International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 8 Issue 6, June 2021

ISSN: 2394-4404

Natural Gas Consumption And Economic Growth In Africa

Menoja Nathaniel AKOKAIKE
Adeola ADENIKINJU
Augustine Nyong EKPE
Adeola Ijeoma ELERI
Kayode Daniel AJULO
Centre for Petroleum Energy Economics and Law (CPEEL)
University of Ibadan, Ibadan

Kiyentei Benneth GINI
University of Uyo, Uyo

Abstract: ***This study mainly investigates natural gas consumption and economic growth in African from the period of 1992 to 2018. The countries covered include Nigeria, Algeria, Egypt, South Africa, Gabon and Angola. Specifically, the study analyses the long-run relationship that exists between domestic natural gas consumption and economic growth in Africa as well as determines the extent to which gas consumption affects economic growth in Africa.***

The study employs panel data, and the variable are real GDP (RGDP), gas consumption (GAS), oil consumption (OIL), electricity consumption (ELECT), capital stock (CAPITAL) and labour stock (LABOUR). All data were sourced from World Data Atlas and BP statistical bulletin, apart from oil consumption for Nigeria and Angola that were sourced from Index Mundi.

The study utilizes Romer growth model (1986) an extension of Solow growth (1956) model. In addition, the average growth rate of each variable for each country is presented alongside the panel Fisher-ADF test to for stationarity. The result shows that all variables are stationary at first difference. Furthermore, the Kao residual co-integration test is run to determine the long run relationship among variables. Since the residual is stationary at levels the study implies that the variables are co-integrated in the long-run. Finally, the relationship between natural gas consumption and economic growth is determined with the Fixed Effect and Least Squares Dummy Variable panel techniques.

The main findings from this test show that all variables are significant at 95 percent confidence interval ($P < 0.05$). Specifically, the finding shows positive relationship between natural gas and economic growth under Fixed effect and Least Square Dummy variables respectively. In the case of oil, the results show negative relationship for all panel techniques used but also statistically significant at 95 percent confidence interval ($p < 0.05$). On the other hand, electricity consumption is also statistically significant and indicates positively relationship with RGDP.

In conclusion, natural gas consumption is positively related to economic growth in Nigeria, Angola, Gabon, Algeria, South Africa, and Egypt. Thus, this study suggests, that policy-makers in African countries should actualize the progress of the sector.

Keywords: natural gas, economic growth, real GDP, gas consumption, oil consumption, electricity consumption, capital stock, Africa.

I. INTRODUCTION

Natural gas consumption plays dynamic roles for sustainable development. In fact, 8 percent of world gas reserves in Africa is sufficient to power 40,000MW plants continuously for 50 years in Africa. Nigeria's 187tcf gas reservoir is enough to fuel 60,000 MW power plants continuously for 100 years (Adenikinju, 2017). Furthermore, Nigeria's gas resource endowment, if properly used for electricity supply has the potential to turn Nigeria into a

country with uninterrupted electricity supply which can meet the needs of several generations of Nigerians. Just as it is for developed and emergent countries, indeed, natural gas is a great option of energy mix and as alternative source because it is relatively efficient, clean and environmentally friendly. Natural gas is an attractive option because it provides a better operational flexibility, emits lesser amount of carbon dioxide (CO2) and lower capital costs (Isik, 2013). So, many world economies are working hard to encourage and promote the use of natural gas to mitigate CO_2 emission in line with the Kyoto convention.

Despite the fact that natural gas has been identified as clean, inexpensive, and environmentally friendly, and that proven gas reserves are bigger than those of oil, oil continues to gain favorable attention at the expense of the real sector. In general, natural gas is an essential component of the energy mix, with numerous potential benefits.

However, natural gas consumption in Africa is at a low ebb. Only a negligible portion of the available gas reserves is used to generate electricity. This low level of gas consumption is visible in critical sectors of the economy such as transportation, residential, and commercial. Poor infrastructure and investment development are common in natural gas projects and these negatively contribute to low domestic natural gas demand and this stagnates the African economy.

Gas flaring remains, a threat to economic growth in Africa, a contributing factor to low natural gas consumption. In addition, emissions from gas flaring are very hazardous to man and his environment. These are evident in the forms of greenhouse gases common to production fields, acid rain, and depletion of the ozone layer, low agricultural outputs, and health complications. This obstacle further results in poor electricity, and inadequate inputs to industry and manufacturing sector. So, Africa is yet to harvest optimally and utilize it natural gas resource to enhance and stimulate economic growth. Therefore, it is pertinent and expedient to investigate the dynamic link between natural gas consumption and economic growth, as well as determine the extent to which natural gas consumption affects economic growth in Africa.

The vast natural gas reserves in Africa are not enough to guarantee economic growth. Natural gas consumption is a critical determinant of economic growth. Even until now, Africa is still grasping with the problem of poor electricity supply and industries inputs from natural gas. This informs a backward and terrifying case in Africa, instead of leveraging on natural gas endowment as an energy mix.

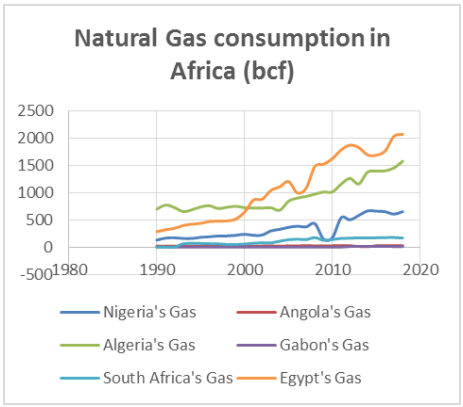
Of course, the dynamic link between natural gas consumption and economic growth has been receiving increasing attention and several research literatures have been published. Going through existing literature in relation to natural gas consumption and economic growth Isik (2010), Shahbaz, Chandran and Azeem (2011), Rahman and Mohammad (2012), Tahari, Nazari and Kakhi (2015), Paul and Hewen(2016), Solarin and Shabhbaz (2015), and Ahmed and Muttaqah(2016), viewed it from different approaches. However, there is paucity of comprehensive study that captures the African continent. Moreover, most of the extant studies are on the impact of electricity consumption, or energy consumption, or oil consumption on economic growth. Adeyemi and Ayomide (2013), Adegbemi, Olalekan and Babatunde (2013) worked on electricity and energy consumption respectively. In addition, this study will use a heterogeneous panel approach, which have more accuracy and greater capacity for capturing the complexities of the study is employed.

