SSRG International Journal of Economics and Management Studies
ISSN: 2393 – 9125 / https://doi.org/10.14445/23939125/IJEMS-V7I2P126

Volume 7 Issue 2, 177-185, February 2020

Original Article

Energy Consumption, Industrial Production and CO_2 Emissions in Two Major African Countries

Victor Okechukwu Nwatu

Emerald Energy Institute, University of Port Harcourt, Choba, Rivers State, Nigeria

Received Date: 29 January 2020
Revised Date: 02 March 2020
Accepted Date: 05 March 2020

Abstract - *This paper estimates the relationship between energy consumption, carbon (iv) oxide emission, and industrial production for Nigeria and South Africa.*
The usual preliminary analysis and formal tests were performed on the data before the Autoregressive Distributed Lag (ARDL) were applied in the model estimation. The choice of the ARDL was due to the results obtained from the formal tests, especially the unit root tests. The model estimation for the data took into account the need to lag the data to be able to achieve stationary property. Both short-run and long-run estimates were generated. Diagnostic tests were also carried out on the estimated models.

The results coefficients for energy consumption and carbon (iv) oxide emission were obtained for the short and long run for Nigeria and for only the short-run for South Africa. Conclusions and policy recommendations were then made to the government in line with the results of the model estimation. Top of the list is the regulation of energy consumption and carbon footprint via policies in the effort to increase industrial production.

Keywords - *CO2, Energy Consumption, GDP, Policy, ARDL.*

I. INTRODUCTION

Ever since the industrial revolution of the 1760s, the level of development or otherwise has been tied to its industrial production. The industrial revolution manifested in agrarian economies moving to urban and industrialized economies. Over the years, the scale of this industrialization has been increased with its additional consequences. These consequences, so to speak, are other additional factors that industrial production has engendered. Top among these are the energy consumption and the production of carbon (iv) oxide, as examined by [6].Over the years, the available models have not been incorporating the three variables in a single equation. The models usually explore the relationship between the output from the economy and the energy consumption on the one hand and the relationship between the carbon (iv) oxide emission and the energy production on the other hand. Very few models have captured the three variables. Examples are the review of the relationships between industrial production, energy consumption, and carbon (iv) oxide in France by [3].

It should be noted that the case for estimating the relationship between the emission of carbon (iv) oxide and other parameters such as industrial production has become more important for various reasons. Of late, emphasis has been on sustainable development. That is the achievement of development occasioned by industrial production but being mindful of protecting the environment. What comes to mind is the effect of carbon (iv) oxide as a greenhouse gas with a contribution of up to sixty percent (60%) of the total greenhouse effect [11], [12]. This situation has garnered international attention, especially with the signing of the Kyoto protocol.

The aim of this write-up, therefore, is to use the Autoregressive Distributed Lag to estimate the coefficients for the model relating the industrial production (with Gross Domestic Product - GDP as a proxy), energy utilization, and carbon (iv) oxide emission. The data is annual series data from Nigeria and South Africa between 1980 and 2015. Their requisite tests would be applied to the data and to the model after estimation. The results of this model estimation would be used to make forecasts and policy decision suggestions to the government. This is also expected to cascade to the relevant international organizations.

II. LITERATURE REVIEW

Multiple studies have been done in the area of model estimation for industrial production, energy consumption, and carbon (iv) oxide emission by many authors. These studies have been done either in whole with the entire three parameters considered or in parts. These parts include two different parameters only examined or a combination of some of the parameters mentioned above and other parameters. We would review some of these research works to look at the crux of their respective researches.

[4] worked on determining if there is a relationship between industrial output and the energy requirementin

Nigeria. The study applied the knowledge of the policy framework to ensure that the relationship between industrial output and the energy requirement is properly. The major addition to the model, which is a gap, is to acknowledge the role played by carbon (iv) oxide in altering the production and environment package of the model. Also, the model used is the error correction model (ECM) and not the ARDL.

