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RESEARCH ARTICLE

APPRAISAL OF ENERGY CONSUMPTION AND CARBON DIOXIDE EMISSIONS ON FIXED CAPITAL FORMATION IN NIGERIA

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Abstract

There is growing interest for the use of renewable energy and carbon dioxide emission in Nigeria, and the world over. Despite the volume of consumption, and the enabling oil and gas laws to protect the environment and improve the well-being of citizens over the years, the gross fixed capital formation have not received a remarkable growth in Nigeria which motivated for this study. The gross fixed capital formation was the dependent variable against energy consumption, and carbon dioxide emission that represented the explanatory variables were sourced from the World Bank and the Central Bank of Nigeria Statistical Bulletin between 1985-2014. The study adopted the Augmented Dickey-Fuller and the Autoregressive Distributive Lag model for the analysis. The data were integrated at levels and first order differenced. The Johansen cointegration test indicated co-integrating equations in long run. Furthermore, the error correction found energy consumption to be positive, while carbon dioxide emission had a negative but insignificant impact on the Nigerian fixed capital formation. The study recommended the ministry of environment to enforce the existing oil and gas laws, and advocate for the use of modern energy in rural areas of Nigeria.

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Introduction:-

Capital formation is an essential component required for rapid and sustained growth of any nation. Much more important is the impact energy has in any country's effort to realise an increase in gross fixed capital formation (GFCF) in order to promote various aspects of economic activities which foster economic growth in the long run. The higher the accumulation and deployment of fixed capital for further production of goods and services in an economy, the faster the economy can grow its aggregate income. According to Sodersten et al (2017) investment in capital goods is a well-established driver of economic activity, associated resources use, and environmental impact. Fixed capital formation for instance, is critical to the operations of the agricultural, manufacturing, health, tourism, transportation and communications sectors and indeed sustenance of modern economies. No doubt, gross fixed capital formation is like an amplifier for economic growth, but this comes at a cost to the environment given the high level of embedded energy consumption and carbon dioxide emissions which in effect are behind the environmental degradation. Chen et al. (2019) revealed that energy is central to many economic and social development problems faced by human society. This has necessitated growing global concern amongst environmentalist, economist, investment and public analyst on the effect of global warming and climate change

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mainly arising from the huge quantum of greenhouse gas (GHGs) emissions into the atmosphere (Wang et al., 2011 and Perveen et al., 2020).

Capital formation can be considered as an important element of gross domestic growth (GDP) which shows how much of new value added in the economy is invested rather than been consumed. It is a vital indicator for measuring the level of business activity, confidence and pattern of economic growth in a nation. Thus, investment in fixed asset increases in times of economic boom and decreases accordingly in periods of recession. Oil and gas exploration has also demonstrated to be a major source of Nigerian capital formation that has led to rapid economic growth in recent time. Nigeria is well known as the Africa's largest economy despite the negative oil price shocks and the declining of oil revenue that even caused a recession in 2015's periods. Much of this growth has been driven and sustained mainly from the oil and gas revenue. However, the Niger Delta region in Nigeria which is endowed with large quantity of oil and gas deposit, large bodies of water and aquatic resources has continued to bear the brunt of environmental degradation resulting from gas flaring, dredging of large rivers, oil spillage and reclamation of land due to oil and gas extraction thereby depleting the farmlands, fishing and water resources that indigenes have traditionally depended on for their livelihood. Inglesi-Lotz (2016) stated that promoting renewable energies bears benefits not only for the environment but also for economic conditions of countries.



Fig. 1.1:- First oil well in Nigeria located at Olobiri, Bayelsa State in 1956.



Fig. 1.2:- Farm produce of plantain at Ogbia town in Bayelsa State, Nigeria.



Fig. 1.3:- Gas refining station located at Rumougi, Rivers State, Nigeria.

Fig.1:- Oil and gas deposits as well as farm produce in the Niger Delta part of Nigeria.

