TESTING THE LONG RUN RELATIONSHIP BETWEEN NATURAL GAS UTILIZATION AND ECONOMIC ACTIVITIES IN NIGERIA

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ABSTRACT
This study investigated the long run relationship between natural gas utilization and economic activities in Nigeria using quarterly data from 2001 – 2017. The result showed that there are two cointegration equations implying that there exists a long run relationship between Natural Gas and its determinants. The finding suggests that investing in gas supply infrastructure will enhance gas utilization via power generation, LNG production and Gas-based industrial utilization and also reduce gas flaring while encouraging national growth. A policy implication with respect to this finding is that, stimulating power generation through gas, which constitutes about 60% of power generation mix in Nigeria will help in addressing a lot of our macroeconomic problems like poverty and unemployment because it will stimulate the manufacturing sector and also improve the service sector with much needed electricity supply. As a recommendation, the Federal government should encourage investment both local and foreign in the gas industry so as to harness the abundant gas reserves available in the country and also improve on exploration activities to increase available reserves.

Keywords: Natural Gas utilization, determinants of gas utilization, cointegration analysis
JEL Classification: Q34, Q42**,** E29: C19

1. INTRODUCTION

Nigeria is among the top ten economies with huge deposits of natural gas. Natural gas is abundantly found in the Niger Delta region, either in gas reservoirs or produced along with crude oil as associated gas. Nigeria's natural gas reserves were estimated at 184.6 billion cubic feet (bcf) in 2016, with dry natural gas production estimated at 8.4 bcf per day in 2017 against 1.1 bcf in 2000 (BP Statistical Review of World Energy, 2017). Total gas reserves are made up of 98 (trillion cubic feet) tcf of associated gas and 89 tcf of non-associated gas, almost a 50/50 distribution (Nwaozuzu, 2014). Nigeria flares about 2.6 bcf per day of its gas, representing 12.5% of global gas flared and equivalent to 51% of total gas produced; making it the second largest gas flaring country in the world after Russia (Onolemhemhen, Laniran, Isehunwa, & Adenikinju, 2017). More so, the Federal Government is harnessing the potentials in its gas reserves through electricity generation and production of Liquefied Natural Gas (LNG) and Natural Gas Liquids (NGL) exports. NLNG (2017) informs that Nigeria has converted 5.16tcf of associated gas to 1864 cargoes of LNG and NGL from 1999 to 2015, which would otherwise be flared. Nigeria is now ranked 36th in gas flaring and previously flared gas has been channeled to the power sector, which accounts for 80% of the total domestic gas consumption and generates 81% of total electricity supply in Nigeria (Emodi, et al., 2016).
Domestic power generation and industrial power supply is at the forefront of the government's interest to harness natural gas as an energy source. Nigeria has an installed electricity capacity of 7 Giga Watts (GW), but less than 4GW is operational (Shell , 2015). The country's electricity grid is gas-dominated with 74% of its power generation from gas, as at October 2017 (Utuk, 2017). The sector experiences inadequate gas supply, obsolete infrastructure, and thermal plants suffer decay due to lack of maintenance and inadequate gas supply. This has resulted in a mismatch of energy demand and supply that has devastating implications in the economy.

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The foregoing analysis shows that Nigeria has huge deposits of gas and much of it flared, is geared only for export. Therefore, the main objective of this study is to investigate the long-run relationship between gas utilisation and its economic activities in Nigeria. The rationale behind examining this long run relationship is because gas is found in abundance in Nigeria, yet the country lacks adequate energy especially in power generation and industrialisation. Natural gas is wasted through flaring while it can be à huge revenue generator through LNG exports. If a long run relationship is established, investment should be made in gas supply infrastructure.

The rest of the paper is structured as follows. Section two reviews the literature; section three ushers in the methodology; section four presents the results and analyses, while section five submits the conclusion and recommendations.