Consequently, this study will serve as a reference material to energy experts, energy studies students, government and all stakeholders in energy sector and natural gas subsector. All the aforementioned disparities therefore, make it important and necessary to consider the dynamic linkage between natural gas consumption and economic growth in Africa.

This study examines the impact of natural gas consumption on economic growth in Africa. Six countries Nigeria, Algeria, Egypt, South Africa, Gabon and Angola are selected based on availability of data. This study proceeds to determine the extent to which natural gas consumption affect economic growth in Africa. The study employs the use of secondary data for the periods of 1992 to 2018.

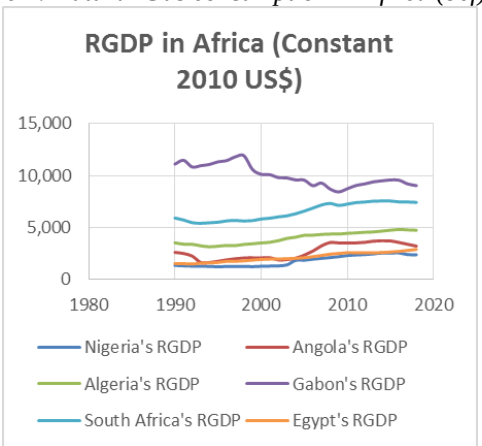
This study is structured into six chapters. Section one is the introduction. Section Two gives an insight into the background of the study. Section Three reviews relevant literatures. Section Four provides the methodology for the study. Section Five covers empirical analysis and results. Section six summarises, concludes, and provides recommendation.

A. TREND ANALYSIS OF MAIN VARIABLES OF THE STUDY



Source: Authors Compilation

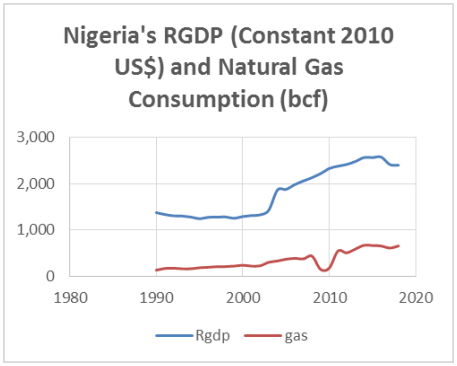
Figure 1: Natural Gas consumption in Africa (bcf)



Source: Authors Compilation

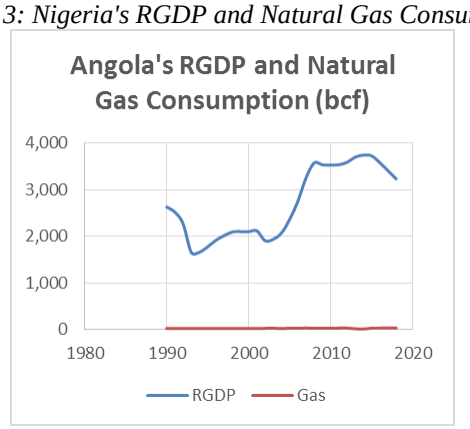
Figure 2: RGDP in Africa (Constant 2010 US$)

