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An Evaluation of Domestic Gas Utilization on the Nigerian Economy

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Authors' contributions

This work was carried out in collaboration between all authors. Author RUO designed the study, developed the methodology and wrote the first draft of the manuscript. Author TJL managed the literature searches and the econometric analysis of the study while authors AA and SOI did the revised conceptual framework. All authors read and approved the final manuscript.

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ABSTRACT

Natural gas has continued to experience high patronage over the years, largely due to its efficiency as an energy source. Economic growth literature posits that there is a relationship between energy consumption and growth. More recent literature have argued for the efficiency of the form of energy used. The robustness of this relationship is however often questioned. Indeed natural gas remains one of the most efficient forms of energy source, and it is found in abundance in Nigeria with a proven reserve of over 180 trillion cubic feet of natural gas and the ninth country in the world regarding proven natural gas reserves. Hence, given the significant outlays of natural gas to economic growth, this study attempts an evaluation of domestic gas utilisation in Nigeria. Key macroeconomic variables with the theoretical potential of influencing the level of gas utilised in Nigeria were subjected to econometric model testing using time series data from 1980 to 2013. The result in conformity with literature reflected that gas plays a pivotal role in the Nigerian economic advancement.

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1. INTRODUCTION

Natural gas is a fossil fuel formed when layers of buried plants and animals are exposed to intense heat and pressure over millions of years. Natural gas is the cleanest and most hydrogen- rich of all the hydrogen energy sources with high energy conversion efficiencies for power generation [1].

Nigeria is among the world's top ten (10) countries in terms of natural gas proven reserves (over 180 trillion cubic feet [2], world's top five (5) exporters of liquefied natural gas (LNG) and a major supplier to the West African Gas Pipeline (WAPCo). Historically, there has been an over-reliance on crude oil export and more search for oil than gas. However, with the continuous decline in global crude oil prices and increased demand for natural gas to fuel the power plants in the country. Natural gas is gaining more importance in Nigeria.

Nigeria started out primarily as an oil producing economy, sequel to the crude oil discovery in 1956. In the early days of the energy industry, the concurrent exploitation of associated gas was not taken into consideration to be worthy of pursuing because of the magnitude of revenue being generated from oil sales [3]. Although in more recent times, Nigeria is often referred to as a gas-rich economy that produces oil [4] Nigeria is, however, often cited as an example of how not to develop and manage a natural resource. Similar to most oil-rich developing economies, Nigeria's economic development has been heavily dependent on the oil industry to the detriment of other sectors.

As at the 1960s, there were already calls for domestic gas utilization, however, this was grossly hindered and impeded by infrastructural issues. On the other hand, the country was in discussions with United Kingdom which was later delayed because of price disagreement and before agreements were made there were North Sea discoveries which halted the process [5, pp.289-326]. However, after a couple of decades of gas flaring, the Nigeria LNG company began operation in 1999 as part of export-driven efforts to mitigate the environmental impacts of gas flaring and at the same time monetize Nigeria's gas deposits [6 pp.973–981,]. With the commissioning of the West Africa Gas Pipeline (WAGP) in 2011, Nigeria commenced exporting gas to neighbouring Ghana with plans to extend delivery to Benin and Togo as well [7]. While at the moment, gas is already domestically utilised in the generation of power, for example, the initial export emphasis has led to a situation not too encouraging for effective domestic consumption and utilisation.

In addressing this, the Nigerian government has instituted a domestic supply obligation (DSO) aimed at guaranteeing gas availability for local and domestic use as part of plans of deepening the domestic gas market and support industrialisation. [4], identified fertiliser, aluminium, methanol as well as additional power plants as some of the available options proposed for deepening domestic gas market In addition to guaranteeing domestic gas supply, a new pricing policy was adopted to encourage domestic gas demand.

This study, therefore, aims at evaluating the implications of domestic gas utilisation for economic growth in Nigeria. In achieving this, Key macroeconomic variables with the theoretical potential of influencing the level of gas utilised in Nigeria were subjected to econometric model testing using time series data from 1980 to 2013. The study starts by providing a brief background of trends in gas consumption in Nigeria, after which an outlay of challenges and policy developments about Gas in Nigeria is provided. The Next section provides a review of some relevant literature followed by a section of methodology. Empirical results are then presented followed by a section on policy recommendations and conclusion.