Besides capital, labour and materials, energy is a key factor of production which is imperative for gross fixed capital formation growth to foster other development initiatives in the economy. Primarily, energy can be derived from renewable and non-renewable sources. However, the undue reliance of the global population on non-renewable sources of energy such as fossil fuel for further production despite the more environmentally-friendly, cheap, and sustainable renewable energy sources like solar, wind, geothermal, hydropower and biomass renders the ecosystem vulnerable to enormous environmental challenges (Ajayi and Ajanaku, 2009). This is evidenced by the changes in seasonal patterns; increase in temperature and humidity; unpredictable rainfall; rise in sea level, flooding and submersion of coastal lands; aridity, drought and desertification; land degradation; loss of fresh water resources and biodiversity with consequent negative impact on population and economic activities (Federal Ministry of Environment, 2014; Ebele and Emodi, 2016; Abdulkadir et al., 2017).

However, among the six components of greenhouse emissions, carbon dioxide (CO₂) emissions have been regarded as the major contributor with more than 60 % of the total of greenhouse gases (Kaygusuz, 2009). The impact of high emissions of greenhouse gases (GHGs) is not geographically confined but, Khan, et al (2019) asserted that, it cuts across the industrialized and non-industrialized countries. Although, Nigeria's energy consumption had vacillated in recent years, it has shown upward movement through 2000-2019 period perhaps in response to the average economic growth rate of 6% observed within this period. Accordingly, Inglesi-Lotz (2016) found a positive and significant relationship between energy consumption and economic growth.

Greenhouse gas emissions and its other variants depend on two key factors which as Ebele and Emodi (2016) observed are natural process (Bio geographical) and Anthropogenic factors which are human related activities like urbanization, industrialization, energy usage, trade openness, and foreign direct investment (FDI). Although, Nigeria

is richly endowed with energy resource but it suffers from inadequate development and inefficient management of the energy sector which has resulted in a serious demand-supply gap (Akpan and Akpan, 2012). The epileptic supply of electricity, which is one of the most demanding energy sources in the country, has necessitated many households, and firms operating in the country to rely on other alternative sources of power that requires the burning of fossil fuels with the attendant environmental consequences. As been observed, fossil fuel-based consumption is a major contributor to carbon emissions, whereas non-fossil fuels will help reduce the concentration of CO₂ in the atmosphere and sustain environmental condition without affecting GFCF (Alege et al, 2016). The fundamental challenge for developing countries like Nigeria is how to efficiently pursue its carbon emissions reduction policies that could bring about sustained increase in fixed capital formation over a long period of time for further production of goods and services that would improve the living standard for her citizenry, and enhance economic and social development without degrading the environment.

Despite the existing oil and gas laws, international treaties and protocols to manage and control the Nigerian environment, pollution and other dangerous emissions hamper well-being of the citizens against value addition to the production, since we all know that health is wealth. The growing number of outbreak of illnesses as caused by environmental imbalances manifest in poor management and control of oil and gas exploration activities. This appears to have spiked an upward trend in energy consumption and CO₂ emissions that is likely induced by the twin problem of oil spillage and gas flaring in the Niger Delta, that begged for urgent attention. Some existing studies had showed that, changes in weather conditions will continue to have a majorly adverse impact on human life and the ecosystem (Amanchukwu et al, 2015). The continued destruction of ecosystem without adequate alternative means of livelihood, health care facilities, good drinkable water, etc. for the host communities are expose to sudden spread of infectious disease and food- and water-borne illnesses and deaths which had further created an avenue for youths' restiveness. Also, destruction of the ecosystem and the consequential obstruction of farming, aquatic and wildlife environment have led to reduction in agricultural produce and loss of land and water flora and fauna. This informed the view by Chindo et al, (2014) that climate change is an environmental issue which threatens the sustainable development of Nigeria therefore requiring developmental policy approach to forestall further descent. As a results of the oil exploration, and gas flaring which the ecosystem is adversely affected.



Fig. 2.1:- Farm land obstructed by Gas pipe-line located in Rivers State, Nigeria



Fig. 2.2:- Oil spillage at Kolo-Creek in Bayelsa State, Nigeria



Fig. 2.3:- Gas flow station in Rivers State, Nigeria.

Fig. 2:- Gas pipe-line, flow station, and oil spillage in Nigeria.