ISSN: 2394-4404



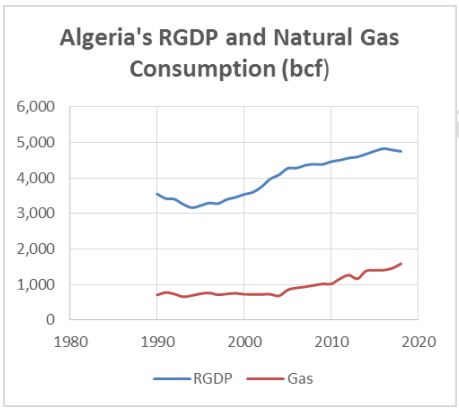
Source: Authors Compilation

Figure 3: Nigeria's RGDP and Natural Gas Consumption



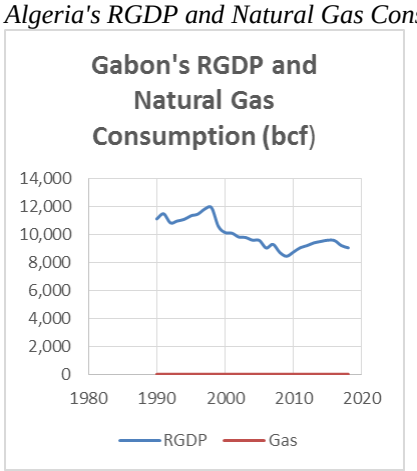
Source: Authors Compilation

Figure 4: Angola's RGDP and Natural Gas



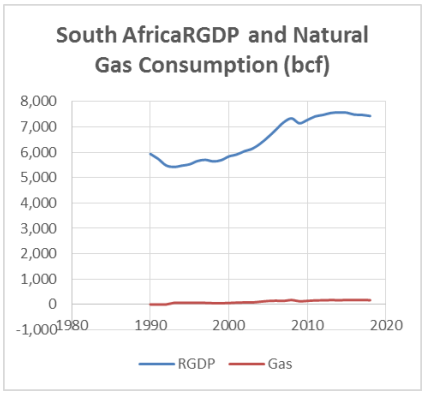
Source: Authors Compilation

Figure 5: Algeria's RGDP and Natural Gas Consumption



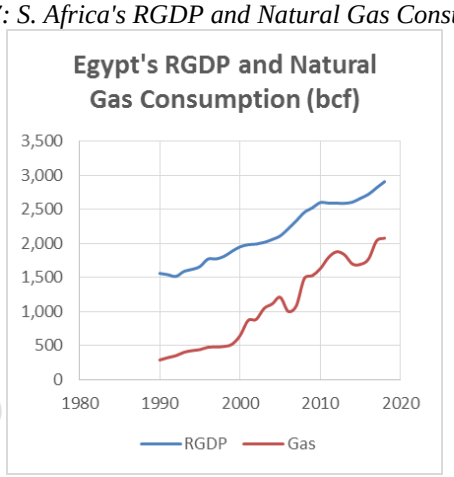
Source: Authors Compilation

Figure 6: Gabon's RGDP and Natural Gas



Source: Authors Compilation

Figure 7: S. Africa's RGDP and Natural Gas Consumption



Source: Authors Compilation

Figure 8: Egypt's RGDP and Natural Gas

II. LITERATURE REVIEW

A. THEORETICAL REVIEW

ADAM SMITH GROWTH THEORY

This school of thought is based on the principle of Laissez-Faire, which holds that economies should not impose any restrictions on freedom of an individual, business or firm. By implication, this model emphasizes saving, division of labour and wide extant market. Saving or capital accumulation is the key aspect of this model. According to him, they are three factors of production-labour, capital and land

Y = F (K, L, N)
Y = Output
K = Capital Stock
L= Labour
N = Land

According to Smith, the production function does not consider the event of diminishing marginal productivity. It is with respect law of increasing return to scale. He opined that real cost of production will have a diminishing behavior with time, due to internal and external economics in increasing man at size. Adam Smith also emphasizes the role of technological development for improvement in productivity. He maintained that farmers, producers and businessmen are the important agent of growth. Smith also assumed institutional, political

ISSN: 2394-4404

and natural factors are taken for granted in the process of growth.

NEOCLASSICAL GROWTH THEORY

The neoclassical school of thought explained three factors necessary for economic growth and temporary equilibrium. The three factors efficiently associated are namely labour, capital and technology. The production function shows the functional relationship between capital and labour to determine output. In the same technology arguments labour productivity. This is symbolically written as

Y = AF (K, L)
Y = GDP
K = Capital
L= Labour
A = determinant of technology

This is rewritten as Y = F (K, AL) because of the relationship between labour and technology. So, increasing either independent variables will affect GDP and the equilibrium of an economy. However, technology is boundless in the growth it can bring about and the output it can yield. Evidence validating the view this school are included in the works of early theoretical studies like Solow (1956), Solow-Suran (1956), Harrod-Domar

ENDOGENOUS GROWTH THEORY

The endogenous model in the mid 1980s postulates that economic growth is mainly influenced by endogenous and not external factors. It argues that investment in human capital, innovation and knowledge are precursor of economic growth characterized with spillover effect and positive externalities which will result in economic development. Prominent among the early theoretical studies on the endogenous model is based are Romer (1987, 1990, Aghion and Howitt (1992) and Helpman. (1991). Paul Korugman criticized endogenous growth model as mainly impossible the check by empirical evidence.

EXOGENOUS GROWTH THEORY

Solow Model, Harod-Domar model, and Ramsey model are prominent theoretical studies. The theory states that economic growth is influenced by external factors which exist outside the given economic. This model highlights the determinants of economic growth such as production, diminishing returns of capital, savings rates and technology. It argues that if a definite amount of labour and static technology is given, economic growth will stagnate at some point, but exogenous factor are thereby needed to stimulate growth.

B. EMPIRICAL REVIEWS

S/No	Author(s)	Title	Country	Period	Objectives	Methodology	Variables	Theories	Results
1.	Guvenek, Acet, Mangir and Kasap (2017)	Relationship Between Natural Gas Consumption And Economic Growth In Turkey	Turkey	1986 to 2015	examines the relationship between natural gas consumption and economic growth of Turkey	ADF, Engle-Granger co-integration test, Granger Causality Test	natural gas consumption, GDP	Solow growth model	long-run relationship between the variables according to the econometric results, it is revealed that there is no mutual causality.
2.	Burke and Yang (2016)	The price and income elasticities of natural gas demand: International evidence		1978 – 2011	estimates the price and income elasticities of natural gas demand	Panel estimators	gross domestic product (GDP) per capita, S is the size of each country's population, L is land area, T is average temperature,D is the price of road-sector gasoline	production model	the price elasticities of demand in the cross-sectional and between estimates are both near –1.25
3.	Adamu and Muttaqah (2016)	Inland Natural Gas Consumption and Real Economic Growth in Nigeria: ARDL Co-integration Test	Nigeria	1981 to 2013	identifies the co-integration and relationship between gas consumption and economic growth in the country	ARDL bound co-integration test	oil production, gas consumption, real GDP.	theory ofendogenous growth	Co-integration was found,and positive and significant long run relationship was found between gas consumption and real economic growth
4.	Solarin and Shahbaz (2015)	Natural Gas Consumption and Economic Growth: The Role of Foreign Direct Investment, Capital Formation and Trade Openness in Malaysia	Malaysia	1971-2012	The objective of this paper is to reinvestigate the relationship between natural gas consumption and economic growth	ARDL	Natural gas consumption, foreign direct investment, capital formation and trade openness	neoclassical model	The results support the presence of feedback hypothesis between natural gas consumption and economic growth, foreign direct investment and economic growth, and natural gas consumption and foreign direct investment
5.	Tabari, Nazari and Kahki (2015)	Investigating the Effect of Using Oil, Natural Gas and Coal on Economic Growth of Iran	Iran	1980 to 2012	investigates the role of oil, natural gas and coal consumption in Iran's economic growth	ARDL	oil consumption, natural gas consumption and coal consumption		variables are co-integrated. The consumption of natural gas and coal was concluded to have positive and significant effect on economic growth, while the consumption of petroleum shows no significant effect on economic growth.
6.	Adamu (2014)	Independence of Domestic Gas Consumption on Nigerian Economy	Nigeria	1981 to 2013	this research studied the causality between domestic gas utilization and real economic growth in the country	granger causality test was applied using F-statistics	GDP, Oil price, Oil production, Gas consumption	neoclassical model	It was found that domestic gas consumption nor economic growth causes each other in the country
7.	Shahbaza, Arouri and Teulon (2014)	Short- and long-run relationships between natural gas consumption and economic growth: Evidence	Pakistan	1972 – 2011	examines the dynamic relationship between natural gas consumption and economic	ARDL bound testing	GDP, Gas consumption	Cobb-Douglas production function	natural gas consumption and economic growth are complements.