2. BACKGROUND TO THE STUDY

2.1 Trend Analysis of Key Variables

Based on the analysis of natural gas consumption in Nigeria by the United States Energy Information Administration, natural gas consumption rose from 37.8 billion cubic feet in 1980 to 385.64 billion cubic feet in 2006 and then dropped to 190.7 billion cubic feet in 2011[8].

The reason for the decline in gas consumption (see Fig. 1) after the gas master plan initiation in 2008, was as a result of a contagion effect (The aftermath of the global recession was felt by the Nigerian economy which is a resultant

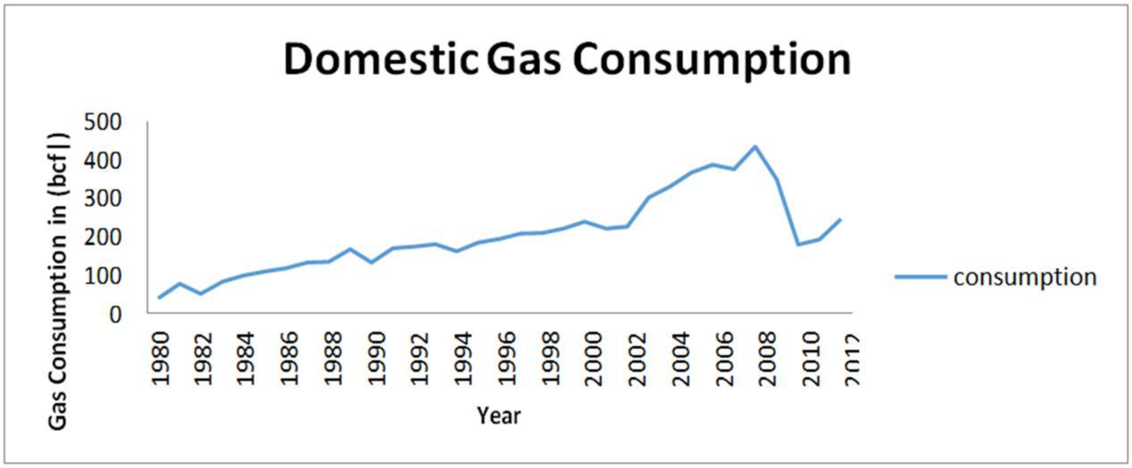

Fig. 1. Domestic Gas Consumption in Nigeria (1980-2012)

effect of the interwoven global stock market). The contagion effect can also be seen in Figs. 2 and 3 (see Appendix). Gas utilisation has potentials for power generation, industrial heating, fertilizer, petrochemicals, and manufacturing and as feedstock for direct steel reduction. Over the years, the interest to use gas to meet domestic utilisation demand has continued to decline as a result of continued interest in its foreign revenue earning potentials.

2.2 Challenges facing the Domestic Utilisation of Natural Gas in Nigeria

Despite the growing importance of Natural gas in the country, some factors are hindering the optimal domestic utilisation of gas. According to Falobi, natural gas in Nigeria has not been fully maximised in its value for the domestic economy, nor as a source of fiscal revenue to the domestic economy due to the inadequacies of infrastructural development funding, inefficient regulatory framework and gas policy for the domestic use [9] .Due to unsustainable exploitation practices coupled with the lack of gas utilisation infrastructure, Nigeria flares a substantial proportion of the gas it produces, currently about 10% of its production[10, pg34] when compared to the oil production in developed economies. Furthermore, Nigeria lags behind regarding associated gas conservation and utilisation. For example, Natural gas reserves in a marginal oil field can contribute to the sustainable development of Nigeria economy if properly harnessed. As with most oilfields in Nigeria, the designated marginal fields projects are produced with associated gas, but over the year's natural gas produced in the associated field in Nigeria has been flared [11]. Gas Flaring has grave implications for Nigeria and potentially other countries as well. External costs are the costs imposed on Nigerians and others as a result of the activities of private oil companies (IOC and MFO), which are not currently factored into the cost of doing business. Egbuna studied the environmental hazards of the natural gas industry. He observed that in 1986, the total gas flared from over 300 fields in Nigeria yielded a wasted heat equivalent of about 60x10 nine kWh which is approximately equal to all the Total Electric Power PLC (NEPA) that year from all sources. He states that the economic loss estimates put the price of flared natural gas at about fifty million Naira (or over 30 million dollars, indexed to 1985 price), per day [12].