The study above by [4] focused on two of the three major parameters of interest, but [6] incorporated the three. His study worked on the relationship between energy consumption, GDP, and carbon (ix) oxide emission in Nigeria. Data from the period 1970 to 2010 was used for the studies. In the end, a negative relationship between the GDP and energy utilization was determined. Also, a positive relationship between the GDP and the carbon (iv) oxide emission. However, it must be noted that this relationship in this form may be traceable to the nature of the data utilized in the model selection. Also, it should be noted this study was domiciled only in Nigeria without the benefit of data from other locations to work on the model validation. [10] also worked on similar parameters in Nigeria, while [9] and [16] studied natural gas, economic growth, and carbon dioxide emission in Nigeria.

[17] tookinvestigations between energy consumption, carbon dioxide, and industrial production a bit further by incorporating other middle-level energy-demanding countries. It studied the relationship between sectoral output, energy use, and carbon (ix) oxide emission in medium-income countries. These were studied for mediums income countries such as BRIC (Brazil, Russia, India, China), MENA (the Middle East and North African) countries, a handful of Asian and American countries, etc. The study was able to obtain the relationship between the three parameters above for these countries. However, the identified gap in this study is that the cross-correlated effect mean group (CCEMG) and the augmented mean group (AMG) were applied to arrive at the relationship between these factors. The ARDL model was not used.

In other to incorporate the high energy-demanding G7 countries, [3] used the ARDL to estimate the relationship between industrial output, carbon (iv) oxide emission, and energy consumption in France. The study was able to follow all the critical steps in model estimation and validation without issues. However, the inherent gap is that the study was done for France. This could be domiciled and replicated in Nigeria with all the conditions set up to achieve the results required.

III. MATERIALS AND METHODOLOGY

A. Data

The dataset for the study uses the gross domestic product (GDP) as a proxy for industrial productivity, energy consumption, and carbon dioxide (CO2) emission for Nigeria and South Africa. CO2emission is in kilo-tonnes, energy consumption is in quadrillion BTU, GDP is measured is presented in USD. The data series for energy consumption was obtained from the US Energy Information Administration (EIA) website [8]. GDP and CO2emissiondata are readily available at the World Bank [19]. The study uses a yearly dataset from 1980 to 2015, a total of 36 observations. The period and frequency of the chosen data set adapted for the study are based on the data availability. GDP is considered the dependent variable, and energy consumption and CO2 emission are considered as independent variables in this study.

B. Graphical Analysis

The data for this study were plotted in their log form for both Nigeria and South Africa. The graphed data are shown in Figures I and II below.

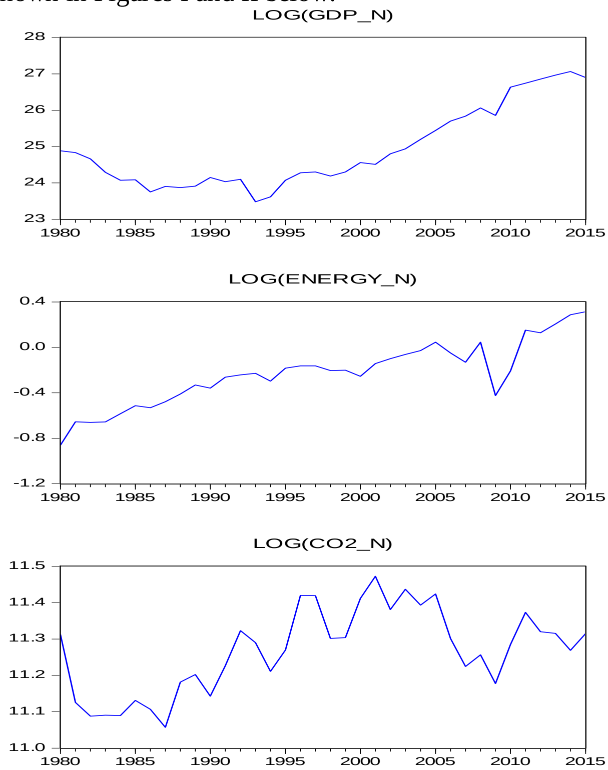

Fig. 1 Eviews-9 Timeseries of GDP, Energy Consumption and CO2 emission for Nigeria.

