.0300	0.0419	I (1)
LNELEC	0.4474	0.3871	0.0000	0.0000	I (1)
LNEXR	0.8784	0.8810	0.0003	0.0001	I (1)
LNCPI	0.4321	0.9460	0.0401	0.0346	I (1)
LNGE	0.5287	0.5138	0.0001	0.0000	I (1)

Source: Author's analysis using Eviews 10

Bounds Co-integration Test

Table 3 presents the output of the bounds co-integration test. The result suggests a cointegrating relationship among the variables based on the F-statistic value of 8.904. This value exceeds the upper bound thresholds at all significance levels (1%, 5%, 10%), therefore a rejection

of the null hypothesis of no cointegration.

Therefore, the variables exhibit a long-run equilibrium relationship, fulfilling a key requirement for applying the ARDL model. Consequently, the ECM within the ARDL framework can be utilized for further analysis.

Table 3: Result of Bound Co-integration Test

F-Bounds Test	Null Hypothesis: No level relationship			
Test Statistic	Value	Signif.	I(0)	I(1)
F-Statistic	8.904207	10%	2.45	3.52
K	4	5%	2.86	4.01
		2.50%	3.25	4.49
		1%	3.74	5.06

Source: Author's analysis using Eviews 10

ARDL Long Run Coefficients

Table 4 presents the findings of the long-run analysis conducted. The results suggest that a 1% increase in electricity consumption (LNELEC) is associated with a 0.1178% rise in the dependent variable (RGDP) in the long run. This relationship is statistically significant at the 5% level (p-value = 0.0494). LNXER: a 1% appreciation of the exchange rate leads to a 0.0392% increase in the dependent variable in the long run. This relationship is also statistically significant at the 5% level (p-value = 0.0238). LNCPI: a 1% increase in the consumer price index is associated with a 0.0197% decrease in the dependent variable in the long run. However, this relationship is

not statistically significant (p-value = 0.2781). LNGE: a 1% increase in government expenditure leads to a 0.0031% increase in the dependent variable in the long run. However, this relationship is also not statistically significant. Dummy variable (DUM): When the dummy variable switches from 0 to 1, the dependent variable experiences an increase in the long run. However, this change is not statistically significant (coefficient = 0.050993). In summary, electric consumption and exchange rate have statistically significant positive long-run relationships on the dependent variable, while consumer price index and government expenditure do not show statistically significant relationships.

Table 4: ARDL Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNELEC	0.117764	0.05722	2.058081	0.0494
LNXER	0.039157	0.01635	2.394948	0.0238
LNCPI	-0.01969	0.017787	-1.10684	0.2781
LNGE	0.003107	0.017733	0.175207	0.8622
DUM	0.050993	0.036387	1.401395	0.1725
C	1.157511	0.398545	2.904344	0.0073

Source: Author's analysis using Eviews 10

Short Run Analysis and Error Correction Mechanism

Table 5 presents the result of short-run analysis and ECM, the DUM coefficient of 0.050993 suggests that, in the short run, when the dummy variable (DUM) changes from 0 to 1, the dependent variable increases by 0.050993%. This effect is statistically significant (Prob. = 0.0005). Additionally, the error correction term (ECT) with a coefficient of 0.222 indicates that about 22.27%

of short-term disequilibrium is corrected annually. The ECT meets the criteria for size, sign, and significance, signifying stability. The system is converging to long-run equilibrium at a slow rate of about 22.27% per period, which, though slow, falls within an acceptable range of -1 to 0. This slower adjustment may be influenced by factors such as government policies hindering a quick return to long-run equilibrium after a shock.

Table 5: ARDL Short Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNELEC	0.114477	0.045077	2.53958	0.0172
LNXER	-0.011464	0.016934	-0.67694	0.5042
LNCPI	-0.157093	0.038836	-4.04505	0.0004

LNGE	-0.012371	0.014057	-0.88007	0.3866
DUM	0.050993	0.012863	3.964201	0.0005
CointEq (-1)*	-0.222767	0.031158	-7.1496	0.0000

Source: Author's analysis using Eviews 10

Post Diagnostic Tests

Table 6 presents the summary of some post-diagnostic tests carried out on the model. The summary of the key findings is as follows: Normality: No evidence of deviation from a normal distribution (Jarque-Bera test p-value > 0.05). Heteroskedasticity: No evidence of unequal variance of residuals (F-statistic p-value > 0.05). Serial Correlation: No evidence of correlation between consecutive residuals (F-statistic p-value > 0.05). This implies independent and identically distributed error

terms, a key assumption for valid regression analysis. Model Specification: The model appears to have the correct functional form and includes all relevant variables (Ramsey RESET test p-value > 0.05). Relationship between variables: There is a strong linear relationship between the dependent and independent variables (R-square = 99%). Overall, the post-diagnostic results suggest that the regression model is well-specified, and its results are reliable.