2. Literature Review

Nigerian Gas Policies and the Nigerian Economy

The energy sector in Nigeria is strategic and has strong linkages to the macro economy, with the petroleum sector accounting for 90 per cent of Nigeria's foreign currency earnings while the electricity sector utilizes 85 per cent of Natural gas produced into the domestic market and 75 % production of gas being flared daily (Adegbite, 2017). The government through the Ministry of Petroleum Resources articulates gas policies with primary focus on meeting local gas demand requirements, register significant presence in international markets and to gradually move Nigeria away from crude oil export-based economy to an industrial economy. The National Energy policy Commission of Nigeria, has developed various policies over years to encourage domestic demand predicated on the following: identify gas as a stand-alone commodity, establish a midstream for the gas sector, emphasize on industry structure for sustainable development and growth, focus on developing gas resources, infrastructure as well as building gas markets, proposes fundamental reforms to improve efficiency of gas operation companies and emphasize on domestic gas supply to strategic sectors.

Oil and natural gas policies in Nigeria started in the 1960s and up till date, these policies have continuously undergone modifications to meet domestic and international demand, and to further harness its production. Immediately after independence in 1960, a seven-year first National Development Plan (1962-1968) was developed aimed at industrializing the economy through import substitution strategy. However, the gas policy in 1960s gave exploration rights in onshore and offshore areas leading to significant exploration activities both on and off- shore in Nigeria. Oil and gas accounted for approximately 1.8 per cent on an average of the total GDP which was quite insignificant in foreign earnings. The low foreign earnings were due to the political instability that was exacerbated by the civil war in the mid-1960s and due to fact that agriculture was the mainstay of the Nigerian economy (Adedipe, 2004).

In the 1970, the average contribution of oil and gas to the nations GDP was 9.2 per cent which rose significantly to approximately 19.3 per cent in 1975 due to Nigeria's entry into OPEC in 1971 and the establishment of the NOC (now NNPC) in 1977 which saw the country recording significant exploration and production growth. It should be noted that broader economic policies in the 1970s were designed for reconciliation and reconstruction. For instance, a national commission was created (Udoji Commission) to review and evaluate the public service, which led to new pay and benefits structure, representing the first policy impact of the oil wealth.

In the 1980s, major oil and gas policies were implemented to foster exploration and production of oil and gas related products. First, a Memorandum of Understanding (MOU) was signed between NNPC and International Corporations which led to 24.8 per cent increase of oil and gas production with respect to the total GDP of the country. However, the contribution of oil and gas to GDP started dropping after the MOU till it finally reached 16.7 per cent in 1985 due the slump in world price of crude-oil in the 1980s. In response to the declining oil and gas foreign earnings, a Stabilization Act of 1982 was put in place and more

importantly the Structural Adjustment Programme (1986-1988) that had a wide-range of reforms in almost all the major sectors of the economy proposed by the World Bank.

The 1989 fiscal year witnessed impressive recovery with oil and gas contributing 37.4 per cent foreign earnings to the total GDP. The impressive performance continued throughout the 1990s such that by the year 2000 its percentage contribution stood at 47.7 per cent. Accordingly, successive regimes continued to pay lip service to the diversification of the Nigeria economy, while the oil industry continued to maintained its domineer with a percentage contribution hovering around 35-40 percent for the past nine years of democratic rule (Luqman & Mutonyaro, 2011). Specifically, the policies that increased the sectors' activities were the deregulation and liberalization policies in 1994 that regulated the economy, by capping exchange and interest rates and also the introduction of the AGFA in 1992 that initiated LNG, EGP, WAGP projects (Avuru, 2013).

Even though the oil and gas sector witnessed impressive recovery with significant contribution to the GDP of the nation, there was no clear policy that guided its exploration and production until 2004 when a National Oil and Gas policy further provided a policy framework for a liberalized and functional gas industry, especially the domestic gas utilization. The policy statement paved the way for a Marginal Field Development Programme in 2004, a downstream Gas Bill in 2005 that further liberalized domestic gas market.