ISSN: 2394-4404

		from Pakistan			growth in Pakistan				
8.	Shahbaz, Farhani and Rahman (2013)	Natural Gas Consumption and Economic Growth Nexus: The Role of Exports, Capital and Labor in France	France	1970 to 2010	the relationship between natural gas consumption and economic growth	ARDL, VECM	Real GDP, gas consumption, real capital and exports	Cobb-Dougl as production function	bidirectional causality is found between exports and economic growth, gas consumption and exports, capital and energy consumption, exports and capital
9.	Farhani and Shahbaz (2013)	The Role of Natural Gas Consumption and Trade in Tunisia's Output	Tunisia	1980-2010	examines the impact of natural gas consumption, real gross fixed capital formation and trade on the real GDP in case of Tunisia	ARDL, VECM	Real GDP, gas consumption, real capital and total trade.		existence of long-run relationship among the variables Natural gas consumption, real gross fixed capital formation and real trade Granger cause real GDP.
10.	Shahbaz, Chandran and Azeem (2011)	Natural Gas Consumption and Economic Growth: Co-integration, Causality and Forecast Error Variance Decomposition Tests for Pakistan	Pakistan	1972-2009	examines the relationship between natural gas consumption and economic growth	ARDL	Real bidirectional causality is also found between exports and economic growth, gas consumption and exports, capital and energy consumption, exports and capital GDP,gas consumption, capital and labour	neo-classical production model	unidirectional causality running from natural gas consumption to economic growth
11.	Algarhi (2016)	Oil and economic growth in Egypt	Egypt	1991 to 2010	assesses the oil and natural gas sector in Egypt	ARDL, SWOT analysis	real crude oil price, governm ent expenditure, consumer price index, capital and labor	Solow growth model	oil prices have an adverse impact on economic growth
	A.	**EMPIRICAL REVIEW AND METHODOLOGICAL REVIEW ON ENERGY CONSUMPTION AND ECONOMIC GROWTH**							
1.	Marcus (2016)	Energy Consumption and Economic Growth in Malaysia: A Case of Oil and Natural Gas	Malaysia	1980 to 2011	examines the relationship between energy consumption and economic growth in Malaysia	Toda Yamamoto Granger causality	Real GDP per capita, Energy consumption kilo-tons of oil equivalent,Oil consumption barrels per day	production function	The results show that economic growth and aggregate energy consumption possess a bi-directional causality between each other. For disaggregate analysis, findings exposed a unidirectional causality from gas to GDP.
2.	Sama and Tah (2016)	The Effect of Energy Consumption on Economic Growth in Cameroon	Cameroon	1980 to 2014	determines the Effect of Energy Consumption on Economic Growth in Cameroon	Generalised Method of Moments technique	Petroleum prices and electricity consumption, GDP	production function	positive and significant relationship between petroleum consumption, electricity consumption, Gross domestic investment (GDI) and
3	Per-Ola (2015)	Fractional Co-integration, Energy Consumption and Growth Revisited: Evidence from Taiwan	Taiwan	1954 – 2013.	determines the relationship between GDP and energy consumption is of a central concern.	Fractional Co-integration	GDP, Coal, Oil, Energy	neoclassical growth, endogenous growth, and ecological-economics	A unidirectional causality from economic growth to energy consumption
4.	To, Wijewera and Charles (2015)	Energy Consumption and Economic Growth – The Case of Australia	Australia	1970 to 2011	examines how energy consumption affects economic growth in Australia	bound testing co-integration	Labour, capital and energy consumption	endogenous growth,	positively related, not statistically significant
5.	Ali and Maryam (2014)	Energy Consumption and Real GDP in Iran	Iran	1967 – 2010	examines the causal relationship between Real GDP and energy consumption in various economic sectors including (household and commercial, industry, transportation and agriculture sectors) for Iran	Toda-Yamamoto method	GDP, Energy consumption in transport, agriculture and household sectors	neo-classical theory	unidirectional causality from energy consumption in industry sector to real gross domestic product.
6.	Isik and Shahbaz (2014)	Energy Consumption and Economic Growth: A Panel Data Approach to OECD Countries	OECD countries	1980 – 2010	purposes to examine the relationship between energy consumption and economic growth in OECD countries	panel data method	energy (per capita) consumption and GDP (per capita)	neo-classical theory	there is significant correlation between energy consumption and economic growth in OECD countries.
7.	Adegbemi, OlalekanandBabatunde (2013)	Energy Consumption and Nigeria Economic Growth: An Empirical Analysis	Nigeria	1975 to 2010	evaluates the causal nexus between energy consumption and Nigeria's economic growth	Aqeel and Butt model	economic growth, total energy consumption, petroleum, gas, electricity, coal	Production function	The result shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption
8.	Orhewere and Henry (2011)	Energy Consumption and Economic Growth in Nigeria	Nigeria	1970 – 2005	investigates the causality between GDP and each of the basic sub-components of energy consumption in Nigeria	VECM	Electricity consumption, gas consumption, oil consumption and GDP	neo-classical theory	unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality from Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP

									is found in the long-run
9.	Apergis and Payne(2010)	Energy consumption and growth in South America: Evidence from a panel error correction model	South Am erica	1980 – 2005	examines the relationship between energy consumption and economic growth for a panel of nine South American countries	panel co-integration and error correction model	real GDP, energy consumption, the labor force, and real gross fixed capital formation		short-run and long-run causality from energy consumption to economic growth
B. **EMPIRICAL REVIEW AND METHODOLOGICAL REVIEW ON ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH**									
1.	Enu and Havi (2014)	Influence of Electricity Consumption on Economic Growth in Ghana an Econometric Approach	Ghana	1980-2012	examines the extent to which electricity consumption influences economic growth in Ghana	Augmented Dickey-Fuller test, Co-integration test, Vector Error Correction Model and Granger Causality test	GDP, Electricity consumption, capital and labor	production function	unidirectional causality run from electricity consumption to economic growth
2.	Adeyemi and Ayomide (2013)	Electricity Consumption and Economic Growth in Nigeria	Nigeria	1980-2008	examines the relationship between electricity consumption and economic growth in Nigeria	Vector Error Correction Modelling and the Pairwise Granger Causality test	GDP, Electricity consumption, labor and capital	Cobb-Douglas growth Model	bi-directional causal relationship between electricity consumption and economic growth
3.	Orhewere (2013)	ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN NIGERIA	Nigeria	1970-2005	estimates the relationship between electricity consumption and economic growth in Nigeria	vector error correction basedgranger Causality	GDP AND ELECTRICITY CONSUMPTION		unidirectional causality from electricity consumption to GDP
4.	Fateh and Fares (2012)	Electricity consumption and economic growth in Algeria: A multivariate causality analysis in the presence of structural change	Algeria	1971 – 2010.	investigates and analyze the causal relationship between electricity consumption (EC), Brent oil price (BOP) and economic growth (GDP) for Algeria	Vector Error Correction Models (VECM)	electricity consumption (EC), Brent oil price (BOP) and economic growth (GDP)	neo-classical	show that there is evidence of short-run and a strong long-run bi-directional causal relationship between EC and real GDP in Algeria. Findings indicate also the absence of causal relationship between BOP and EC.

Table 1

III. METHODOLOGY

A. MODEL SPECIFICATION

In view of the fact that technology is indispensable in energy consumption, the Romer growth model (1986) will be employed, since it sees technology as energy and endogamies it. Hence, the dynamic relationship between natural gas consumption and economic growth by incorporating oil consumption (OIL), electricity consumption (ELECT) capital stock (CAPITAL) and labour stock (LABOUR) as explanatory variables. The estimated econometric model will be presented as follows:

$$RGDP = (GAS, OIL, ELECT, CAPITAL, LABOUR) \text{.....4.3.1}$$

However, the Cobb-Douglas production function is not linear, therefore, the model will be modified to take the form of log-linear mode specification to examine the dynamic link between natural gas consumption and economic growth. This is modeled as follows:

$$In\,RGDP_t = \alpha_o + \alpha_1 In GAS_t + \alpha_2\, In OIL_t + \alpha_3\, In ELECT_t + \alpha_4\, In CAPITAL_t + \alpha_5 In LABOUR_t + \varepsilon \text{.....4.3.2}$$

Since it is a panel data analysis, equation 4.3.2 is rewritten as

$$In\,RGDP_{it} = \alpha_o + \alpha_1 In GAS_{it} + \alpha_2\, In OIL_{it} + \alpha_3\, In ELECT_{it} + \alpha_4\, In CAPITAL_{it} + \alpha_5 In LABOUR_{it} + \varepsilon \text{.....4.3.2}$$

Where, In RGDP represents real gross domestic product, InGAS represent natural gas consumption. InOIL represents oil consumption, InELECT represents electricity consumption, InCAPITAL represents the capital stock, InLABOUR represents the labour stock. Also, α_o and $\varepsilon_t$indicates the constant and the classical error term respectively. α_{ik}stands for the estimated coefficient of all independent variables where K = 1…..5. The subscript i=1…6 connote the countries. The subscript t=1...28 connotes the time period.

But, the main objective of this study is to model the long-run relationship that can exist between natural gas consumption and economic growth. To examine these variables the models is as shown below:

$$In\,RGDP_{it} = \alpha_o + \alpha_1 In GAS_{it} + \alpha_2\, In OIL_{it} + \alpha_3\, In ELECT_{it} + \alpha_4\, In CAPITAL_{it} + \alpha_5 In LABOUR_{it} + \varepsilon \text{.....4.3.2}$$

The use of these variables is informed by previous studies that show the long-run relationship between natural as consumption and economic growth.

B. DEFINITION OF VARIABLES

Variables	Description	Measurement
RGDP	Real gross domestic product	constant US dollar
GAS	Natural gas consumption	billion cubic feet
OIL	Oil consumption	barrels per day
ELECT	Electricity consumption	kwh
CAPITAL	Capital stock	constant US$
LABOUR	Labour stock	constant US$

Table 2

C. DATA SOURCES

BP statistical bulletin, Index Mundi and World Data Atlas are the sources of the data gathered for this study. Thus, the data are completely secondary data.

Apriori Expectation

Variable	Explanation	Expected
GAS	A rise in natural gas consumption will induce and increase economic growth	Positive
OIL	A rise in oil consumption will increase economic growth	Negative
ELECT	A rise in electricity consumption would increase	Positive

	economic growth	
CAPITAL	A rise in investment in capital will increase and induce economic growth	positive
LABOUR	A rise in labour of a country will induce and increase economic growth	Positive

Table 4.1: Author's compilation

D. ESTIMATION TECHNIQUES

This study employs a panel data model. The study makes use of annual data with a multivariate analysis method. The empirical equation is expressed as follows

$$In\,RGDP_{it} = \alpha_o + In\,RGDP_{it-1} + In\,GAS_{it} + \beta X_{it} + \mu_{it} + \varepsilon_{it} \quad \text{4.3.3.1}$$

Where In RGDP represent respectively, the RGDP and Natural gas consumptions of country iat time t. a is the parameter to be estimated; X represent the vector of explanatory variables to be used to model economic growth and natural gas consumption. μis country-specific effects and ε is the classical error term. Furthermore, average growth rate of each of the variables in the model is calculated using original data. In addition, the ADF-Fishers panel unit root is employed to test for the stationarity of variables in the model. However, the Kao co-integration is adopted to account for the long-run relationship among variables utilized in this study.