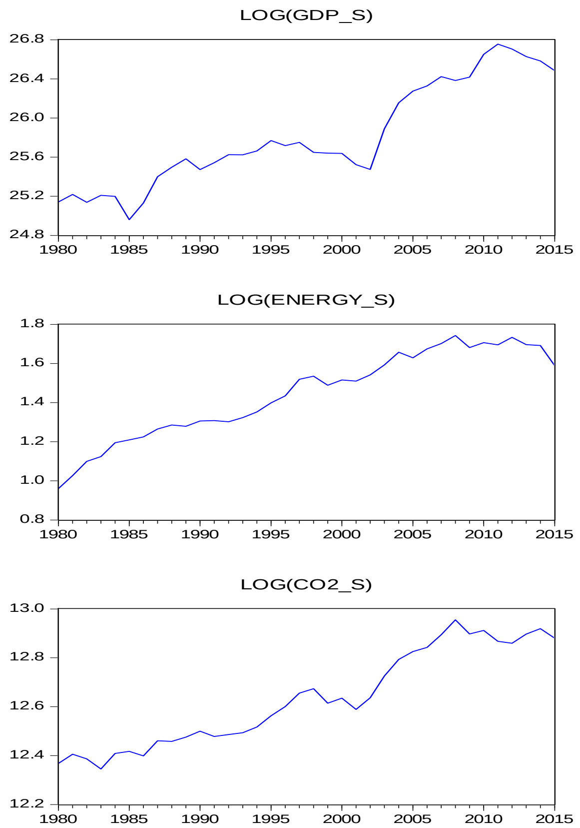

Fig. 2 Eviews-9 Timeseries of GDP, Energy Consumption and CO2 emission for South Africa.

C. Descriptive Statistics

The descriptive statistics of the data series for this study are as contained in Tables 1 and 2 for Nigeria and South Africa as computed from EVIEWS 9. The moments of the distribution and Jarque-Bera are illustrated in table 4 for Nigeria. The first and second moment of the distributions, mean and standard deviation, suggesting that the mean are not zero and evidence of deviation from the mean. The log(GDP) is the most volatile series when compared with other variables in consideration. The log(Energy consumption) and log(CO2 emission) series are skewed to the left. The descriptive statistics show that there might be the presence of asymmetry in the probability distribution for all series around the mean. The series does not exhibit fat tails, indicating that they are not leptokurtic since kurtosis is less than 3. This also indicates that changes are not extreme for the variables in consideration. The Jarque-Bera test indicates that the series is normal for log(GDP) since there is no statistical significance among series.

The moments of the distribution and Jarque-Bera are illustrated in table 5 for South Africa. The first and second moment of the distributions, mean and standard deviation, suggesting that the mean are not zero and evidence of deviation from the mean. The log(GDP) is the most volatile series when compared with other variables in consideration. The log(Energy consumption) series is skewed to the left, while log(GDP) and CO2 emission are skewed to the right. The descriptive statistics show that there might be the presence of asymmetry in the probability distribution for all series around the mean. The series does not exhibit fat tails, indicating that they are not leptokurtic since kurtosis is less than 3. This also indicates that changes are not extreme for the variables in consideration. The Jarque-Bera test indicates that the series is non-normal for all at any level since there is no statistical significance.