In 2006, a gas policy document was drafted to address environmental issues, generate much revenue from gas as from oil, create an operating environment that encourages growth of the existing local gas markets, and development of new ones (e.g. CNG) in a manner consistent with export aspirations. This policy paved way for Nigerian Gas Master Plan (NGMP) which was introduced in 2008 that guaranteed the Domestic gas development agenda in line with the National Energy Policy and National Oil and Gas Policy. This policy defined the terms of domestic gas supply obligation, putting in place a gas infrastructure blueprint and a Gas Pricing Policy (GPP). It should be noted that in 2010, a Domestic Gas Aggregator (DGA) was established to implement the Domestic Gas Supply Obligation, ensure the implementation of the National Gas Pricing Framework, coordinate buyers and sellers activities, with an expeditious development of a gas market in Nigeria and critical for the early success of the Gas Master Plan (Adeniji, 2013). Still in 2008, a National Domestic Gas Supply and Pricing Regulations were instituted with a lucid framework for determining gas pricing across various sectors in the economy. Despite the Oil and Gas policies that regulated its exploration, the sector still witnessed bunkering and illegal production of petroleum products.

Consequently, the reforms in these sector that started in2000 were later reinforced with Petroleum Industry Bill (PIB) 2012 that provided comprehensive legal framework for the exploitation of petroleum, including gas. Objectives of the reviewed (Petroleum Industry Governance Bills, 2017) includes promoting transparency and accountability in administering petroleum resources , as well as a conducive environment for operators in the industry aimed at remedying some of problems associated with natural gas and oil utilization and designed to reform the entire hydrocarbon sector . Despite these reforms, the contribution of the oil and gas sector witnessed a steady and marginal drop from 38.8 per cent in 2005 to 37.6 per cent in 2006 and to 36.4 per cent in 2007 and assumed a marginal increase to 39.0 per cent in 2008.

Notably, the shortcomings of the 2008 Gas Master Plan ("GMP") in attracting the needed private sector investment for building critical infrastructure and developing a mature domestic gas market by the target-year of 2015, seemingly necessitated the formulation and adoption of a new and better policy thrust for the industry. It is intended that the NGP will be complemented by a National Oil Policy and a Petroleum Fiscal Policy. Fundamentally, the NGP sets the goals, strategies and an implementation plan for establishing a framework that will drive the institutional, legal, regulatory and commercial reforms necessary for attracting investment into the gas sector (Banwo& Ighadalo, 2017).

Natural Gas Pricing Policy and Nigeria's Exportation of Natural Gas

The price of natural gas is benchmarked to Henry hub, in the international market and traded in form of LNG. Prices in the domestic market are set up by Oil Producers Trade Section (OPTS), NNPC and NGC. At the international scene, the prices ranged from US$1.70/million British thermal unit (mBtu) in 1991 to US$4.23/mBtu in 2000 and Nigeria's total export of LNG within this period stood at 228 bcm. In 2003, prices rose from US$5.63/mBtu and further to US$8.85/mBtu in 2008. Correspondingly, the volume of LNG export increased on average by 23.42% reaching 726 bcm in 2008. Natural gas prices were higher in these years, due to withdrawals from existing coal and nuclear capacity, which led to increased use of existing natural gas-fired plants and the development of new plants. The quest for clean energy, following the Kyoto resolution of 2001, led to an increase in the demand for gas for electricity generation amidst constrained supply (Kyoto Mechanisms, Monitoring and Compliance, 2001).

Conversely, the international price of LNG dropped drastically and steadily immediately after 2008. Between 2009 and 2013, the average annual LNG price was US$3.75/mBtu which further dropped the approximately to US$3.09/mBtu on an average between 2014 and 2017. The drop in prices reflected large growth in unconventional gas production, as well as weak energy demand unconventional gas production has already had a considerable impact upon the LNG market, and could further affect the global gas supply if developed more widely (Jacobs, 2011). Ironically, the volume of Nigeria's LNG export has been on the increase despite the sharp decline of LNG prices. For instance, the average LNG export increased to approximately 831.25 bcm between 2009 and 2012 and further rose to an annual average of approximately 864 bcm between 2013 and 2015. On a general note, in 2015, Nigeria's LNG exports Nigeria stood at 930 billion cubic feet. LNG Exports increased from 0 billion cubic feet in 1996 to 930 billion cubic feet in 2015 growing at an average annual rate of 54.81 %.