2.3 Policy Developments

According to the National Energy policy by the Energy Commission of Nigeria, various policies have been developed to encourage domestic utilisation of natural gas. These are:

- The nation's gas resources shall be harnessed and optimally integrated into the national economy, energy mix and industrial purposes.
- The nation shall engage intensively in gas exploration and development to (or "intending to") increasing the reserve base to the highest level possible
- The nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry.

- The nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network.

Policy/ regulations	Objective
National Oil and Gas Policy 2004	In line with the National Energy Policy. Broad policy statements for petroleum industry provides the policy framework for a liberalised and functional gas industry, especially the domestic gas utilisation
Downstream Gas Bill, 2005	Proposed to implement the liberalisation of the domestic gas market.
Nigerian Gas Master Plan (NGMP) 2008	Domestic gas development agenda in line with the National Energy Policy and National Oil and Gas Policy. -Domestic gas supply obligation -Gas infrastructure blueprint -Gas Pricing Policy
National Domestic Gas Supply and Pricing Regulations 2008	Provides the framework for determining gas pricing across various sectors
Petroleum Industry Bill (PIB) 2012	Following the industry reforms that began in 2000, the PIB proposes a comprehensive legal framework for the exploitation of petroleum, including gas.
Associated Gas Framework Agreement (AGFA) 1991 & 1992 and Sec. 39, Companies Income Tax Act 2007	Provide fiscal incentives for gas utilization-gas-fired power plants, GTL Plants, fertiliser plants, LNG, gas distribution and transmission pipeline.

The Gas Aggregator Company of Nigeria (GACN) was incorporated in 2010. It was created to manage domestic gas supply obligations volumes and to act as the first point of contact for gas buyers to access gas for domestic market use. The main role of the GACN includes engaging in demand management until the end of government's intervention through the domestic supply obligation. Also, it provides aggregate price / securitization / escrow management services until the expiry of the first set of gas supply and purchase agreements. Finally it engages in the gas network and system administration and provides trading platform when the market fully matures commercially and is fully deregulated.

3. LITERATURE REVIEW

In the literature of energy economics, the causal relationship between energy consumption and income is a well-studied topic. In their pioneering studies on Granger causality, Kraft and Kraft found unidirectional causality running from GNP to energy consumption for the United States [13, pp.401–403]. However, Akarca and Long pointed out that the Kraft-Kraft results are spurious by changing the period for two years [14, pp.326–331]. Oh and Lee argued that particularly in distinguishing dynamics of short-run relationships from long-run relationships, the empirical results suggested that multivariate VECM models can be useful in examining Granger causality in the presence of cointegration [6]. They found the existence of a long-run unidirectional causal relationship from Gross Domestic Product (GDP) to energy, but no short run causal relationship between energy and GDP. The source of causation, in the long run, points to the error correction term. Paul and Bhattacharya examined the different direction of a causal relation between energy consumption and economic growth in India [15, pp.977–983]. Applying Engle-Granger cointegration approach combined with the standard Granger causality test on Indian data for the period 1950–1996, it is found that bi-directional causality exists between energy consumption and economic growth. Further, they applied Johansen multivariate cointegration technique on the different set of variables. The same direction of causality exists between energy consumption, and economic growth is used. In their study, empirical results using the standard Granger causality test reveal a unidirectional causal relation from energy consumption to economic growth. This process does not show any causal effect from economic growth to energy consumption. However, use of Engle-Granger cointegration process exhibits a unidirectional long-run causality from GDP along with capital to energy consumption [10]. No short-run relation is found [16]. The results of the Engle-Granger approach combined with the standard Granger causality process indicate that there is bi-directional causality between energy consumption and economic growth. The long-run causal relation runs from GDP to energy consumption, and the short-run causal relation runs from energy consumption to GDP.

Aqeel and Butt investigated the causal relationship between energy consumption and economic growth and energy consumption and employment in Pakistan. They applied co-integration and Hsiao's version of Granger causality; the results found inferred that economic growth causes total energy consumption. Economic growth also leads to growth in petroleum consumption, while on the other hand; neither economic growth nor gas consumption affects each other. However, in the power sector, it has been found that electricity consumption leads to economic growth without feedback. The implications of the study are that energy conservation policy regarding petroleum consumption would not lead to any side-effects on economic growth in Pakistan. However, an energy growth policy in the case of gas and electricity consumption should be adopted in such a way that it stimulates growth in the economy and thus expands employment opportunities [17, pp.101–110].