The panel approachis used in this study because panel data usually contain more accurate inference of model parameters, hence improving the efficiency of econometrics estimate. Also it has greater capacity of capturing the complexity of human behaviour than a single cross-section or time series data for instance by controlling the impact of omitted variables and generating computation and statistical inferences. The use of panel data allow not only to examine dynamic relations, but also to control for unobserved cross-country heterogeneity.

IV. EMPIRICAL ANALYSIS

A. DESCRIPTIVE STATISTICS

COUNTRY	RGDP	GAS	OIL	ELECT	CAPITAL	LABOUR
NIGERIA	0.0928	0.2102	0.0271	-0.1461	0.3956	0.0927
ANGOLA	1.6072	7.1992	6.8369	9.3119	29.0285	3.4412
ALGERIA	1.2153	3.1360	2.6814	6.4757	6.7179	2.3850
GABON	-0.5086	17.0167	1.3403	3.1409	7.2046	3.5305
SOUTH AFRICA	0.9225	6.6241	1.8706	1.5407	4.6496	2.2289
EGYPT	2.1886	7.8247	2.4507	5.6702	6.5994	2.5713

Table 5.2.1: Average Annual Growth rate of each of the variables in the model (percent)

Table 5.2.1 presents the average annual growth rates for each of the variables in adopted for this study. There is heterogeneity across countries for these statistics. For instance, the average annual real GDP growth rate is 2.19% for Egypt followed Angola 1.61%, Algeria, 1.22%, South Africa 0.9% while carbon recorded a negative average growth rate for real GDP of 0.51%.

In addition, the average annual gas consumption growth rate is 17.02% for Gabon, followed by Egypt 7.83%, Angola 7.20%, South Africa (6.62%), Algeria (3.14%) and Nigeria (0.21%). For oil consumption, the average animal growth rates is 6.84% for Angola, followed by Algeria 2.68%, Egypt 2.45%, South Africa 1.87%, Gabon1.34% and Nigeria 0.03%. The highest average annual consumption of electricity is recorded for Angola 9.31%, Algeria 6.48%, Egypt 5.68%, Gabon 3.14%, South Africa 1.54% and Nigeria records a negative average annual growth rate of -0.15%. Moreso, it is noteworthy that average annual growth rate of gas consumption is greater than that of oil consumption in all countries for the sample period. In the same vein apart from Nigeria and South Africa, Angola, Algeria, Gabon and Egypt average annual growth rate of electricity consumption is also higher than that of oil consumption.

B. UNIT ROOT TEST

This test is performed in order to ascertain that none of the variables for this research is integrated of an order higher than one and to verify that the results are free from spurious regression. Thus, the unit root test for this study is carried out using theFisher-ADF.

H_0: $\delta = 0$ (the series is non stationary)

H_1: $\delta < 0$ (the series is stationary)

Variable	Order of Variable	ADF-Fishers Statistic	P-Value	Order of Integration
RGDP	Level	14.6684	0.2601	
	1st Difference	20.8067	0.0533**	I(1)
GAS	Level	17.2552	0.1402	
	1st Difference	68.1906	0.0000***	I(1)
OIL	Level	13.8176	0.3125	
	1st Difference	27.8717	0.0058***	I(1)
ELECT	Level	5.40288	0.9432	
	1st Difference	48.8442	0.0000***	I(1)
CAPITAL	Level	9.49395	0.6603	
	1st Difference	27.6501	0.0062***	I(1)
LABOUR	Level	3.60799	0.9895	
	1st Difference	21.8298	0.0395**	I(1)

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5.2.2: Unit root Test

From table 5.2.2 above, the unit root results for each variable indicates that all the variables are integrated of order one I(1). This is shown in their probability values. Specifically, the Fisher-ADF statistics shows that all the variables rgdp, gas consumption, oil consumption, electricity consumption, capital and labour are integrated of order one I(1) and therefore have to be differentiated at first difference before they could be stationary.

C. CO-INTEGRATION TEST

Having determined the stationarity status of the variables which indicates 1(1), the study therefore, test for the existence of a long-run co-integration among the dependent variables and independent variables. The Kao residual co-integration test is adopted to test for stationarity of the residual at levels. The results obtained are presented in the appendix. The result of the co-integration test obtained from the model shows that there is a long run relationship among economic growth, natural gas consumption oil consumption, electricity

consumption, capital and labour. The result of the co-integration test is summarized in Table 5.2.3 below.

	t-Statistic	Prob.
ADF	-3.169498	0.0008
Residual variance	0.002286	
HAC variance	0.003268	

Table 5.2.3: Kao Residual Co-integration tests

The core objective of this study is to examine the relationship between natural gas consumption and economic growth in Africa. Thus, it is necessary on this basis to test for the existence of long-run relationship among these variables in the model within the framework of Kao residual co-integration test. The above table 5.2.3, from the probability value shows that the residual is stationary at levels and significant at one percent leading us to reject the null hypothesis of no stationarity. Thus, since the residual is stationary at levels, the implication in that the measure of relationship among economic growth, natural gas consumption, oil consumption, electricity consumption, capital and labour have an equilibrium condition that could keep them together in the long-run situation in Africa.