The major suppliers of domestic gas in Nigeria is Shell Nigeria Gas (SNG) Ltd that supplies natural gas via pipelines to industrial customers within the Agbara/Ota axis, including the Ogun-Guangdong Free Trade Zone (Ogun state), Aba industrial areas (Abia state) and Port Harcourt (Rivers State) Nigeria. Consumers of natural gas range from medium-scale businesses to large corporations, in industries as diverse as glass making, foods and beverages, packaging, pharmaceuticals and chemicals, as well as CNG companies. In Nigeria, natural gas is often used for power generation using turbines, micro turbines or gas generators. Industrially it is used for space heating, rising of steam via boilers, furnace operations etc. For agriculture it is used as chemical feedstock for fertilizer and methanol production. And lastly for transportation, Compressed Natural Gas (CNG) is used as fuel for Natural Gas Vehicles (NGV) like forklifts, cars and buses, and also attractive to organizations that operate large fleets of vehicles, enabling them to enjoy considerable economies of scale.

Specifically, the gas pricing policy defines domestic gas pricing which recognises the diversity in the ability of the various industrial sub-sectors. The policy enables the selective maximization of net revenues for Nigerian gas from sectors. Secondly, the Nigerian Gas Master Plan (GMP) stipulated a revised transitional pricing structure for gas to power projects in 2010, and ultimately a price of $2.50 per MMBTU was set in 2014. The price by 2010 was $1.99 per MMBTU. The GMP also imposed penalties for non-compliance with the DGSO which includes: payment for volumes not supplied, or a penalty price of $3.50/Mscf, whichever is higher; and disqualification from supply of gas to any export projects.

Domestic demand for natural gas is growing specifically to meet electricity demand in Nigeria, experts have said. Over the years, the total demand (export and domestic) for natural gas has always exceeded the supply until between 2011 and 2016 that the supply became outweighed the demand. For instance, between 1996 and 2000, the average annual gas supply was 6.0 while the will demand was 13,47. Between 2001 and 2005, gas supply rose average annual gas supply rose to 19.1 while the corresponding demand was 20.78. Finally, gas supply rose to 29.87 on an average while the corresponding demand also rose to 30.04. The rise in demand was attributed the growth in demand by the power sector and by an increasing requirement by large industries such as fertilizer and methanol that require gas in high quantities (Nwaozuzu

, 2018)**.** But between 2011 and 2016, the supply of gas skyrocketed to 46.81 on an average exceeding the total demand for gas which rose to 39.88 on an average. The increase supply could be associated with thediscovery of new non-associated gas (NAG) reserves, the development of deep offshore oil fields with huge associated gas (AG) reserves in Nigerian.

Theoretical Literature

This area of study particularly reposes on the neoclassical theory that tries to explain LNG utilization based on demand models. A plethora of analyses have directly applied the standard neoclassical microeconomic theory to model and estimate energy demand. A handful of literature has modeled energy demand in function of price and income while considering other structural variables with restrictions.

From a theoretical standpoint, there is an inextricable link between stock of energy-consuming equipment both in households and in firms. In this regard, a static neo-classical gas model often estimates a short run restricted cost function that considers the level of capital stock as a function of price, which ultimately solves the long run relationship by considering the derivative of the cost function with respect to the fixed factor (capital) (see, CEA, 2008).

Specifically, the Balestra-Nerlove model (BN), which is predicated on the neoclassical theory has a different approach to natural gas demand modeling. The BN model introduced by (Balestra & Nerlove, 1966) models the demand function for natural gas in residential and commercial markets in the short run in function of the relative price of natural gas and has a neutral effect on consumers' choices. The authors note that in the natural gas markets, consumption of gas to a large extent is governed by the stock of gas appliances and the price of gas which vary over time. And over time new demand is responsive to price changes, total energy supplied, capital cost and the lifetime of equipment that consume gas. Although the model leaves room for the elimination and reintroduction of key variables, it does not explain inter-fuel competition between gas and other fuels. In short, the model is restricted to residential and commercial use of natural gas especially for heating.

Hybrid demand models have also lent credence to the neoclassical theory because it forms the basis for testing a hypothesis relating to economic development. In Nigeria, Mahmood & Ayaz (2018) built on Solow's 1994 growth model with the inclusion of peripheral sources of energy.