Table 1. Descriptive Statistics of Timeseries for Nigeria

	LOG(GDP_N)	LOG(ENERGY_N)	LOG(CO2_N)
Mean	24.91353	-0.227989	11.26810
Median	24.53543	-0.205755	11.28754
Maximum	27.06627	0.313282	11.47264
Minimum	23.48258	-0.860573	11.05696
Std. Dev.	1.090868	0.279550	0.115330
Skewness	0.761878	-0.106206	-0.146215
Kurtosis	2.253239	2.617402	2.010251
Jarque-Bera	4.319228	0.287250	1.597679
Probability	0.115370	0.866212	0.449851
Sum	896.8871	-8.207604	405.6515
Sum Sq. Dev.	41.64978	2.735184	0.465532
Observations	36	36	36

Table 2. Descriptive Statistics of Timeseries for South Africa

	LOG(GDP_S)	LOG(ENERGY_S)	LOG(CO2_S)
Mean	25.81264	1.444283	12.63436
Median	25.64472	1.499098	12.60740
Maximum	26.75606	1.743026	12.95509
Minimum	24.96039	0.960348	12.34560
Std. Dev.	0.530798	0.222036	0.197293
Skewness	0.365552	-0.372010	0.216076
Kurtosis	1.876062	2.045188	1.575583
Jarque-Bera	2.696625	2.197846	3.323580
Probability	0.259678	0.333230	0.189799
Sum	929.2550	51.99420	454.8369
Sum Sq. Dev.	9.861134	1.725496	1.362355
Observations	36	36	36

Table 3. Augmented Dickey-Fuller test for Nigeria

	Level			First Differenced			
Variable	None	Constant	Constant + Trend	None	Constant	Constant + Trend	I(0) or I(1)
log(gdp_n)	1.806290	0.613393	-2.321869	-5.102584***	-5.294637***	-6.299142***	I(1)
log(energy_n)	- 2.380718**	-1.699004	-3.753960**	-7.317583***	-7.744187***	-7.614630***	I(1)
log(co2_n)	0.589078	-2.043614	-2.893259	-6.411931***	-6.366492***	-6.300706***	I(1)

****, **, * represent 1%, 5%, and 10% significance level respectively.*

Table 4. Augmented Dickey-Fuller test for South Africa

	Level			First Differenced			
Variable	None	Constant	Constant + Trend	None	Constant	Constant + Trend	I(0) or I(1)
log(gdp_s)	1.743396	-0.708084	-2.903112	-4.177879***	-4.349797***	-4.275097***	I(1)
log(energy_s)	2.177890	-2.907418*	-0.600251	-4.098453***	-4.571944***	-5.511075***	I(1)
log(co2_s)	-2.225867	-0.692523	-2.209963	-4.897771***	-5.378078***	-5.288178***	I(1)

****, **, * represent 1%, 5%, and 10% significance level respectively.*

Table 5. Bounds Co-Integration Tests for Nigeria

ARDL Bounds Test		
Test Statistic	Value	k
F-statistic	5.121051	2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	4.19	5.06
5%	4.87	5.85
2.5%	5.79	6.59
1%	6.34	7.52

Table 6. Bounds Co-Integration Tests for South Africa

ARDL Bounds Test		
Test Statistic	Value	k
F-statistic	3.020743	2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	4.19	5.06
5%	4.87	5.85
2.5%	5.79	6.59
1%	6.34	7.52

Table 7. ARDL Long-run and Short-run estimates for Nigeria

Dependent Variable: Log(GDP); Parsimonious model: ARDL (1,1,0)		
Panel A: Long-run estimates		
Variable	Coefficient	Standard Error
Log(ENERGY_N)	-3.139706*	1.646106
Log(CO2_N)	-2.047483	1.760657
C	43.537138**	43.537138
@TREND	0.2111457***	0.042031
Panel B: Short-run results		
LOG(GDP_N(-1))	0.763956***	0.065621
LOG(ENERGY_N)	0.432619	0.341759
LOG(ENERGY_N(-1))	-1.173727***	0.316033
LOG(CO2_N)	-0.483295	0.478581
C	10.27666	6.387528
@TREND	0.049913***	0.011375
R-squared	0.975227	
Adjusted R-squared	0.970955	
F-statistic	228.3220***	
Durbin-Watson Stat	2.306423	