In the light of the above, it is imperative to assess the impact of energy consumption, and carbon dioxide emission on fixed capital formation in Nigeria. The need becomes urgent considering the high level of pollution and other environmental hazards in the course of the oil exploration, and gas flaring. The study is aimed to appraised the impact of energy consumption, and carbon dioxide emission on gross fixed capital formation in Nigeria from 1985-2014. In this view, the study ask, to what extent does energy consumption, and carbon dioxide emission significantly contributes to gross fixed capital formation in Nigeria from 1985-2014? Hypothetically, energy consumption, and carbon dioxide emission did not significantly contribute to gross fixed capital formation in Nigeria from 1985-2014.

The findings from this study will be of benefits to scholars/academics as it will add to the body of literature. Again, multinationals and other oil and gas practitioners will see this study as research tool to aid and sustained their production. Also, the general public and the host communities would be able identify some sources of the environmental issues and the right avenue to place their demand and setting-up palliative measures.

Empirical literature review

This assertion finds theoretical relevance in Solow Growth model of 1957 which postulated that the primary contributing factor of growth is productivity through sufficient capital accumulation. In the context of this study, the theory has established a relationship between energy consumption, CO₂ emissions and fixed capital formation. Some studies have shown empirical evidence in support to this theory. Bekhat (2017) ascertained the dynamic linkages among financial development, economic growth, energy consumption, CO₂ emissions, and gross fixed capital formation patterns from 1970-2013 in Malaysia. The study used autoregressive distributive lag (ARDL) for the analysis. The study found long run and short run relationship between energy consumption, CO₂ emission and the growth of the Malaysian economy.

Rafindadi and Mika'llu (2019) evaluated the sustainability of energy consumption and capital formation from 1970-2013 in United Kingdom. The study employed autoregressive distributive lag model for the analysis. The results established a long-run and short-run relationships between energy consumption and capital formation within the periods.

Rahman and Ahmad (2019) assessed the relationship between gross capital formation and CO₂ emissions from 1980-2016 in Pakistan using the Non-linear autoregressive distributive lag (NARDL). The results confirm existence of asymmetric effect of gross capital formation shocks on CO₂ emissions.

Abbas et al (2020) evaluated energy usage of renewable and non-renewable on economic growth of some selected countries from 1995-2014, and found that the activities opened many opportunities and hazards in the participated nations.

Hassan et al (2020) investigated the connection between energy consumption, natural resources and gross capital formation from 1971-2015 in Pakistan. The study adopted autoregressive distributive lag for the analysis. The study established a long-run relationships between gross capital formation and natural resources, also a causality flow between the two variables.

Topcu et al (2020) identified the link between economic growth, natural resource, energy consumption and gross capital formation from 1980-2018 in 124 countries. The study applied the panel vector autoregressive (PVAR) for the analysis. The results showed that natural resources and energy consumption positively impact gross domestic product, but capital formation negatively affect in low-income countries.

Aslan and Altinoz (2021) studied the impact of natural resources and gross capital formation of the European, Asian, Africa, and America from 1980-2018 using panel vector autoregressive (PVAR). The study found a positive effect of globalization on economic growth, but natural resources had a negative impact in Africa.

Yasmeen, et al (2021) examined the relationship between natural resources, energy consumption and gross capital formation with a quarterly data from 1990Q1-2018Q4 in Pakistan. The findings revealed a positive relationship between natural resources and economic growth rate in Pakistan.

Etokakpan et al (2020) evaluated natural gas consumption, capital formation, globalization, CO₂ emissions and economic growth from 1980-2014 in Malaysia. The study adopted multivariate framework for the analysis. The results showed evidence of long run relationships among the studied variables, while the granger causality test indicated that growth-energy drive the Malaysian economy.

The above literature has shown empirical evidence that there exists a relationship between energy consumption, CO₂ emissions, and capital formation. In essence, energy consumption, and CO₂ emissions influence capital formation, and economic growth. Most of these has indicated a positive relationship among the variables. However, many of these studies were conducted outside the African continents like Europe, Asia, and America. It will be of important to empirically apprise this study in Nigeria, knowing fully that our laws and level of enforcement might be different. In this light, the study empirically assessed the impact of energy consumption, CO₂ emissions on fixed capital formation in Nigeria. The study closed this gap by using Nigerian data which intended establish different results that will be useful for policy formulations and implementation.