Even though energy is a major determinant of economic growth, it portends adverse effect on developing economies where energy demand is higher than the energy supply. For instance, an increase in the demand for energy could enlarge energy demand and supply gaps. These gaps may likely halt economic development in the long-run. Asufu-Adjaye (2000) cited in Mahmood and Ayaz (2018) supporting this claim, observed that in Thailand and Philippine, an increase in energy consumption did not raise economic development because (at that time) the energy supply of those countries was less than the energy demand. Similarly, Aqeel and Butt (2001) observed a neutrality hypothesis between energy consumption and economic development in Pakistan. But in developed countries, energy gaps are very small, implying that an increase in energy demand may increase economic growth. A clear example is the case of Sweden, Canada and USA, where the increase in energy usage has led to an increase in economic development (Ghali & El-Sakka, 2004; Chima & Freed, 2005; Stern & Enflo, 2013).

A Further extension of the hybrid production function by Hunt, Judge and Nimomiya (2003) shows that energy-saving technical progress and a range of other exogenous factors (distinct from income and price) can have potential impact on energy demand. These factors include environmental pressures and regulations; energy efficiency standards; substitution of labor, capital or raw materials for energy inputs; and general changes in tastes that could lead to a more or less energy intensive situation. Hence there is the need for a broader concept to capture not only energy saving technical progress in an energy demand function but also other unobservable factors that might produce energy efficiency (Ackah, 2014). Natural gas consumption results from demand for energy services such as cooking, heating and industrial production.

The overall effect of natural gas consumption on the GDP growth of Nigeria based on the hybrid new production function is premised on the microeconomics principles of supply and demand equilibrium with the following assumptions:
Firstly, equilibrium is always attained in natural gas market. Thus, structural models that include dynamic equations of supply and demand for natural gas and assume equilibrium at market price of natural gas are employed.
Secondly, endogenous variables are influenced by all macroeconomic exogenous variables–the price of natural gas and its quantity –are assumed to grow over time at a constant rate.
Finally, we regard an increase in the quantity of natural gas due to natural gas utilization as a positive quantity shock to our model.

Empirical Review
Due to the growing interest of the federal government in the natural gas sub-sector in Nigerian, natural gas consumption and economic growth nexus have also been keenly investigated by researchers. Although most researches in the past have shown negative or neutral relationship betweeen the two varaibles, initiatives and policies such as the reduction and eventual elimination of flaring, DSGO of the Gas Master Plan, power sector reform and growing LNG exports have prompted researchers to revisit and reinvestigae the matter for appropriate and more beneficial recommendations. Infact, Adebola and Olamide (2018) examined the trade off between gas production and gas flaring in nigeria using the multivariate regression technique and found that GDP increases with gas production, and an increase in gas production also leads to increase in gas flared. However, Audu (2010) used ECM to investigate the relationship between gas utilisation and nigerian economic performance, and found a cause-effect relationship among gas utilisation, economic performance and other explanatory variables, which include FDI, broad money supply, inflation rate, fiscal deficit and crude oil production.
Gabriel et al. (2012) examined the impact and sustainability of gas utilisation and the structure of gas flaring using dummy linear models and results showed that gas utilisation has significant positive impact on the economy, and that it is also sustainable. Again, Diugwu & Mohammed (2013) used multiple linear regression analysis to investigate the impact of gas production, utilisation and flaring on GDP in Nigeria, and results showed that gas utilisation has a positive impact on nigeria's GDP. Hence investment in infrastructure becomes imperative.

Interestingly, Adamu (2015) used the Fisher's test to determine the causality between gas consumption and economic growth, and found no causality between the two variables. However, in a related study, Adamu and Darma (2016) found positive and significant relationship between gas consumption and real GDP, using the ARDL bound test approach. Onolemhemhen et al. (2016) forecasted the domestic utilisation of natural gas in Nigeria using time series analysis, and the forecasted values reveal evidence of a slow but gradual increase in gas utilisation pattern in the near future from 2015- 2020.