Table 8. ARDL Long-run and Short-run estimates for Nigeria

Dependent Variable: Log(GDP); Parsimonious model: ARDL (2,0,0)		
Panel A: Long-run estimates		
Variable	Coefficient	Standard Error
LOG(ENERGY_S)	-0.702974	1.232208
LOG(CO2_S)	2.262326*	1.258959
C	-2.079212	14.810821
@TREND	0.019683	0.023389
Panel B: Short-run results		
LOG(GDP_S(-1))	0.922252***	0.188540
LOG(GDP_S(-2))	-0.341090*	0.181236
LOG(ENERGY_S)	-0.294432	0.560615
LOG(CO2_S)	0.947547	0.618233
C	-0.870852	6.206811
@TREND	0.008244	0.011072
R-squared	0.958130	
Adjusted R-squared	0.950654	
F-statistic	128.1487	
Durbin-Watson Stat	1.891479	

****, **, * represent 1%, 5%, and 10% significance level respectively.*

D. Stationarity Analysis

It is important that the time series be employed in the model estimation to be trend stationery. Sometimes, it may be necessary to take the first difference of some data series in order to get them to be stationary. This is as per the studies of [1] and [15].

For this study, the stationarity analysis of the augmented Dickey-Fuller (ADF) unit root test was performed in [1]. Table II shows the stationarity report for the level I (0) and first difference I(1) state for Nigeria, while Table II shows the same for South Africa. Both tables show that none of the variables in the level form for the category: none, constant, and constant + trend is non-stationary. However, the variables' timeseries are stationary at a certain significance level after the first difference, which allows for the implementation of the ARDL model for model estimation for both countries being studied.

E. Co-integration analysis

The bounds co-integration technique, as in [11], is a more realistic approach to check for a long-run relationship as it allows for both I(0) and I(1) in the regression model.

The underlying test equation for the bounds co-integration test is the $ARDL\ (p, q_1, q_2)$ model, which is given as:

Level form I (0):

$$\gamma_t = \alpha + \sum_{i=0}^{p} \rho_i y_{t-1} + \sum_{j=0}^{q_1} \gamma_j X_{t-j} + \sum_{j=0}^{q_2} \alpha_j Z_{t-j} + \epsilon_t \quad (1)$$

First differenced form I (1):

$$\Delta y_t = \alpha + \rho_i y_{t-1} + \gamma_j X_{t-j} + \alpha_j Z_{t-j} + \sum_{i=0}^{p} \rho_i \Delta y_{t-1} + \sum_{j=0}^{q_1} \gamma_j \Delta X_{t-j} + \sum_{j=0}^{q_2} \alpha_j \Delta Z_{t-j} + \epsilon_t \quad (2)$$

wherey_t is the dependent variable and x_t and z_tAre independent variables.

The decision for the bounds co-integration test are:

$$H_0: \rho = \gamma = \alpha = 0 \Rightarrow No\ Co-integration \Rightarrow No\ long\ run\ relationship$$

$$H_0: \rho = \gamma = \alpha \neq 0 \Rightarrow Co-integration \Rightarrow long\ run\ relationship\ exist$$

The results of the Bounds Co-integration Tests are as presented in Table V for Nigeria and Table VI for South Africa.

For Nigeria:
F-Statistic = 5.121051.
1%: F-statistic < Lower Bound, which means that Only Short Run Estimates exist at this probability level.
5%: Lower Bound <F-statistic < Upper Bound,which means that the Bound Test is inconclusive at this probability level.
10%: F-statistic >Upper Bound,which means that Both Long Run and Short Run Estimates exist at this probability level.

This means that at the 10% probability level, the null hypothesis is rejected; a long-run relationship exists in the model, suggesting that model can be used for the forecast.

For South Africa:
F-Statistic = 3.020743.

This value is less than the bound value at all probability levels. So, this means that at all probability levels, the null hypothesis is not rejected; only short-run estimates can be estimated with this model.