Some studies have been published to evaluate the relationship between natural gas consumption and economic growth. Audu evaluated the relationship between gas utilization and the Nigerian economic performance using the error correction analysis; based on his findings he recommended that Nigerian gas sector should be fully utilized and policies should be made to attract foreign direct investment as well as full liberalization of the upstream and downstream sectors of the oil and gas industry [18]. Okotie and Ikporo [19] assessed the economic cost of gas flaring in Nigeria using Empirical Method(t-test and correlation statistics), his study found that there is Significant wastage of the nation's income as a result of gas flaring in Nigeria. Ojide et al. [20, pp. 2244-2251] evaluated the impact and sustainability of gas utilisation on the Nigerian economy using the distributed lag (DL) model, a dummy variable regression model and co-integration analysis, they, however, found that Utilization of Nigerian natural gas impacts positively on the economy and it is sustainable. Adegbemi et al. carried out an Evaluation of the causal nexus between energy consumption and Nigeria's economic growth using the co-integration and ordinary least square technique, the empirical results reveal that petroleum, electricity and the aggregate energy consumption have significant and positive relationship with economic growth in Nigeria. The study also reveals that although gas consumption was positive, it does not have a significant effect on economic growth [21].

Soheila and Nikos [22] conducted a study to determine the causality relationship between Natural gas consumption and Economic Growth in Iran using the Autoregressive distributed lag bounds testing approach, results indicated that natural gas consumption, capital formation, employment, financial development, exports are contributing factors to domestic production and economic growth in Iran. Sahib et al. [23] carried out a study to determine the causality relationship between Natural gas consumption and Economic growth in France, using Cobb-Douglas Production function. Their findings indicated that natural gas consumption, capital, labour and exports are contributing factors to domestic production and economic growth in France. Demko [24] investigated the type of causality between natural gas consumption and Regional economic growth in Ukraine using the Arellano-Bond estimator; he, however, found out that there is a Positive impact of natural gas consumption on regional economic growth was found.

Jahan, investigated the possible pattern of natural gas consumption in Bangladesh over the time period 1990 to 2013 using an econometric modeling, by fitting linear regression model, impacts of socioeconomic variables like per capita GDP, Natural gas production, total amount of gas sale, number of customers on gas consumption were studied in his paper. Probable econometric validations for the models like heteroscedasticity, autocorrelation were examined, and it was observed that the value of the coefficient for per capita GDP implies that an increase in GDP raises gas consumption [25]. With electric power generation at its ground state, a crippling rate of unemployment, emergent global climate change caused by greenhouse emissions from flare-out, it has become imperative to find further ways to exploit and utilise the nation's natural gas reserves and translate it to the improvement of the nation's economy [26, pp.310-316].

4. METHODOLOGY

Data used in the study is taken from World Development Indicators as well as the International Energy Statistics covering 1980-2013. For the study, Gas consumption is measured in Billion Cubic Feet, Labour is measured in millions, and economic growth is proxied to real GDP, while gross capital formation is used as a measure of investment in the economy.

This research adopts the Aqeel and Butt model which examines the impact of energy consumption on economic growth in Pakistan [17]. For the purpose of this research, the model will relate only to gas consumption on economic growth in Nigeria. The general form of the model is set as:

$$Y = f(K, L, G) \quad (1)$$

Where

Y= Real Gross Domestic Product (Dependent variable)
L = Labour
K = Capital (Investment)
G = Total Gas consumed

We have transformed all the series into logarithmic form. The logarithmic specification of Eq.(1) is as follows:

$$\log Y = \alpha + \beta 1 \ \log Lt + \beta \ 2 \log Kt + \beta \ 3 \log Gt + \varepsilon t \quad (2)$$

β 1 , β 2 , β 3 = are the elasticity of each of the independent variable.

Log denotes logarithms; t denotes time, β parameter value and ε denote the residual term. Logarithmic specification produces a better result compared to the linear functional form of the model. Thus, all data are transformed to natural logarithms.

5. RESULTS AND DISCUSSION

Table 1 presents brief preliminary information about the data used for the study. The total number of observations covered by the study per variable is 34 implying the study covered a total number of 34 years. The data was log transformed. The variables were log transformed considering the exponential growth pattern of some of the observations so as to avoid spuriousness in the relationships.

The data was then subjected to a correlation analysis. A significantly positive correlation was found to exist between economic growth and all the independent variables including total Gas consumption. A positive but weak relationship was found to exist between investment and labour. However, regarding gas consumption and investments in Nigeria a relatively insignificant negative correlation was found.