Onolemhemhen et al. (2017) further examined the implication of domestic gas utilisation for economic growth in Nigeria using ARDL cointegration test and observed a long run relationship between gas consumption, labour, investment and economic growth. Also, Agbede (2018) employed OLS, Granger Causality and Johansen Co-integration test to investigate the relationship between a disaggregated energy supply and industrial output in Nigeria. Findings showed that the generated electricity, capital expenditure and PMS have a positive impact on industrial output; while gas consumption and AGO were negatively related. Results further indicated that LNG availability does not have any positive impact on industrial output in Nigeria. Similarly, Egbichi, Abuh, Okafor, Godwin and Adedoyin (2018) examined the dynanic impact of energy consumption and growth of Nigerian economy between 1986 and 2016. Results of the symmetrial ARDLapproach showed that electricity consumption and gas consumption had no significant impact on the economy, while petroleum consumption had a significant impact on the Nigerian economy.

I two separate studies, Galadima and Aminu (2017) employed the momentum threshold autoregressive model and momentum threshold ECM to investigate asymmetric cointegration, causality and adjustment between natural gas consumption and economic growth in Nigeria. The results showed that, a consistent

gas supply increases economic growth and a rise in growth leads to an increase in gas consumption. In a related study, Galadima & Aminu (2018) sort to identify the level of natural gas capable of improving the growth of the Nigerian economy using the smooth transition regression model. Findings showed that consumption threshold is below optimal levels, though natural gas consumption was found to have a positive and significant impact on economic growth in Nigeria. In their recent study, Galadima & Aminu (2019) investigated the positive and negative impacts of natural gas consumption and economic growth using the nonlinear ARDL (NARDL) model and found an asymmetric relationship between them only in the longrun. This implies that natural gas consumption can stimulate economic growth in the long run.

3. METHODOLOGY

Two approaches are often used for testing the long-run relationship among variables - the ARDL and Johansen cointegration approaches. The ARDL approach to cointegration helps in identifying the cointegrating vectors. These vectors are re-parameterized into an ECM, which gives a short run dynamics and long run relationship of the variables in a single model (see, Pesaran, Shin & Smith, 2001). However, the ARDL approach is employed only for a mixture of I(0) and I(1) variables (Wooldridge, 2002). On the other hand, the Johansen cointegration approach simply depicts the relationship among variables by identifying the cointegrating vectors among multiple intervening vectors (Nkoro & Uko, 2016). This approach is employed only for a mixture of variables. Hence, this study applied the Johansen cointegration approach because all the variables were integrated of order one. Hence, the relationship between domestic natural Gas utilization and economic activities in Nigeria can be expressed as:

$$TGU = F(GDP, GBI, POWER, LNG, TGF) \quad ....(1)$$

In order to capture the response of the dependent variable on the exogenous variables, equation (2) was transformed by taking the log form as below:

$$\log(TGU) = \rho_0 + \rho_1\log(GDP) + \rho_2\log(GBI) + \rho_3\log(POWER) + \rho_4\log(LNG) + \rho_6\log(TGF) + \mu_t \quad ....(2)$$

ρ_0 is the intercept, while $\rho_1, \rho_2, \rho_3, \rho_4, \rho_5$ and ρ_6 are coefficients of the independent variables, and LTGU is the Log of Total Gas Utilization and is the dependent variable. LGBI is the log of Gas Based Industrial use for gas, LPOWER is log of Power generated using gas; LLNG is Log of Liquefied Natural Gas and LTGF is Log of Total Gas Flared in Nigeria.

Source of Data

This study employs secondary data for the purpose of its analysis. Data on natural gas demand was sought from NNPC ASB 2017 1st edition and price of natural gas was sought from World Bank Commodity Price Data. Data on GDP population was sourced from World Development Indicators website. Also, data on gas flared and gas utilized by the three different strategic sectors (domestic, commercial and export) were sought from Oil and Gas Industry Annual Reports (NOGIAR) 2017 - Department for Petroleum Resources. As earlier indicated, the rationale of this study is to examine the long run relationship between gas utilization and economic activities in Nigeria because NG is often wasted through flaring while it can and is à huge revenue generator through LNG exports. If a long run relationship is established, investment should be made in gas supply infrastructure.

4. Analysis of Results

This section begins the analysis of the unit root test in order to avoid spurious results, forms the basis for the testing the long run relationship between two or more variables. Results on table 1 shows that all variables have unit root and were all differenced once, to make them stationary.Thus, all the variables are stationary after the first difference, implying that they are all integrated of order one (1).