IV. EMPIRICAL RESULT

A. ARDL results and interpretation

The study presents results for the long-run and short-run estimates in Tables VII for Nigeria and Table VIII for South Africa. The joint explanation of the model parameters are given as follows:

a. Model Interpretation (Long-run):

- For Nigeria, there is a negative relationship between industrial production (GDP) and energy consumption. The impact of energy consumption on industrial production is significant at a 10% probability level. Energy consumption has an impact on the industrial production of Nigeria. On the other hand, carbon (iv) oxide emission in Nigeria does not have much impact on the industrial production of the country. This is shown by the coefficient of the carbon (iv) oxide emission not being significant at any probability level. However, there is a negative relationship between the two variables.
- For South Africa, there is a negative relationship between industrial production and energy consumption. However, it should be noted that the coefficient is not significant at any probability level. Also, the results in the long run for South Africa do

not exist since the Bound Tests have already shown that only Short-Run relationships exist for South Africa. This means that the impact of energy consumption on industrial production is minimal. On the other hand, there is a positive relationship between CO_2emission and industrial production. It should be noted that the coefficient of the CO_2emission is significant at 10%. Hence this model could be used for prediction purposes to determine the output given certain. This is because the model is a long-run one.

- The impact of CO_2 emission on industrial production is not significant at any level for Nigeria but significant at 10% for South Africa.
- In the specification, the slope coefficient of CO_2emission is not significant at any level for Nigeria. This suggests that CO_2 emission is not a good predictor of industrial production in Nigeria. For South Africa, the slope coefficient of the emission of$CO_2$is significant at 10%, so it is a good predictor of industrial production.

b. Model Interpretation (Short-run):

- For Nigeria, there is a negative relationship between industrial production (GDP) and energy consumption. The impact of energy consumption on industrial production is significant at a 1% level with an inverse relationship. This also suggests that energy consumption can be a major predictor of Industrial production. For South Africa, there is a negative relationship between industrial production and energy consumption. However, the slope coefficient of energy consumption is not significant at any level. Hence, energy consumption may not have much impact on the value of industrial production.
- The impact of CO_2 emission on industrial production is not significant at any level in both Nigeria and South Africa.
- In the specification, the slope coefficient of CO_2 emission is not significant at any level. This suggests that CO_2emission is not a good predictor of industrial production for both Nigeria and South Africa.
- The coefficient of determination of about 97.5% indicates that the predictive ability of the model is very high, with R squared at 97.5% since the unexplained component is 2.5% for Nigeria. In South Africa, the coefficient of determination is at 95.18%. This means that the explained component of the model is 95.18%. while the unexplained component of the model is 4.82%
- The overall models for both Nigeria and South Africa are statistically significant, judging by the F-statistic. The latter is significant at the 1% level.

B. Post-diagnostic Tests

a) Linearity:

For Nigeria:

$$\mathrm{H_0}: \text{linear}$$

$$\mathrm{H_1}: \text{Non} - \text{linear}$$

$$[t - statistic\ (df = 28)] = 0.664955$$

The above model is linear since the computed statistics are not significant at any level.

For South Africa:

$$\mathrm{H_0}: \text{linear}$$

$$\mathrm{H_1}: \text{Non} - \text{linear}$$

$$[t - statistic\ (df = 27)] = 1.168546$$

The above model is linear since the computed statistics are not significant at any level.

b) Multicollinearity:

For Nigeria:

$$\log(Energy\_n): [VIF(Centered)] = 7.62793$$

$$\log(Co2\_n): [VIF(Centered)] = 2.983792$$

The degree of collinearity in the model falls within the allowable threshold. There is no evidence of severe multicollinearity problem since the calculated VIF < 10.