Methodology:-

The study adopted Ex-post facto research design. The work is country-specific, and it was based on past events. The *ex-post facto* research design is best fit for the establishment of casual impact. Thus, in an attempt to appraised the impact of energy consumption, and carbon dioxide emission on gross fixed capital formation in Nigeria from 1985-2014, the study is anchored on the Solow Growth model. This assertion finds theoretical relevance in the Solow Growth model (SGM) which opined that the primary contributing factor of growth is a function of sufficient capital accumulation. Conversely, the theory has established a relationship between energy consumption, CO₂ emissions and fixed capital formation. The theory by implication is suggesting that, the increase of energy consumption and CO₂ emissions tends to grow fixed capital formation in Nigeria. This study added in its design, the econometric/analytical framework to theoretically test the ex-post facto.

The data was sourced from the World Bank and the Central Bank of Nigeria Statistical Bulletin (various issues). The data sets were time series that followed regular time-frequency of annualized for both the dependent and explanatory variables. The proxy for the dependent variable being capital formation was the gross fixed capital formation, and the explanatory variables were energy consumption, and CO₂ emissions. The study did not adopt any technique for sampling and population given that the study employed already existed data. The coverage period was 1985 to 2014 representing 29 years. The study intended extend to current date but data were not available from the source at the time of the study. The study adopted the Autoregressive Distributive Lag (ARDL) model. The adoption of ARDL was based on its merits in different order levels of data stationary.

Model specification

The theory of Solow Growth model (SGM) holds that the primary contributing factor of growth is productivity through sufficient capital accumulation. In the context of this study, the theory has established a relationship between energy consumption, CO₂ emissions and fixed capital formation in Nigeria. Although, with the nature and the laws of oil and gas exploration in Nigeria needed to be appraised, since there were other harmful factors like oilspillage, gas combustion, etc.

Thus, the SGM function was expressed as:

$$GFCF = f(\text{environmentalfactors}) \text{ ----- eq. 1}$$

Using GFCF to be a productivity index and environmental factors to be oil and gas indicators such as energy consumption, and CO₂ emissions were theoretically, and empirically analyzed for, in a linear functional relationship as follows:

$$GFCF = f(ENCR, CABR) \text{ ----- eq. 2}$$

Equation eq. 2 was restated into linear mathematical form, thus:

$$GFCF = \beta_0 + \beta_1 A_1 + \beta_2 A_2 \text{ ----- eq. 3}$$

From the theoretical standpoint, this study was designed to validate or otherwise of the SGM using variables in Nigeria. Normally, from the empirical viewpoint, the regression in eq. 3 can be rewritten in econometric form. Based on this fact, the linear equation is stated thus:

$$GFCF_t = \beta_0 + \beta_1 ENCR_t + \beta_2 CABR_t + \varepsilon_t \text{ ----- eq. 4}$$

In eq. 4 above, all the variables were β_0 = the constant (the value of the dependent variable when all the regressors are at zero); β_1 - β_2 were the coefficients of the explanatory variables and ε_t is the noise or error term. The model variables of this study consisted of gross fixed capital formation as a broad dependent variable that being influenced byenergy consumption, and CO₂ emissions which served as explanatory variables.

Concepts of the model variables

- i. **Gross fixed capital formation: gross fixed capital formation was adopted as the dependent variable.** It is a measure of the value of new or existing fixed asset acquisitions by businesses, governments, and private households less disposals of fixed assets. It refers to value addition or value set for production. It is measured in Billions of Y. An appreciation in gross fixed capital formation would translate to a higher economic performance, and the sensitivity is expected to be higher than zero.
- ii. **Energy consumption:** Energy consumption was employed as independent variable. Energy consumption refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, after exports and fuels supplied to ships and aircraft engaged in international transport. It is measured in kilo grams. An appreciation in energy consumption would translate to a higher gross fixed capital formation, and the sensitivity is expected to be higher than zero.

- iii. **Carbon dioxide emission:** Carbon dioxide emission was used as independent variable. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. It includes carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. It is measured in metric tons. An appreciation in CO₂ would translate to a higher economic performance, and the sensitivity is expected to be higher than zero.