Table 1: Unit Root Test Result

Trend and Intercept. Test Critical Values: 1% = -2.600471; 5% = -1.946072; 10% = -1.613448. Critical Test Results for ECM-term: 1% = -3.54019; 5% = -2.90926; 10% = -2.592215					
	Augmented Dickey Fuller (ADF) Test		Phillips Perron (PP) Test		
Series	**Levels**	**1st Difference**	**Levels**	**1st Difference**	**Order of Integration**
GBI	-4.380	-4.309	2.187	-4.743	I(1)
LNG	-1.435	-5.785	-1.220	-4.984	I(1)
POWER	2.313	-3.757	0.482	-2.892	I(1)
TGF	-3.045	-3.674	-1.371	-3.727	I(1)
TGU	2.8412	-4.745	1.449	-4.698	I(1)
RESID	-2.4418			-3.6255	I(0)

Source: Author's Computation using Eviews 9.0

The results on Table 2 shows the Johansen's cointegration test. The test allows for more than one cointegrating relationship and the results of the tests statistics are interpreted based on the trace and maximum Eigen statistics. The null hypothesis of no co-integration, is rejected when the P-value is less than 0.05 (5%) level of significance under both the trace statistic and the maximum eigenvalue. Both tests reject the null hypothesis indicating that a maximum of two cointegration vectors exist at the 0.05 significance level. Therefore, there is a cointegration relationship between TGU, GBI, POWER, and LNG, implying that a long run relationship exists among the variables under consideration. Hence, investment should be encouraged in infrastructure development for gas supply so as to enhance efficient utilization of gas reserves. The policy implication here is that, stimulating power generation through gas, which constitutes about 60% of power generation mix in Nigeria will help in addressing a lot of our macroeconomic problems like poverty and unemployment because it will stimulate the manufacturing sector and also improve the service sector with much needed electricity supply. Also, LNG production and gas based industrial use in production of fertilizer, methanol, compressed natural gas for transport, LPG for cooking etc., translates into economic productivity and growth. This is in line with the findings of (Onolemhemhen et al, 2016), whose study showed a slow but gradual increase in utilization of gas.

Table 2: Johansen cointegration results forResults

Null Hypothesis	Trace	5% C.V.	Prob.	Max-Eigen	5% C.V.	Prob.
R = 0	90.12809	69.81889	0.0005	36.55630	33.87687	0.0234
R≤1	53.57179	47.85613	0.0132	27.63574	27.58434	0.0492
R≤2	25.93605	29.79707	0.1306	14.46431	21.13162	0.3282
R≤3	11.47173	15.49471	0.1841	8.292867	14.26460	0.3497
R≤4	3.178867	3.841466	0.0746	3.178867	3.841466	0.0746

NOTE: Trace test indicates 2 cointegrating eqn(s) at the 0.05 level;
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
Source: Author's computations using Eviews 9.0

Table 3 shows the estimated results of the short run (ECM) and Long run Models with total gas utilization as the dependent variable. The different diagnostic tests: DW, Breusch-Godfery LM-Test; Breusch-Godfery Heteroscedasticity; Jacque-Bera and Ramsey tests show that the two models robust. That is the functional forms are correct and the residuals are serially uncorrelated, normally distributed and homoscedastic, thus, making the models fit for interpretation. The residual series (RESID) of the estimated long run model is stationary at levels as shown by the Phillip Peron test on Table 2, which further supports the fact that the variables are cointegrated.

The error correction term is negative and significant indicating that the speed of adjustment of total gas utilization and to changes in the explanatory variables is approximately 67%, which is just well above average.

The results show that the total gas flared (TGF) in Nigeria increases the total gas utilization (TGU) significantly by approximately 17.6 % only in the short run. Its insignificance in the long run may be due to the huge fines being levied on explorers to curtail gas flaring. Also, many countries including Nigeria have developed great apathy for gas flaring due to its harmful effects on the environment. This finding is in line with that of (Diugwu, Ijaiya, Mohammed & Egila, 2013) for Nigeria.

