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Natural gas utilisation and economic growth nexus in Nigeria

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Abstract
This study investigates the relationship between natural gas utilization and economic growth in Nigeria. The study adopted Vector Error Correction Model for long run cointegration, pairwise granger causality for causal relationship between study variables. The finding depicts a positive relationship between natural gas utilization and economic growth in Nigeria and also unidirectional causal relationship from natural gas utilization to economic growth. The study, therefore, recommends intensive investment in modern gas utilization infrastructure and aggressive adherence to the zero gas flaring policy with a view to increasing natural gas utilization.

Keywords: economic growth, natural gas utilization, vector error correction

1. Introduction

Natural gas utilization plays a critical role in economic growth, it is a vital component of the global supply of energy, which is not only utilised within household units, but also in industrial (particularly in petrochemicals) and agricultural sectors[1], natural gas is seeing as co-product of crude oil production, but according to [2] it now provides about one-fifth of all the world's primary energy requirements.

The significance of natural gas utilization in growth and development process gained more prominence in Nigeria following the establishment of the liquefied natural gas (LNG) plant at Bonny Island in 1999. Nigeria had an estimated 200.4 trillion cubic feet (Tcf) of proved natural gas reserves by the end of 2019, according to the Oil & Gas Journal. Nigeria has the largest natural gas reserves in Africa[3]. The identification of natural gas as a cleaner and more environmentally friendly energy source makes it even more attractive in this age of sensitivity to the wellbeing of the environment [2].

Studies (see [4, 2] were conducted on natural gas utilization and its causality with economic growth. The direction of causality between energy consumption and economic growth has four estimable strands. First, if the causal relation is running from energy consumption to economic growth see [4] then energy conservation policies may be harmful for economic growth. Secondly, if the causal relationship is from economic growth to energy consumption [5], then conservation hypothesis postulates that energy consumption is determined by economic growth. To this end, energy conservation policies do not influence economic growth. Thirdly, the bivariate causal relation between energy consumption and economic growth see [6] implies that energy conservation policies may retard economic growth and also fluctuations in economic growth may distort the consumption of oil and gas. Fourthly, it is also plausible to attain no causal relation between energy consumption and economic growth. There seems to be no consensus as the direction of causal relationship. This is the gap this study intends to fill.

In view of this, the study intends to answer the following question: Does this natural gas deposit contribute effectively to the Nigerian economy within the principles of productivity and growth? What are the causal relationship and the direction of the causality?

To answer these questions the study use Vector Error Correction Model to capture the relationship as well as the shortrun and longrun causality.

The remaining paper is methodology, empirical studies, and conclusion.

2. Methodology

The research employ VECM as used by [7] methodology "Taking inference from the empirical findings and theories, which has been derived from the theoretical exposition of the exogenous growth theories and then making energy central to the equation.

If natural gas is taken as an independent variable then the model can be stated as:

$$Y = f(K, L, G) \tag{1}$$

Where; Y = Output, K= Gross fixed capital formation, L= Labor force, G = natural gas.

The study employ Augmented Dickey Fuller (1979) and Phillips Peron (1988) tests to avoid the criticisms of individual test.

Equation 2 present the Maximum Eigenvalue statistic which tests the null hypothesis of r cointegrating relations against the alternative of r+1 cointegrating relations for r = 0, 1, 2…n-1. This test statistics are computed as:

$$LR_{\max}(r/n+1) = -T^{*}\log(1-\lambda) \tag{2}$$

Where λ the Maximum Eigenvalue and T is is the sample size. Trace statistics investigate the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of variables in the system for r = 0, 1, 2…n-1. Its equation is computed according to the following formula:

$$LR_{tr}(r/n) = -T^{*}\sum_{i=r+1}^{n}\log(1-\lambda_i) \quad (3)$$

The establishment of cointegration allow for VECM, otherwise the granger causality test should be directly applied to determine the causal relationship, where the cointegration is not established