D. RELATIONSHIP BETWEEN NATURAL GAS AND ECONOMIC GROWTH IN AFRICA

The study adopts four techniques to test for the relationship between natural gas consumption and economic growth. However, the Fixed Effect (FE) with its estimators as Least Squares Dummy Variables (LSDV) and Within Estimator (WE) techniques are emphasized. This is because other omitted variables that are supposed to be in the model are accounted for. In the same vein, period specific and country specific analysis are also put into consideration in the analysis.The Fixed Effect is valid for observations that cannot be described as being random sample from a given population.

VARIABLES	(1) OLS	(2) FE	(3) LSDV	(4) GLS
lngas	-0.0419***	0.0667***	0.0667***	-0.0419***
	(0.0142)	(0.0137)	(0.0137)	(0.0142)
lnoil	-0.406***	-0.112**	-0.112**	-0.406***
	(0.0739)	(0.0511)	(0.0511)	(0.0739)
lnelect	0.359***	0.525***	0.525***	0.359***
	(0.0359)	(0.0547)	(0.0547)	(0.0359)
lncapital	0.268***	0.0946***	0.0946***	0.268***
	(0.0224)	(0.0237)	(0.0237)	(0.0224)
lnlabour	-0.429***	-0.712***	-0.712***	-0.429***
	(0.0279)	(0.0945)	(0.0945)	(0.0279)
2.crossid			0.216*	
			(0.119)	
3.crossid			-0.642***	
			(0.170)	
4.crossid			-0.111	
			(0.359)	
5.crossid			-0.605***	
			(0.185)	
6.crossid			-1.156***	
			(0.134)	
Constant	10.08***	16.20***	16.58***	10.08***
	(0.455)	(1.355)	(1.499)	(0.455)
Observations	168	168	168	168
R-squared	0.925	0.773	0.979	
firm effect	NO	YES	YES	YES
year effect	NO	NO	YES	NO
Number of crossid		6		6

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

Table 5.2.4: Results of Panel Estimates

The results of Fixed Effect and Least Squares Dummy Variables presented in Table 5.2.4 reveal that natural gas consumption is positive and significantly related to economic growth in Africa at one percentage. Taking ceteris paribus on other variables, a one percent increase in natural gas consumption lends to 0.07 percent increase in economic growth. This finding conforms to a priori expectation and substantial parts of previous studies most especially Isik (2010) who investigates the dynamic link between natural gas consumption and economic growth in Turkey. The result depicts that natural gas consumption positively impact economic growth in Turkey. This result also conforms to Adamu and Muttaqah (2016) who evaluate inland natural gas consumption and real economic growth in Nigeria. Additional, the result conform Solarin and Shahbaz (2018), Farhani andShahbaz (2013) who investigate the impact of natural gas consumption on real GDP in Malaysia and Tunisia respectively.

However, the result for oil consumption is negative but significantly related to economic growth in Africa at five (5) percent significant level. Holding other variables constant, a one percent increase in oil consumption will lead to a 0.11 percent decrease in economic growth in Africa. This result also agrees with a priori expectation and other previous studies. (See Tabara, Nazari and Kahki (2015)).

In addition, results for electricity consumption are also positive and significantly related to economic growth in Africa at ten (10) percentleve. Holding other variables constant a one percent increase in electricity consumption yields a 0.53 percent increase in economic growth. This result behaves in the same way as most other studies. Enu and Havi (2014) and Adegbemi, Olalekan, and Babatunde (2013).

In the same vein, the results also reveal that capital is positive and significantly related to economic growth in Africa at five (5) percent level of significance. Thus, holding other variables constant, a one percent increase in capital will bring about a 0.095 percent increase in economic growth. This result is equally in conformity with a priori expectation and most other previous studies. For instance, Apergis and Payne (2010) examine the relationship between energy consumption and economic growth for a panel of nine South American countries. The findings reveal positive and significant relationship between capital and economic growth.

Moreso, the R-squared results for Fixed effect (FE) and Least Squares Dummy Variable (LSDV) indicate that seventy-seven (77) percent and ninety-seven (97) percent variation of economic growth is explained by the independent variables adopted for this study.

V. SUMMARY, CONCLUSION AND RECOMMENDATION

A. SUMMARY OF THE STUDY

The main findings from this test show that all variable are significant at 95 percent confidence interval (P<0.05). Specifically, the finding shows positive relationship between natural gas and economic growth under Fixed Effect and Least

Square Dummy variables respectively. In the case of oil, the results shows negative relationship for all panel techniques used but also statistically significant 95 percent confidence interval ($p < 0.05$). On the other hand, electricity consumption is also statistically significant and indicates positively relationship with RGDP. It is noteworthy, that natural gas consumption shows an increasing trend among countries within the time under investigation.

B. CONCLUSION

Based on the main purpose and the findings of the study, there is link between natural gas consumption and economic growth in Africa. Natural gas consumption is imperative as major commanding height to attain socio-economic growth in Africa. To this end, countries are increasingly showing interest in gas utilisation to stimulate economic growth. However, natural gas consumption has not been optimally encouraged in Africa comparatively. Propagating increase in demand for natural gas in the future means countries must create more investment in the entire value-chain of natural gas to develop natural gas market and exploitation. Moreover, the political economy of African countries have played a vital role in the behaviour of natural gas consumption. Therefore, policy and regulatory frameworks are indispensable to promote natural gas consumption in Africa in such a way to positively trickle down on the aggregate economy of Africa.

C. RECOMMENDATION

Based on the findings of the study, viable policy implications and recommendations are indispensable. A negative and positive relationship between natural gas consumption and RGDP was established with the various panel techniques, which suggest that gas consumption can be improved if government embarks on policy and regulatory frameworks to promote gas utilization. This implies that stringent policies tailored towards implement Policies tailored towards implementing domestic natural gas consumption is appropriate iachieving consideration level of economic growth. Hence, expanding natural gas policies are regarded beneficial to the African economy.