Estimation Procedure

The estimation process for this work followed the preliminary and other diagnostics test, as well as inferences- Test of Hypotheses using the autoregressive distributive lag model estimates (ARDL). The preliminary test for data stationarity of the study variables were conducted. The traditional unit root test for stationary of the data by Dickey-Fuller test was initiated to indicate the unit root properties of the series following equation specified (eq. 5).

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \alpha_i \sum_{t=1}^m \Delta y_{t-1} + \varepsilon_t \text{----- eq. 5}$$

Where the test is for H₀ = δ = 0 and H₁ = δ < 0.

The lag selection was based on the Bayesian Criterion generated automatically by the estimation software following the form of equation 6 below:

$$BIC = \ln(n)K - 2\ln(\hat{L}) \text{----- eq. 6}$$

where:

n represents either the sample size, the number of observations, or the number of data points in x.

k represents free parameters to be estimated.

\hat{L} represents the maximized value of the likelihood function for the estimated model M given as $\hat{L} = p\left(\frac{x}{\theta}, \mathcal{M}\right)$.

Long Run and Co-integration Test (Bound Test)

This study also carried out the long run test following the ARDL framework.

ARDL short run error correction representation

After the establishment of the possible long-run impact relationship through the bound test, the ARDL model was used to appraise the impact of energy consumption, and carbon dioxide emission on gross fixed capital formation in Nigeria from 1985-2014. This follows the form specified below for the Model with GFCF as the dependent variable in eq.7

$$\Delta GFCF_t = \pi_p + \sum_{i=1}^{\beta} \delta_{ip} \Delta GFCF_{t-i} + \sum_{i=1}^{\beta_1} \sigma_{ip} \Delta ENCR_{t-i} + \sum_{i=1}^{\beta_2} \tau_{ip} \Delta CABR_{t-i} + \omega_p GFCF_{t-1} + \omega_{1p} ENCR_{t-1} + \omega_{2p} CABR_{t-1} + \xi_{1t} \text{-----eq. 7}$$

All the variables were discussed above with combined modelling of the short-run and long-run coefficients using the ARDL framework.

The a priori expectations from the models' tests of the hypotheses were given as follows; β₁ > 0, β₂ > 0

To ensure that estimates were valid, efficient, and unbiased inferences in this study, the diagnostic test and the procedure as prescribed two critical values namely lower and the upper bound, and the decision rule guides were contained in table 1 below:

Table 1:- Summary of Adopted Diagnostic Tests and Decision Rules for the Bound Tests Process.

S/No	Test Name/ State	Test Function/ Remark	Decision Rule/ Inference
1.	Coefficient of Correlation (R ²)	To measure the goodness of fit of the model	The higher the R ² the better the fit
2.	F-Statistics	To Test the significance of the overall regression	A Probability value of F-stat less than 0.05 suggests that the model is good enough for analyses/inferences.
3.	t- Statistics	To confirm the significance level	t- Statistics higher than 1.96 shows evidence of significance.
4.	F stat is more than upper bound/t-	A cointegrating relationship	Reject the null hypothesis

	statistics greater than 1.96 or P-value less than 0.05	exists	
5.	F stat less than the lower and upper bound/t-statistics less than 1.96 or P-value higher than 0.05	No cointegrating relationship exists	Refuse to reject the null hypothesis
6.	F stat at the chosen level of significance falls within the lower and upper bound/ t-statistics equals to 1.96 or P-value exactly 0.05	Results are indecisive	Inconclusive Finding
7.	Durbin Watson Statistics	To measure the first-order autocorrelation	DW approximately 2 shows evidence against the first-order autocorrelation.
8.	Breusch Godfrey Serial Correlation test	To measure higher-order autocorrelation	A p-value greater than 0.05 shows evidence against higher-order autocorrelation
9.	Ramsey Reset test	To test for the constant variance of error term	A p-value greater than 0.05 shows evidence in favor of Ramsey Reset.

Source: Authors' Compilation.