For South Africa:

$$\log(Energy\_n): [VIF(Centered)] = 30.16135$$

$$\log(Co2\_n): [VIF(Centered)] = 34.94559$$

The degree of collinearity in the model falls outside the range of 10. There is evidence of severe multicollinearity problem since the calculated VIF > 10. This shows that there is a higher level of correlation between energy consumption and CO_2emission, and this could be traceable to the data available that was used in this model estimation exercise.

c) Heteroscedasticity:

$$\mathrm{H_0}: \text{Constant Variance}$$

$$\mathrm{H_1}: \text{Non} - \text{Constant variance}$$

For Nigeria:

$$[F - stat(df: 1{,}32)] = 0.432270$$

$$[F - stat(df: 2{,}30)] = 0.245632$$

For South Africa:

$$[F - stat(df: 1,32)] = 0.049574$$

$$[F - stat(df: 2,30)] = 0.024839$$

The variance of the error term in the estimated model is constant, judging by the F-statistics, which is not significant. This indicates homoscedasticity.

d) Non- autocorrelation:

$$H_0: \text{There is no autocorrelation}$$

$$H_1: \text{There is a presence of auto} - \text{correlation}$$

For Nigeria:

$$[F - statistics\ (df: 2,27)] = 0.617730$$

For South Africa:

$$[F - statistics\ (df: 2,26)] = 0.535110$$

There is no presence of serial correlation in the model since the probability values are not significant,so we accept the null hypothesis.

f) Normality:

$$H_0: \text{Normal distribution}$$

$$H_1: \text{non} - \text{normal distribution}$$

For Nigeria:

$$\text{Jarque} - \text{Bera}: 11.37182^{***}$$

For South Africa:

$$\text{Jarque} - \text{Bera}: 0.768913$$

The residual term is normally distributed judging by the Jarque-Bera statistics, which is not statistically significant for South Africa, but for Nigeria, it is statistically significant, which means that the residual term is not normally distributed for Nigeria.

V. CONCLUSION AND POLICY RECOMMENDATION

This study was aimed at developing a model to explain the relationship between industrial production, energy consumption,andCO_2 emission. The relationship between the input parameters (regressors), energy consumption, and the carbon (iv) oxide emission and the output, industrial production, was then established and evaluated for Nigeria and South Africa.

For Nigeria,in the long run, there is a relationship (although negative) between energy consumption and industrial production. This is significant at the 10% probability level. It should be noted that there should be a positive relationship, but the results from the data at hand show a negative coefficient for energy consumption. This could be as a result of all the data availability as most of the energy consumed during gas flaring, etc.,is not captured.

The model also shows that for Nigeria, the level of industrial production is not affected by the carbon (iv)oxide emission. The coefficient of this parameter is not significant at any probability in the model. This could also be traceable to the data available as most of the carbon (iv) oxide emitted during gas flaring, and other activities are not accurately collected and reported.

Part of the implementation of the energy policy for Nigeria is the insistence that accurate data is captured and recorded for all energy activities in the country. Energy consumption in terms of gas flaring and carbon (iv) oxide emissions from the same flaring should have their values properly recorded. Also, all the other parts of the energy policy include having plans in place for energy conservation and the utilization of renewable energy sources that do not produce greenhouse gases. It is also recommended that these models be evaluated with different, and if possible, more recent data.

For South Africa, the model is estimated in the short run, so all the estimates for the relationship between industrial production, energy consumption, and carbon (iv) oxide emission. The model shows a negative relationship between energy consumption and industrial production. However, it should be noticed that the coefficient of this relationship is not significant at any probability level. This means that energy consumption does not have much impact on industrial productivity. This is a very curious observation that requires further investigation.

On the other hand, there is a positive relationship between CO_2 emission and industrial production. This means that as a matter of policy, plans should be in place to regulate the production ofCO_2 since it would be produced more as the industrial production of the country increases.

The polluter pays principle should also be adopted in both countries to ensure that CO_2 is not indiscriminately being produced. For a start, the suggestions made by [9] and [16] could be adopted in utilizing natural gas as a transition, less-polluting energy pending the eventual complete migration to the use of renewables.

REFERENCES

[1] Abimelech, G. P., Zhen, W., Presley, W., & Isaac, R. Y., The impacts of oil price shocks on small oil-importing economies: Times series evidence for Liberia. Energy, (2017) 975-990.