Each variable was subjected to unit roots test, using Philip Perron (PP) unit root test. This choice is based on the advantage of PP test specifically when dealing with financial observations. PP test is unique in dealing with serial correlation and heteroscedasticity in errors. It corrects for serial correlation and heteroscedasticity in the errors by directly modifying the test statistics. PP unit root test is robust to general forms of heteroskedasticity in the error term u t and does not require specified lag length.

Table 1. Descriptive statistics

Descriptive	**LY**	**LK**	**LL**	**LG**
Mean	25.04306	22.80964	17.35353	5.179439
Median	24.85338	22.55683	17.38903	5.230861
Maximum	25.93444	23.81108	17.80818	6.071873
Minimum	24.50055	21.91424	16.81343	3.632045
Std. Dev.	0.444740	0.534701	0.289630	0.565544
Skewness	0.811388	0.510725	-0.264887	-0.768539
Kurtosis	2.158714	1.982045	1.970118	3.514385
Observations	34	34	34	34
Correlation	LY	LK	LL	LG
LY	1.000000	0.657126	0.856967	0.632668
LK	0.657126	1.000000	0.261510	-0.039724
LL	0.856967	0.261510	1.000000	0.875784
LG	0.632668	-0.039724	0.875784	1.000000

Table 2. Unit root test

	Level		First differencing		Status
Variable	**t-statistic**	**Prob. value**	**t-statistic**	**Prob. value**	
LY	-2.470905	0.3393	-3.804243	0.0004	I(1)
LK	-3.377706	0.0735	-5.699182	0.0003	I(1)
LL	-3.403183	0.0180	-3.403183	0.0019	I(0)
LG	-3.002335	0.0450	-3.002335	0.0053	I(0)

Based on the nature of the data used as indicated in Table 1, we observe an upward trend in the series meaning that the means of the time series change over time signalling the possibility of the data not to be stationary in natural form. To adjust for this, we transform the series to first differenced logarithmic form. In validating these statistically, we subject the data to formal stationarity test using Philip Perron (PP) unit root test. We subject the variables to PP test individually. We tested for the symptoms of unit roots following the systematic procedure advanced by Enders [27]. The results reveal that not all the variables were stationary at level. The result at level for labour and total gas consumption were stationary at level inferring they are of order 0 I(0). The data for the variables economic growth and investment were stationary after first difference revealing they are of order 1 I(1) (see Apendix; Table 3). The results of the PP unit root test are presented in Table 2 above.

3.1 Co-integration Test

The cointegration test signifies if a long run relationship exists between the variables of the model, and therefore a signal for causality [12,24] Based on the results we conclude that long-run relationship exists between the variables, as presented in Table 4.

To empirically analyse the long-run relationships and dynamic interactions among the variables of interest, the model has been estimated by using the bounds testing (or autoregressive distributed lag (ARDL)) cointegration procedure, developed by [19]. The procedure is adopted for the following three reasons. Firstly, the bounds test procedure is simple. As opposed to other multivariate cointegration techniques such as Johansen and Juselius [28, pp.169-210.] it allows the cointegration relationship to be estimated by OLS once the lag order of the model is identified. Secondly, the bounds testing procedure does not require the pre-testing of the variables included in the model for unit roots unlike other techniques such as the Johansen approach. It is applicable irrespective of whether the regressors in the model are purely I (0), purely I (1) or mutually cointegrated. Thirdly, the test is relatively more efficient in small or finite sample data sizes as is the case in this study. The procedure will, however, crash in the presence of I (2) series. We have however ascertained that all our variables are strictly within I (1) and I (0).

While Engle-Granger Cointegration test is largely suitable for bivariate models, Johansen Co-integration test requires a large set of observation. We have however opted for an ARDL cointegration test because of the short nature of our observations and the mixed order of integration (I (0) and I (1)) of our variables.

Based on the result of the ARDL cointegration test, the result suggests a long-run relationship among the variables. The first lag of gas consumption and economic growth has a positive relationship; the second lag has an inverse relationship with economic growth. However, the first lag of economic growth is positively related to gas consumption but negative in the second lag. Both lags of gas consumption have a positive relationship with gas consumption. Both lags of gas consumption have an inverse relationship with labour. This implies that has more gas is utilised; less labour will be needed within the economy. In the case of investment within the economy, there is a positive relationship with the first lag of gas consumption but inverse in the second lag. Taking these findings into perspective, previous studies such as Sahib et al. [23] using a Cobb-Douglas model for France found a similar relationship between gas consumption and economic growth. Similarly, Jahan conducted a study on Bangladesh and found that economic growth increases gas consumption in Bangladesh [25].