The regression equation form for VECM of simple x and y series is as follows:

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=0}^{n}\beta_i \Delta Y_{t-1} + \sum_{i=0}^{n}\delta_i \Delta X_{t-1} + \sum_{i=0}^{n} y_i Z_{t-1} \quad (4)$$

$$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n}\beta_i Y_{t-1} + \sum_{i=0}^{n}\delta_i \Delta X_{t-1} + \sum_{i=0}^{n} y_i Z_{t-1} \quad (5)$$

A general specifications of the granger causality test in bivariate (X, Y) context can be expressed as:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + ...\alpha_i Y_{t-1} + \beta_1 X_{t-1} + ... + \beta_i X_{t-i} + u \quad (6)$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + ...\alpha_i X_{t-1} + \beta_1 Y_{t-1} + ... + \beta_i Y_{t-i} + u \quad (7)$$

3. Result and Discussion

Estimation of VECM includes the basic steps of stationary test, where the series has to be stationary at first level, meaning the series has to be the same order of integration, the second steps is lag selection criteria which helps in determining the optimum lag selection for model.

Table 1: Summary Statistics

	Ln GDP	Ln GAS	Ln GFC	Ln LABOR
Mean	7.491	0.347	24.294	17.539
Median	7.459	0.242	24.205	17.536
Maximum	7.849	0.699	25.175	17.893
Minimum	7.207	0.137	23.236	17.193
Std. Dev.	0.240	0.191	0.583	0.211
Skewness	0.219	0.727	-0.110	0.023
Kurtosis	1.439	2.019	1.593	1.840
Jarque-Bera	3.066	3.589	2.366	1.573
Probability	0.216	0.166	0.306	0.455
Sum	209.738	9.724	680.233	491.086
Sum Sq. Dev.	1.553	0.983	9.175	1.200
Observations	28	28	28	28

Source: author's compilation

The next step is johanssen cointegration model estimation using the same lag suggested by lag length selection criteria, if the null hypothesis of no cointegration is not rejected we estimate simple unrestricted VAR, establishment of cointegration warrant the estimation of VECM, after which diagnostic test will be perform. **Table 1** present the summary statistics of the series.

The optimum lag order is four as recommended by FPE, AIC, HQ and SC.

Table 2: Unit Root

Traditional Unit Root					
variables	ADF		PP		decision
	t-statistics		t-statistics		
	Level	1st diff	Level	1st diff	
GDP	-2.574	-6.961	-2.531	-2.531	I(1)
gas	-1.147	-5.221	-0.875	-7.209	I(1)
Capital	-0.763	-4.032	-0.845	-4.032	I(1)
Labour	1.145	-7.899	1.293	-8.177	I(1)

Source: author's compilation

3.1. Unit Root Test

Table 2 present the traditional unit root test of ADF and PP, the hypothesis is that, the series has a unit root, the rule is, if the absolute value of ADF is higher than the critical value we reject the null hypothesis, same rule applies to PP. in our series the absolute value of -6.961, -5.221, -4.032, -7.899 of GDP, gas capital and labor respectively is higher than the critical value at fist difference, we reject the null hypothesis of unit root and conclude that our series are stationary at first difference.

3.2. Lag selection

Both AIC, SC, HQ as presented in Table **3** choose lag three as the optimum lag for the model, which can be used in the model.

Table 3: Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	72.280	NA	3.97E-08	-5.690	-5.494	-5.638
1	232.431	253.572	2.47E-13	-17.703	-16.721	-17.442
2	241.210	10.973	5.13E-13	-17.101	-15.334	-16.632
3	310.408	22.104	8.07e-14*	-20.20067*	-16.86285*	-19.31515*

Source: author's compilation

3.3. Johansen Cointegration

The results of Johansen co-integration test shown in **Table 4**, the null hypothesis of no co-integration can be rejected using both the trace statistic and Max Eigen Value Statistics at 5% level. The results indicate at most three co-integrating equations for both maximum eigenvalue and trace statistics. In summary, the calculated values are both greater than the critical values. This simply means that there is a long run relationship among natural gas consumption, GDP, gross fixed capital formation and labor.