Inferences in this study were based on the outcome of the estimation process as well as conclusions drawn based on the tested hypothesis. The choice level of significance for all tests was the 0.05 or 5% level and in confirmation with the 1.96 t-Statistics critical value. All estimations were done using version 10 of the E-views estimation software.

Results and Discussion:-

This section presented data of the study and discussed the findings of the results.

Presentation of data

The data were presented in table 2 below:

Table 2:- Models variable data of Gross Fixed Capital Formation growth (GFCFR), Energy Consumption (ENCR), and Carbon Dioxide emission (CABR), 1985 – 2014.

Ye ar	Gross fixed capital formation (annual % growth)	Energy consumption (kg of oil equivalent per capita)	CO2 emissions (metric tons per capita)
19 85	-15.2925	683.2323	0.836413
19 86	0.218804	671.907	0.857037
19 87	-6.22928	677.2681	0.673985
19 88	6.68359	679.269	0.782645
19 89	6.517264	684.8636	0.457407
19 90	13.80424	697.6134	0.712617
19 91	-1.2394	712.6762	0.773747
19 92	0.512945	722.4018	0.862605
19 93	7.533617	715.8626	0.821902
19 94	-2.45882	681.1114	0.764813
19	-6.64314	682.6686	0.755361

95			
19 96	6.793911	694.1803	0.787756
19 97	5.845782	700.0518	0.73631
19 98	1.393454	687.5077	0.658873
19 99	2.675391	694.5614	0.626027
20 00	7.285385	703.6367	0.622077
20 01	-23.7467	720.4457	0.679059
20 02	10.19303	725.0092	0.669616
20 03	21.40866	747.0192	0.672324
20 04	-19.9368	748.7461	0.654964
20 05	2.342505	758.3651	0.70889
20 06	40.38866	744.9411	0.646844
20 07	-21.8953	751.1784	0.615895
20 08	-2.60106	753.2494	0.609105
20 09	9.924205	721.8145	0.481063
20 10	4.01246	756.3471	0.572417
20 11	-8.24668	778.8437	0.627069
20 12	2.551734	798.63	0.602049
20 13	7.864836	780.1398	0.644599
20 14	13.42649	763.6319	0.658712

Source: Extracted from the World Bank and the Central Bank of Nigeria Statistical Bulletin (various issues).

Data analysis

The results of the unit root test were presented in table 3 below:

Table 3:- Summary of Augmented Dickey-Fuller Unit Root Test Results.

Variables	ADF Test Statistic	Test of Critical Level			Order of Integration	Probability Value
		1%	5%	10%		
D(GFCF)	-4.913448	-4.309824	-3.574244	-3.221728	1(0)	0.0024
D(ENCR)	-4.639305	-4.323979	-3.580623	-3.225334	1(1)	0.0048
D(CABR)	-4.001079	-4.309824	-3.574244	-3.221728	1(0)	0.0201

Source: Extracted E-view 10.0 and compiled by Author

The ADF unit root test results in table 3 showed that two variables were integrated at levels, while one variable was at first levels. This is for the fact that the variables associated probability values were less than 0.05 significance level. This however, necessitated for Breusch-Godfrey and Ramsey reset diagnostic tests that justified the application of long run bound test since all variables were stationary and ARDL is permitted. The results of the Breusch-Godfrey serial correlation test were presented in table 4 below:

Table 4:- Breusch-Godfrey Serial Correlation LM Test results:

F-statistic	0.103836	Prob. F(2,23)	0.9018
Obs*R-squared	0.259504	Prob. Chi-Square(2)	0.8783

Source: Extracted from E-view 10.0 and compiled by Author

From the table, the observed R² value of 0.259504 with its corresponding probability of 0.8783 which is above five percent (0.05) indicated that the model is free from serial correlation. Since the p-value is higher than 0.05, it showed evidence against higher-order autocorrelation. Nevertheless, the study can proceed to conduct for heteroskedasticity in table 5 below.