It is also relevant to substitute other kinds of fossil fuel with gas consumption. This is true because, of its potential benefit to reduce emission and of course being environmentally friendly and relatively cheap. So, it is very key to pursue such efficient policies.

Similarly, gas flaring is a major bane to domestic natural gas utilisation. Adequate legal frameworks should be initiated to achieve the zero flaring of gas. This will develop the entire value-chain of the gas sector for value creation in the aspects of petro-chemicals and provide power supply and feedstock for industries and manufacturing sector.

As a result of the significance of gas utilisation to sustain economic growth and development, it is necessary to also regulate gas pricing in such a way to incentivize investors and consumers to be made better off and in the long run stimulate the economy. This can be achieved by pursuing policies established to reduce the inflationary pressure to maintain a relatively stable domestic currency to stabilize exchange rate since natural gas an international commodity. In the same vein, investment incentives and strategies to attract investment would possibly regulate domestic gas price to be affordable.

Therefore, since Africa is more of a gas province and important energy mix for economic growth, policy-makers in African countries should actualize the progress of the sector.

REFERENCES

[1] Adamu, A. (2014). Independence of domestic gas consumption on Nigerian economy. Ph.D paper, Newcastle University, United Kingdom.
[2] Adamu, A. and Muttaqah, R.D. (2016). Inland natural gas consumption and real economic growth in Nigeria: ARDL Comtegration test. Journal of Economics and Sustainable Development Vol. 7, No. 8
[3] Adegbemi, B.O, Adegbemi, O.O, Olalekan, A.J and Babatunde, O.O. (2013). Energy consumption an Nigeria economic growth. An empirical analysis. European Scientific Journal. Vol. 9, No. 4
[4] Adenikinju, A.F. (2017). Energy and Nigeria's Economic Development: A Troubled but Indispensable Marriage. An Inaugural Lecture at the University of Ibadan.
[5] Adeyemi, A.O and Ayomide, A. (2013). Electricity consumption and economic growth in Nigeria. Journal of Business Management and Applied Economics. Vol. 2 issue 4.
[6] Algarhi, A.S. (2016) oil and economic growth in Egypt. Sheffield Business school
[7] Ali, A. N. M. and Maryam, Z. (2014). Energy consumption and economic growth in Iran. International Journal of Energy Economics and Policy. Vol. 4, No. 1, pp. 15 – 25
[8] Apergis, N. and Payne, J.E. (2010). Energy consumption and growth in South America Evidence from a panel error correction model. Journal of Energy Economics. Vol. 32, pp. 1421 – 1426
[9] Burke, P.J. and Yang, H. (2016). The price and income elasticities of natural gas demand. International evidence. Australian National University, No. 2016/14
[10] Enu, P. 2014. Influence of electricity consumption on economic growth in Ghana an econometric approach. International journal of Economics, Commerce and Management. Vol. II, Issue 9.
[11] Farhani, S. and Shahbaz, M. (2013). The role of natural gas consumption and trade in Tunisia's output. MPRA paper No. 48083
[12] Fateh, B. and Fares, A. 2012. Electricity consumption and economic growth in Algeria: A mulhvade causality analysis in the presence of structural change. Journal of Energy policys Vol.55, pp. 286 – 295
[13] Guvenek, B. Acet, H. Mangir, F. and Kasap, O. (2017). Relationship between natural gas consumption and economic growth in Turkey. Econ World 2017@ Paris Proceedings
[14] Isik, C. and Shahbaz M. 2013. Energy consumption and economic growth: A panel data approach to OECD countries.

[15] Kwame, A.S. (2017). The impact of gas flaring on man and his environment and the way out. International Journal of Engineering and management sciences. Vol. 2, No. 3
[16] Marcus, H.R. (2016). Energy consumption and economic growth in Malaysia: A case of oil and natural gas. Malaysian Journal of Business and Economics. Vol. 3, No. 2, pp. 32 – 47.
[17] Orehewere, B. (2013). Electricity consumption and economic growth in Nigeria. JORIND. vVol. 11(2)
[18] Orhewere, B. and Henry, M. (2011). Energy consumption and economic growth in Nigeria. JORIND, Vol. 19.
[19] Per-Ola, M. (2015). Fractional cointegration, energy consumption and growth revisitied. Evidence from Taiwan. Journal of Economics and Development studies. Vol. 3, No. 1, pp. 23 – 46.
[20] Rahman, M., Tamin, M. and Rahman, L. (2012). Analysis of natural gas consumption by the industrial sector of Bangladesh. Journal of Chemical Engineering Vol. 27, No. 1.
[21] Sama, M.C and Tah, N.R (2016). The effect of energy consumption on economic growth in Cameroon. Asian Economic and Financial Review. Vol 6, No. 9 , 510 – 521
[22] Shahaz, M., Aruori, M. and Teulon, F. (2014). Short-run and long-run relationships between natural gas consumption and economic growth evidence from Pakistan. Economic Modelling Vol. 41, pp219 – 226
[23] Shahbaz M., Chandran, V.G.R and Azeem, P. (2011). Natural gas consumption and economic growth, cointegration, causalility and forecast error vanance decomposition test for Pakistan. MPRA Paper No. 35103
[24] Shahbaz, M. Farhani, S. and Rahman, M.M. (2013) Natural gas consumption and economic growth nexus: The role of exports, capital and labour in frace. MPRA paper No. 50619
[25] Solarin, S.A. and Shahbac M. (2015). Natural gas consumption and economic growth: The role of Foreign direct investment, capital formation and trade openness in Malaysia. MPRA paper No. 67225
[26] Tabari, N. A; Nazari, F. and Kakhi, M.S. (2015). Investigating the effect of thing oil, natural gas and coal on economic growth of Iran. Iran Eco. Rev. Vol. 19, No. 1, p. 17 – 27
[27] To, H. W. jeweera, A. and Charles, M.B (2015). Energy consumption and Economic Growth the case of Australia