[2] Alkhathlan, K., & Javid, M. (2013, November). Energy consumption, carbon emissions and economic growth in Saudi Arabia: An aggregate and disaggregate analysis. Energy Policy, (2013) 1525-1532.

[3] Ang, J. B.., CO2 emissions, energy consumption, and output in France. Energy Policy 35(8) (2007).

[4] Bernard, O. A., & Oludare, A. (2016). is energy consumption relevant to industrial output in NIGERIA? European Journal of Research in Social Sciences, 14 (2016).

[5] Bowden, N., & Payne, J. E, The causal relationship between U.S. energy consumption and real output: A disaggregated analysis. Journal of Policy Modeling, 31(2) (2009) 180-188.

[6] Chindo, S., Abdulrahim, A., Waziri, I. S., Huong, M. W., & Ahmad, A. A., Energy consumption, CO2 emissions, and GDP in Nigeria. GeoJournal, 9 (2014).

[7] Edenhofer, O., Pichs-Madruga, R., & Sokona, Y. .,Climate Change 2014 Mitigation of Climate Change. Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, (2014).

[8] EIA. (2019). eia Beta. Retrieved February 25, 2019, from International Energy Statistics: https://www.eia.gov/beta/international/data/browser/#/?pa=0000000g&c=00000000000000000000000000000004&ct=0&tl_id=3002-A&vs=INTL.26-2-NGA-BCF.A&vo=0&v=H&end=2017

[9] Ezenwa, E. N., & Nwatu, V. O., The Effect of Natural Gas Utilization and CO2 Emissions on the Economic Growth of Nigeria. SSRG International Journal of Economics and Management Studies (SSRG-IJEMS), (2020) 1 - 8.

[10] Gambo, S. L., Binti, S. I., Ismail, N. W., & Idris, M. M., Energy Consumption, Environmental Emissions, and Economic Growth: An Empirical Analysis in Nigeria. Journal Of Humanities And Social Science(2279-0837), (2018) 11-22.

[11] Ilhan, O., & Ali, A, CO2 emissions, energy consumption, and economic growth in Turkey. Renewable and Sustainable energy reviews, 14(9) (2010) 3220-3225.

[12] Kaygusuz, K., Energy and Environmental Issues Relating to Greenhouse Gas Emissions for Sustainable Development in Turkey. Renewable and Sustainable energy reviews, 13(1) (2009) 253-270

[13] Kutu, A. A., & Ngalawa, H.,Dynamics of Industrial Production in BRICS Countries. International Journal of Economics and Finance Studies, (2016) 1-8.

[14] Kutu, A. A., & Ngalawa, H., MONETARY POLICY AND INDUSTRIAL OUTPUT IN THE BRICS COUNTRIES: A MARKOV-SWITCHING MODEL. Folia Oeconomica Stetinensia, (2017)1 - 21.

[15] Lemazoshvili, B. (2014, November 23). Effect of Oil Price Shocks on Oil Importing Developing Economies: The Case of Georgia and Armenia. Economic Education and Research Consortium, (2014) 1-28.

[16] Nwatu, V. O., & Ezenwa, N. (2020, January). Natural Gas Consumption, Economic Growth and CO2 Emission Relationships in Nigeria. International Journal of Scientific & Engineering Research, 11(1) (2020) 226 - 260.

[17] Sohag, K., Mamun, M. A., Uddi, G. S., & Mohamed, A. M., Sectoral output, energy use, and CO2 emission. Environ Sci Pollut Res, (2017) 11.

[18] US Energy Information Administration Website. .,Primary Energy COnsumtion. Retrieved 08 09, 2018, from IEA: https://www.eia.gov/beta/international/data/browser/#/?pa=000000001s&c=00000000000000000000000000000000040000000000000000002&ct=0&vs=INTL.44-2-NGA-QBTU.A&vo=0&v=H&end=2015

[19] World Economic Outlook. (2017, 04). World Economic and Financial Surveys. Retrieved 02 24, 2018, from International Monetary Fund: https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/index.aspx