The POWER generated in Nigeria increases the total gas utilization by approximately, 54.4 % only in the long run. This result is plausible enough because the different sectors using power in Nigeria keep expanding their capacities, as well the bourgeoning population of the country thus, increasing the demand for power. It is crucial to note that the inadequate infrastructure to convey gas to areas of power generation in the country can significantly reduce gas utilization, which is probably the case in the short run as shown on Table 3. The poor infrastructure in the country may also be the reason why Gas Based Industrial (GBI) increases total consumption in Nigeria only in the long run by approximately 14.8 %.

The effect of liquefied natural gas (LNG) on total gas utilization in Nigeria is significant and increases by approximately 52.2 % only in the short run. This agrees with the findings of an earlier study conducted by Diugwu & Mohammed (2013). This finding is justified because gas, which is a major source of government revenue is exported in form of LNG, reason why much of the gas produced is used for the production of LNG. However, its effect can be made significant in the long run, if gas supply infrastructure and other gas processing facilities that will diversify its use such as in manufacturing, transportation etc., are made available.

Table 3: Estimated ECM and Long Run Models (Dependent Variable – D(TGU)

	Error Correction Model			Long Run Model		
Variable	Coefficient	t-value	p-value	Coefficient	t-vavlue	p-value
C	0.0027	2.479	0.0160	0.0020	1.4269	0.1586
D(TGF)	0.1762	4.117	0.0000**	0.0027	0.4351	0.6655
D(POWER)	0.0026	0.2129	0.8321	0.5425	13.754	0.0000**
D(LNG)	0.522	17.439	0.0000**	0.0013	0.0897	0.9288
D(GBI)	-0.00065	-0.1386	0.8902	0.1484	2.51134	0.0146**
ECM(-1)	-0.6674	-7.1117	0.0000**			
Model Criteria: R^2 = 0.91; DW = 2.08; Breusch-Godfery LM-Test = 0.793(0.457); JB = 90.23(7.341); Breusch-Godfery Heteroscedasticity= 2.726(0.0786); Ramsey Test = 1.33(0.187)				Model Criteria: R^2 = 0.83; DW = 1.8; Breusch Godfery LM-Test = 0.921(0.0632); JB = 19.69(0.0561); Breusch-Godfery Heteroscedasticity = 2.163(0.083); Ramsey Test = 0.708(0.481)		
(**) indicates significance at 5%)						

Source: Author's computations using Eviews 9.0

5. CONCLUSION AND POLICY RECOMMENDATION

The main objective of this study is to investigate the long-run relationship between gas utilization and economic activities in Nigeria from 2001-2017. The study employed the Johansen cointegration test, which reveals that a long run relationship exists between gas utilisation and economic activities. This suggests that gas utilisation in domestic industries, for example, the manufacturing sector can be greatly harnessed as a source of energy and also an input for production - production of fertilizer and LPG. Power supply can be greatly improved upon, given the epileptic nature of power supply as Nigeria is bedevilled with the incessant power outages. Also, the problem of pollution that is a global concern can be reduced from gas

flaring and emission of harmful gasses into the atmosphere. Furthermore, utilising natural gas through LNG production, which is evidently a plus to the economy has boosted export of energy products and made Nigeria a recognised LNG exporter, thus, improving trade at the international level and also attracting foreign investments to the Nigerian gas industry.

In order to improve gas utilisation in Nigeria this study recommends that, in providing gas supply infrastructure, priority should to be given to areas of high gas demand in the country especially areas with high industrial localisation e.g. Kaduna and Kano in the north central region; Aba, Awka and Owerri in south eastern region; and Osun, Oyo and Lagos in the south west. This will enable them access the needed power and raw materials to improve their capacity and productivity.

Also, Federal government should encourage both local and foreign investment in the gas industry, so as to harness the abundant gas reserves available in the country and also improve on exploration activities to increase available reserves. Although investment incentives have been made available, the Nigerian government should consider other salient measures like improving on security, consistency and sanctity of laws and policies and anticorruption practices as key enablers of economic growth and factors considered by international investors when selecting investment destinations.

Lastly, the government and in partnership with gas explorers should provide gas supply infrastructure. This will ease the transportation of gas to areas of power generation in the country easily and faster.

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