The results of the Ramsey Reset test were presented in table 5 below:

Table 5:- Breusch-Godfrey Serial Correlation LM Test results:

	Value	Df	Probability
t-statistic	0.578319	24	0.5684
F-statistic	0.334453	(1, 24)	0.5684

Source: Extracted from E-view 10.0 and compiled by Author

From the table, the observed t-statistic value of 0.578319 with its corresponding probability of 0.5684 which was above five percent (0.05) implied that the model is free from Ramsey reset. Since the p-value is higher than 0.05 showed evidence in favor of Ramsey reset, hence the model can proceed for further analysis. This however, authorized for of long run bound test in table 6, even at different order integration as approved by ARDL model. The results of the long run Cointegration Bound Test were presented in table 6 below:

Table 6:- The results of long run Cointegration Bound test

Cointegration Test Results

LONGRUN FORM OF ARDL

ARDL Long Run Form and Bounds Test				
Dependent Variable: D(GFCFR)				
Selected Model: ARDL(1, 0, 0)				
Case 2: Restricted Constant and No Trend				
Date: 09/22/21 Time: 12:13				
Sample: 1985 2014				
Included observations: 29				
Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.61231	51.79401	-0.436581	0.6662
GFCFR(-1)*	-0.957007	0.197387	-4.848366	0.0001
CARBR**	-12.46552	22.21597	-0.561106	0.5797
ENCOR**	0.052938	0.061824	0.856258	0.4000
* p-value incompatible with t-Bounds distribution.				

** Variable interpreted as $Z = Z(-1) + D(Z)$.

Source: Extracted from E-view 10.0 computation

The long run cointegration bound test presented in table 6, showed one cointegrating equation from the results. The results showed that energy consumption and CO₂ emission had a significant long run impact on capital formation in Nigeria. This is because, the associated probability value was less than 0.05 significance levels. Hence, it can be concluded from the findings that the energy consumption and CO₂ emission had a significant response impact on gross fixed capital formation in Nigeria. However, the short-term results for lag adjustment were followed as shown in table 7.

Table 7:- The results of short run Resid test
ARDL RESULT

Unrestricted Test Equation:				
Dependent Variable: GFCFR				
Method: ARDL				
Date: 09/22/21 Time: 12:18				
Sample: 1986 2014				
Included observations: 29				
Maximum dependent lags: 2 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (2 lags, automatic):				
Fixed regressors: C				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GFCFR(-1)	0.214984	0.358431	0.599792	0.5543
CARBR	-48.91830	66.93366	-0.730848	0.4719
ENCOR	0.235466	0.321780	0.731762	0.4714
C	-117.3464	172.0160	-0.682183	0.5017
FITTED^2	-0.216582	0.374502	-0.578319	0.5684
R-squared	0.874481	Mean dependent var		7.478645
Adjusted R-squared	0.802772	S.D. dependent var		10.39156
S.E. of regression	10.76302	Akaike info criterion		7.745696
Sum squared resid	2780.224	Schwarz criterion		7.981436
Log likelihood	-107.3126	Hannan-Quinn criter.		7.819527
F-statistic	0.525152	Durbin-Watson stat		2.025613
Prob(F-statistic)	0.718226			

Source: Extracted from E-view 10.0 computation

The ARDL lag estimation was the model with the Akaike Information Criterion (AIC) of 7.8195 and the highest log-likelihood ratio of -107.3829 is shown in table 7. Hence, the model as shown in table 7 is the optimal model for the test of hypotheses. From the table 7 results, R² is 0.87 represented 87% approximately. This value implied that the model is fit for the study, and also indicated that 87% of the total variation in gross fixed capital formation being the dependent variable (productivity performance) which were explained by the changes in the independent variables of energy consumption and CO₂ emission dioxide been captured in the study, while approximate of 0.13 or 13% can be attributed to noise or other associated variables not captured in the work.

The Durbin Watson test statistic from table 7, is 2.025613, and as rule of the thumb stated, a test against first-order autocorrelation should be approximately 2. From the findings indicated an approximate of 2, hence the results showed evidence against first-order autocorrelation.

Test of Hypotheses

The hypotheses were rewritten in null and alternate forms to enable the study conduct the test; thus:

H_0 : energy consumption, and carbon dioxide emission did not positively and significantly contribute to gross fixed capital formation in Nigeria from 1985-2014.

H_a : energy consumption, and carbon dioxide emission positively and significantly contribute to gross fixed capital formation in Nigeria from 1985-2014.