To validate our ARDL test, a Wald test was conducted (see Appendix: Table 5). The result of the Wald test revealed that coefficients are statistically different from zero with p values suggesting 5%; we, therefore, reject the null hypothesis and conclude that there is a long relationship among the variables.

Table 4. ARDL cointegration test

LY		LG	LL	LK
LY(-1)	1.031790	0.846143	0.037852	0.187942
	(0.21069)	(0.59500)	(0.02688)	(0.67190)
	[4.89722]	[1.42209]	[1.40796]	[0.27972]
LY(-2)	-0.112202	-0.635229	0.004819	0.785887
	(0.21505)	(0.60732)	(0.02744)	(0.68582)
	[-0.52174]	[-1.04595]	[0.17561]	[1.14591]
LG(-1)	0.104194	0.435645	-0.004097	0.142953
	(0.07222)	(0.20394)	(0.00921)	(0.23030)
	[1.44284]	[2.13615]	[-0.44462]	[0.62073]
LG(-2)	-0.070496	0.048039	-0.001809	-0.023732
	(0.06231)	(0.17596)	(0.00795)	(0.19870)
	[-1.13142]	[0.27301]	[-0.22754]	[-0.11943]
LL(-1)	-0.242714	0.483764	0.793621	1.405737
	(1.75237)	(4.94880)	(0.22361)	(5.58845)
	[-0.13851]	[0.09775]	[3.54920]	[0.25154]
LL(-2)	0.391051	0.046123	0.141721	-2.083064
	(1.67278)	(4.72404)	(0.21345)	(5.33465)
	[0.23377]	[0.00976]	[0.66395]	[-0.39048]
LK(-1)	0.028815	-0.314681	-0.001087	0.616825
	(0.05746)	(0.16226)	(0.00733)	(0.18324)
	[0.50151]	[-1.93931]	[-0.14825]	[3.36626]
LK(-2)	-0.009781	0.042928	-0.012993	-0.239195
	(0.06658)	(0.18804)	(0.00850)	(0.21234)
	[-0.14690]	[0.22830]	[-1.52931]	[-1.12646]
C	-1.129031	-5.574588	0.440120	0.890023
	(1.69327)	(4.78190)	(0.21606)	(5.39998)
	[-0.66678]	[-1.16577]	[2.03699]	[0.16482]
R-squared	0.985007	0.895101	0.999290	0.874146
Adj. R-squared	0.979791	0.858615	0.999043	0.830371
Sum sq. resids	0.095498	0.761626	0.001555	0.971238
S.E. equation	0.064437	0.181973	0.008222	0.205494
F-statistic	188.8749	24.53235	4044.197	19.96892
Log likelihood	47.62417	14.40253	113.5071	10.51269
Akaike AIC	-2.414011	-0.337658	-6.531692	-0.094543
Schwarz SC	-2.001773	0.074580	-6.119454	0.317695
Mean dependent	25.05956	5.254317	17.38615	22.75345
S.D. dependent	0.453278	0.483955	0.265720	0.498940
Determinant resid covariance (dof adj.)		2.76E-10		
Determinant resid covariance		7.38E-11		
Log likelihood		191.6601		
Akaike information criterion		-9.728755		
Schwarz criterion		-8.079802		

3.2 Error Correction Test

Having found that there is a long-run relationship between economic growth and domestic gas utilisation, the next step is to test for the causality between the variables used by incorporating the lagged error-correction term Gujarati and Porter [29] The causality, in this case, is examined through the significance of the coefficient of the lagged error-correction term and joint significance of the lagged differences of the explanatory variables using the Wald test. The results of these causality tests are reported in Table 6 (see Appendix). The empirical results reported in Table 6 show that there is a distinct unidirectional causal flow from domestic gas utilisation to economic growth, both in the short run and in the long run. The long-run causality from domestic gas utilisation to economic growth is supported by the coefficient of the lagged error correction term in the economic growth function, which is negative and statistically significant, as expected. The short- run causality from domestic gas utilisation to economic growth, on the other hand, is supported by the F-statistic in the economic growth function, which is statistically significant. The reverse causality from economic growth to domestic gas utilisation, however, is rejected by the lagged error correction term and the F-statistic, which are all statistically insignificant.