Table 4: Johansen Cointegration

Hypothesis	Eigen value	Max. eigen	0.05	Prob.	Trace stat.	0.05	Prob.
none*	0.918	60.111	27.584	0	109.5838	47.856	0
Atmost 1*	0.719	30.486	21.132	0.002	49.473	29.797	0.000
Atmost 2*	0.531	18.173	14.265	0.012	18.987	15.495	0.014
Atmost 3	0.033	0.814	3.841	0.367	0.814	3.841	0.367

Source: author's compilation

3.4. Vector Error Correction Model

Table 5 presents a longrun relationship identified by the cointegration equation. The result reveals GDP to be positively affected by natural gas in the longrun. This effect is statistically significant. This finding reveals the role played by natural gas on Nigerian GDP. The model is free from serial auto correlation and heteroskedesticity.

Table 5: Longrun Estimates

ECT	Ln GDP	Ln GAS	Ln GFC	Ln LABOR
		0.602248	1.226429	-0.006727
		-0.25557	-0.36467	-0.00424
		[2.35647]	[3.36308]	[-1.58691]
Diagnostic Test				
LM Test	0.1923			
JB	0.2808			
White	0.2918			

Source: author's compilation

Table 6 present granger causality test. The null hypothesis gas does not granger cause gdp is rejected while the null hypothesis of gdp does not granger cause natural gas is accepted, meaning a unidirectional causality running from natural gas consumption to gross domestic product, study with similar output is [1] contrary to this [8] found unidirectional causality running from GDP to natural gas consumption in Bangladesh, this is similar to[5] for Malaysia but bidirectional in [6] studies. Meanwhile a bidirectional causal relationship was found between GDP and GFC, unidirectional between GDP and Labor, bidirectional between gas and GFC, unidirectional between gas and labor, finally unidirectional between GFC and labor.

Table 6: Causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
GAS does not Granger Cause LNGDP	26	0.05421	0.9474
LNGDP does not Granger Cause GAS		4.12325	0.0309
LNGFC does not Granger Cause LNGDP	26	1.81604	0.1873
LNGDP does not Granger Cause LNGFC		0.74057	0.4889
LNLABOR does not Granger Cause LNGDP	26	2.27503	0.1276
LNGDP does not Granger Cause LNLABOR		3.54198	0.0473
LNGFC does not Granger Cause GAS	26	1.87098	0.1787
GAS does not Granger Cause LNGFC		0.00313	0.9969
LNLABOR does not Granger Cause GAS	26	4.20383	0.0291
GAS does not Granger Cause LNLABOR		1.51749	0.2424
LNLABOR does not Granger Cause LNGFC	26	3.52796	0.0478
LNGFC does not Granger Cause LNLABOR		1.39303	0.2703

Source: author's compilation

Conclusion

In view of the discussion so far, the study has reached to the conclusion that natural gas utilization is an increasing function of economic growth. This empirical evidence is drawn from the findings VECM which established a long-run positive relationship between natural gas utilization and economic growth as well as unidirectional causal relationship running from natural gas utilisation and economic growth. Thus the null hypothesis of natural gas does not granger cause GDP can be safely rejected, therefore as natural gas utilization increases, the economic activities tend to increased; leading to expansion in the economy. Also the unidirectional causality running from natural gas utilisation to economic growth ascertains the dependency of the economy on oil and gas.

The study suggest more research on gas specifically as its proving to be large in reserves in developing countries and also less carbon emission compared to oil therefore the substitution can be much cheaper compared to renewable energy especially to African countries.

To this end the study recommends intensive investment in modern gas utilization infrastructure and aggressive

adherence to the zero gas flaring policy with a view to increasing natural gas utilization
Prioritizing gas utilization strategy to achieve future targeted rate of economic growth in the economy.

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