Discussion Of Findings:-

The reported coefficients, from the ARDL lag 2 estimations, were 0.214984, 0.235466, -48.91830, with the probability values of 0.5543, 0.4714, 0.4719 respectively for GFCF, ENCR, and CABR. Judging from these results, energy consumption (ENCR) had a positive, while carbon dioxide emission exerted negatively but did not significantly contribute to capital formation in Nigeria. Conversely, gross fixed capital formation contributes positively but insignificantly to the Nigerian economic growth rate by implication. The decision rule was based on the fact that the probability values of gross fixed capital formation, energy consumption, and carbon dioxide emission were higher than 0.05 significance level, and as such H_0 cannot be rejected.

The economic implication of these results revealed that a unit change in energy consumption had caused a 0.235 units passive increases, while carbon dioxide emission caused a decrease of 48.92 units but with no significant effect on the gross fixed capital formation in Nigeria. Whereas, gross fixed capital formation contributed about 21.5% to the Nigeria's economic growth rate for every reduction on energy consumption and carbon dioxide emission. These findings indicated evidence of no significant impact energy consumption and carbon dioxide emission on gross fixed capital formation in Nigeria with hazards effects especially in the host communities of the Niger Delta region as shown in figure 2. While, the Nigerian gross fixed capital formation to economic growth rate would be enhanced more if there would have effective law's provisions and enforcement with regards to oil and gas to reduce by 0.235 and 48.92 for energy consumption rate and carbon dioxide emission respectively. These findings further showed that a reasonable number of Nigerians are not consuming/patronizing energy and CO₂ due poor awareness and the environment they occupied. For instance, most of the dwellers in rural are not conversant with the use of such modern energy and CO₂ and thus, the rural areas in Nigeria occupy the high-density compared to the urban.

From these results in every increase of carbon dioxide emission rate adversely affected the capital formation in Nigeria. Consequently, every increase of energy consumption rate contributes passively to the capital formation performance of Nigeria. Following from these results, the growth rate of gross fixed capital formation cannot be traced to energy consumption rate and carbon dioxide emission in Nigeria between 1985 and 2014. Thus, energy consumption rate and carbon dioxide emission did not constitute significant variables but needed provision and enforcement of laws. Again, another factor that of concern is the standard deviation of 23.22016 representing 23% as associated with carbon dioxide emission is high compared to energy consumption in Nigeria. This result indicated the high-risk factor within the host communities in Nigeria, especially in the Niger Delta region due to gas flaring. Although, the model was log, nevertheless this evidence has shown that the host communities are living in harsh environment that demand urgent attention from the multinational companies as shown in figure 2.

Conclusion:-

Reasonable number of Scholars have advanced interest and reviewed remarkable studies in oil exploration, and gas flaring but little have been recorded in Nigeria. The study in energy consumption, and CO₂ emission have not gained much attention in Nigeria considering the hazardous effect within the environment. The study concluded that, the exploration oil and gas flaring leading to energy consumption, and CO₂ indicated a passive and negative impact on gross fixed capital formation in Nigeria. However, gross fixed capital formation tends to growth Nigerian economy if the provision and enforcement of the laws will much effective in reduction of the hazardous effects within the environment to improve the well-being of the citizens living therein.

Recommendation:-

Based on the above findings, the study recommended the following:

1. The ministry of environment should strengthen its inspectorate division with a view to enforce the extant oil and gas laws directed at addressing environmental issues. The supervisors of the economic agents responsible for capital formation, especially in the sense of ensuring adoption and incorporation of advanced technologies that will mitigate CO₂ emissions, by holding the multinational companies to strengthened their corporate social responsibility.
2. The agency for national orientation should create more awareness to the public especially the rural dwellers to adopt the use of modern energy and at affordable cost. This advocacy will go a long way to increase the consumption of modern energy as well as reduce the traditional method of energy use in the rural areas.
3. The ministry of finance and the Central Bank of Nigeria should also adopt appropriate fiscal policy framework by reducing or giving tax waiver and issuing free interest loans to renewable energy investors. This will encourage the use of renewable energy in further production hence promote energy efficiency as well as imposition of environmental taxes to discourage the use of conventional energy in Nigeria.

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