5. CONCLUSION, POLICY IMPLICATION AND RECOMMENDATION

In conclusion, based on the analysis conducted in this study, it was observed that there is a long-run positive relationship between economic growth and gas consumption, this requires that the appropriate policies need to be implemented and incentives provided to improve economic growth in the country which will improve the lives of the citizenry. Also, there is a long run relationship between Gas consumption and labour, although not very significant because the oil and gas sector is not labour driven. A long run inverse relationship exists between Gas Consumption and Investment in Nigeria, which shows the harsh business investment environment of Nigeria. This is as a result of the multiple taxations from government and fewer incentives for investors. It is recommended that domestic demand for natural gas should be given priority over exportation and government should make the business environment-friendly to attract foreign investment which will require review of some fiscal policies.

Most of the policies mentioned above such as; putting in place necessary infrastructures and incentives to encourage indigenous and foreign companies to invest in the gas industry, are yet to be implemented. One of the constraints to the improvement in gas supply is the lack of negotiated agreement with oil majors. Penalties for gas flaring are still very mild and tolerated because of the lack of infrastructure to transmit and distribute the generated gas.

This study recommends that the IOCs and the indigenous companies who own natural gas assets should be allowed to generate, transmit and distribute the gas but should be regulated by the government to avoid exploitation of consumers. Also, given the multiple application of natural gas, it has a huge potential to fuel the future and economy of Nigeria (Igweonu and Mbabuike [30, pp.190-194]. The government should, therefore, provide incentives to encourage increased use of natural gas.

In another vein, the regulated pricing regimes in the natural gas sector seem to be hampering the growth of the sector; government should allow a competitive market for the sector to encourage foreign investment in the sector. The government should also provide the right policy to incentivize natural gas storage, processing and distribution.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

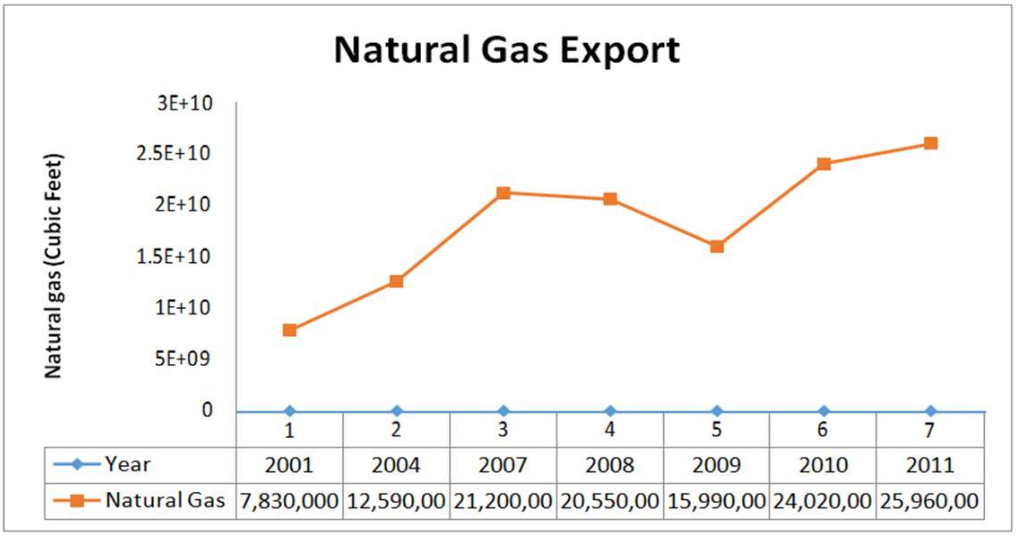

Fig. 2. Natural gas export in Nigeria (2001-2011)