Table 6: Summary of Post-Diagnostic Tests

Breusch-Pagan-Godfrey Heteroskedasticity Test	F-statistic	0.862527	Prob. F (10,27)	0.3006
	Obs*R-squared	11.10478	Prob. Chi-square (10)	0.2791
	Scaled explained SS	4.967721	Prob. Chi-square (10)	0.8639
Breusch-Godfrey Serial Correlation LM Test	F-statistic	0.814631	Prob. F (1,26)	0.3750
	Obs*R-squared	1.154443	Prob. Chi-square (1)	0.2826
Jarque - Bera Normality Test	Jarque-Bera	0.097453		
	Probability	0.952411		
Ramsey Reset Test		Value	df	Probability
	t-statistics	0.111876	25	0.9118
	F-statistic	0.012516	(1,25)	0.9118

Source: Author's analysis using Eviews 10

Stability Test

Figure 1 presents the output of the CUSUM Stability test carried out on Eviews 10. The CUSUM test indicated some instability between 2009 and 2012 as shown. This period predated events like the 2007 - 2008 financial crisis and rising insurgency in Nigeria, for example, the UN building in Abuja, the capital of Nigeria was bombed by terrorists in 2011, suggesting that these internal and external factors might have caused this temporary volatility in Nigeria's economy during that period. Nigeria's growth rate declined due to the global

financial crisis, and the impact on Nigeria's financial institutions was severe leading to unemployment and a negative effect on the economy in 2009 (Atoyebi and Amaefule, 2023). The global financial crisis did not spare Nigeria's economy, consequently, the stock market and the economy lost great value triggered by the crisis, the recovery of the economy did not start until some years later (Njiforti, 2015). However, it's worth noting that the model appears stable before and after this period, suggesting these events may have caused the instability, and its impact had a temporary effect on the economy.

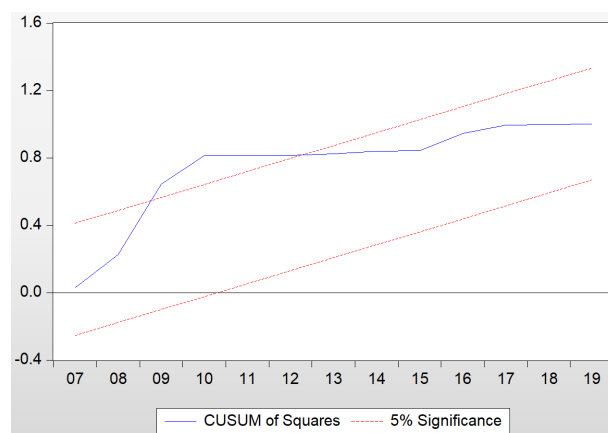


Figure 1: CUSUM Stability Test

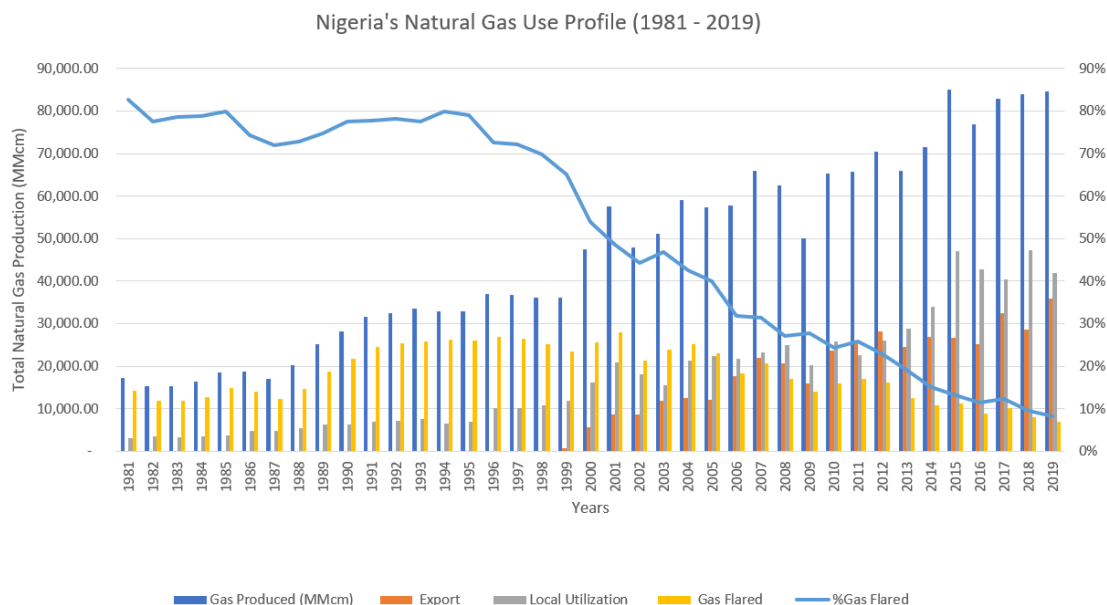


Figure 2: Nigeria's Gas Use Profile (Author's analysis)

CONCLUSION

This study focused on the relationship between real GDP (RGDP), electricity supply (ELEC), and Nigeria's National Gas Policy (NGP) using time series data. The analysis employs unit root tests, ARDL models, Cointegration, and ECM tests. The findings indicate a positive short-term and long-term relationship between RGDP, ELEC, and NGP, with the latter being statistically significant at a 5% level in the short run, therefore, acceptance of the null hypothesis. The depletable nature of Nigeria's NG reserves has policy implications on economic growth and the ability to continue to use NG-fired power plants. It was estimated that the depletion of NG reserves may occur within 20 years if the country achieves 100,000MW of electricity supply through gas-to-power by 2030. The need for diversifying the primary energy mix for power generation is paramount, while also noting that the NGP helps grow domestic NG use, which in turn will contribute to economic growth, but caution must be taken because NG is a depletable resource. The study suggests that Nigeria should formulate policies to provide energy alternatives to mitigate the depletion of NG due to rapid industrialization which may be fueled by the NGP policy attainment. On a broader scale, the Nigerian government should consider other policies in addition to the NGP to stimulate economic growth. Nigeria may explore policies that support increased economic activity in the top ten (10) most traded goods (cars, refined petroleum, integrated circuits, vehicle parts, computers, pharmaceuticals, gold, crude petroleum, telephones, broadcasting equipment) in the world highlighted by the World Economic Forum for possible expansion. The study concludes that while the NGP is beneficial for economic growth, a more comprehensive economic approach is needed to sustain growth in the face of potential NG depletion.

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