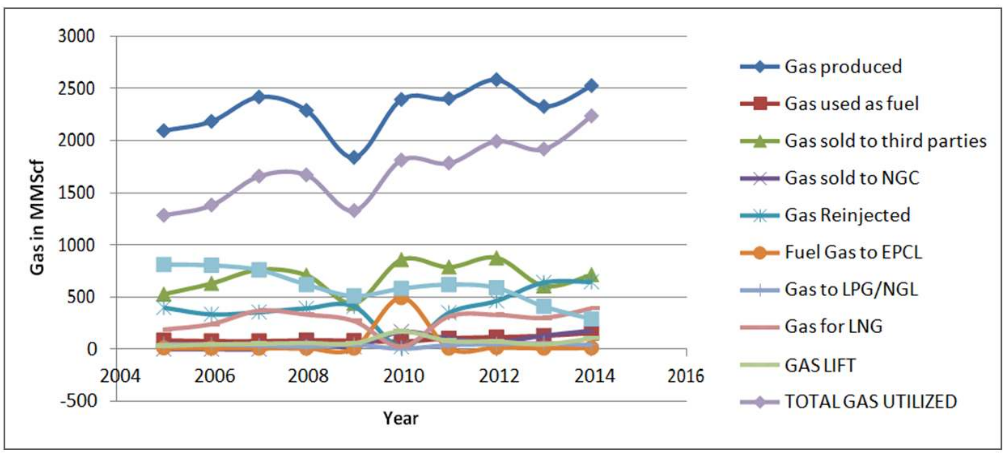

Fig. 3. Gas production and Utilisation in Nigeria from 2004 to 2014

From Fig. 3, we can deduce that gas production rose from 2,082E6Mscf in 2004 to 2,524E6Mscf in 2014 which is a 21. 23% increase while gas flaring dropped from 42.58% to 11.47% within the same period.

Table 3. Lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	10.43125	NA	7.86e-06	-0.401953	-0.218736	-0.341222
1	186.0621	296.3771*	3.69e-10*	-10.37888*	-9.462796*	-10.07522*
2	191.6601	8.047092	7.45e-10	-9.728755	-8.079802	-9.182173

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5. Wald test

Test statistic	Value	df	Probability
F-statistic	2.831087	(4, 20)	0.0520
Chi-square	11.32435	4	0.0232

Null Hypothesis: C(9)=C(10)=C(11)=C(12)=0
Null Hypothesis Summary:

Normalized restriction (= 0)	Value	Std. Err.
C(9)	-0.562868	0.202819
C(10)	0.786778	0.450899
C(11)	-0.510641	0.215877
C(12)	-0.216391	0.600411

Restrictions are linear in coefficients

Table 6. Error correction model

Cointegrating Eq:	CointEq1			
LY(-1)	1.000000			
LG(-1)	-0.593176			
	(0.22501)			
	[-2.63626]			
LK(-1)	- 0.314015			
	(0.09893)			
	[-3.17399]			
LL(-1)	-1.373199			
	(0.43317)			
	[-3.17010]			
C	9.051967			
Error Correction:	D(LY)	D(LG)	D(LK)	D(LL)
CointEq1	-0.086828	0.175870	-0.398457	0.021042
	(0.05142)	(0.16482)	(0.21408)	(0.00698)
	[-1.68859]	[1.06706]	[-1.86124]	[3.01444]
D(LY(-1))	0.116968	0.671183	0.504052	0.015356
	(0.17408)	(0.55796)	(0.72474)	(0.02363)
	[0.67194]	[1.20292]	[0.69550]	[0.64979]
D(LG(-1))	0.061965	-0.230039	0.132464	0.007244
	(0.04900)	(0.15707)	(0.20402)	(0.00665)
	[1.26452]	[-1.46457]	[0.64928]	[1.08887]
D(LK(-1))	0.002911	-0.217126	-0.123464	0.010794
	(0.05332)	(0.17092)	(0.22201)	(0.00724)
	[0.05459]	[-1.27033]	[-0.55612]	[1.49113]
D(LL(-1))	-0.410398	-0.342580	5.038834	-0.088657
	(1.55752)	(4.99228)	(6.48448)	(0.21144)
	[-0.26349]	[-0.06862]	[0.77706]	[-0.41930]
C	0.043308	0.039674	-0.180723	0.031777
	(0.04855)	(0.15561)	(0.20213)	(0.00659)
	[0.89205]	[0.25495]	[-0.89411]	[4.82141]
R-squared	0.337699	0.269075	0.226742	0.392581
Adj. R-squared	0.210334	0.128512	0.078038	0.275769

Sum sq. resids	0.095808	0.984307	1.660667	0.001766
S.E. equation	0.060703	0.194571	0.252729	0.008241
F-statistic	2.651420	1.914269	1.524789	3.360805
Log likelihood	47.57237	10.29882	1.930229	111.4735
Akaike AIC	-2.598273	-0.268676	0.254361	-6.592091
Schwarz SC	-2.323447	0.006149	0.529186	-6.317266
Mean dependent	0.038301	0.039097	-0.003955	0.029946
S.D. dependent	0.068311	0.208424	0.263207	0.009683

Determinant resid covariance (dof adj.)	*4.27E-10*
Determinant resid covariance	*1.86E-10*
Log likelihood	*176.8479*
Akaike information criterion	*-9.302992*

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