Journal of Advanced Research in Humanities and Social Sciences
Volume 7, Issue 3 - 2020, Pg. No. 25-41
Peer Reviewed Journal

Article

Impact of Energy Consumption on Industrial Growth in Nigerian Economy

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How to cite this article:
Abdulkadir KF, Isik A. Impact of Energy Consumption on Industrial Growth in Nigerian Economy. *J Adv Res Humani Social Sci* 2020; 7(3): 25-41.

Date of Submission: 2020-09-19
Date of Acceptance: 2020-10-05

A B S T R A C T

This research investigates the impact of energy consumption on industrial growth. Manufacturing value added as proxy for industrial growth is used as dependent variable while the independent variables are; energy consumption, labor, and capital. The sample size covers a period of 29 years starting from 1990-2018. The OLS method of egression was used to estimate the equation in the period under review. Unit root test, Co-integration test and Granger causality were carried out to test for stationarity, long run relationship, and causal relationship, respectively. Result shows that there is a positive and significant relationship between energy consumption and manufacturing value added in the period under review. The unit root test shows that all variables are integrated of order one except for the variable capital, which is stationary at level. The Co-integration test indicates that there exists the presence of long-run relationships. The granger causality indicates the neutrality hypothesis in energy-industrial growth nexus in Nigeria. Generally, this paper stresses the dangers poor capacity of power generation from energy sources leading to inadequate electricity supply in the functioning of industries and businesses, which further worsens overall growth in the Nigerian economy.

Keywords: Transition, Energy, Industry, OLS, Growth

Introduction

The horror of the aftermath of situations like the current Covid-19 pandemic is what will immediately encourage the unindustrialized countries to effectively invest and ensure the successful operations of industries in the economies to sustain their citizens during economic lockdowns. Sadly, Nigeria is one of the unfortunate countries. We are now finding ourselves in a twin crisis. Amidst the coronavirus pandemic, the international crude oil prices are falling, and Nigeria largely depends on crude oil for national revenue. Even as the country is endowed with energy resources, the sector still lacks adequate development to channel in the growth of other sectors of the economy. Given the vital nature of energy for development, a lot of research has been carried out in the area of energy consumption and economic growth. However, the industrial sector of economies which is also highly crucial for growth needs to be investigated. There is a vast literature on energy- growth nexus, and it is highly recommended to find energy consumption link with the industrial sector of economies. With effective industrialization, countries can rapidly achieve growth and development in the overall economy. This is because the industry is known for income, job, and wealth creation as well as a general improvement in the standard of living of the citizens through productivity and profitability (Abdu and Anam, 2018). Beji and Belhadj (2014) pointed out that industrialization has several long-run advantages in the form of economic diversification, technology transfer, unemployment reduction, and welfare improvement. Hence industrial growth is the motive drive behind economic growth. However, to achieve this, the industrial sector needs power as such work hand in hand with the energy sector to fuel its success in operations. As stated by Tapsin (2017), energy is one of the most critical inputs of the production process. Inadequate energy supply and inefficient energy use pose a threat to industrial growth. One of the most challenging factors to development in Nigeria is the poor quality, unreliability, and limited availability of power supply to industrialization (Adenikinju, 2008). A lot research using different time period, variables, countries, and models stresses the importance of energy in the industrial process.

The economic growth model has been evolving since the time of classical economists. Economists keep building upon these models after several criticisms. The popularly known Cobb-Douglas production function is a linear function that takes into account labor and capital as only inputs for the total output produced in the manufacturing industry. The Solow growth model is an exogenous model which analyses changes in output level over time given changes in population growth rates, saving rate, and technological progress. Given that the Solow model fails to explain sustained growth, the Romer (1989) model came into place in dividing the world into ideas and objects. This model explains technical progress resulting from investment rate, capital stock size, and stock of human capital. Given these three main models, it has been realized that none gave energy its due position. Since the classical and neoclassical economists treated energy as an intermediate input in production, as a facilitator of factors of production, a new model is being developed as the KLEC model which recognizes the crucial role of energy in production (Kümmel and Lindenberger, 2014.

The significance of this study is its contribution of literature to the field of energy economics, particularly on the impact of energy consumption on industrial growth in Nigeria, which is not broad. The uniqueness of the work is, however, the variables selected, which are highly crucial in the industrial sector. Previous studies have focused generally on the entire economy with few researches on the industrial sector. Hence, the main objective of this paper is to examine the impact of energy consumption on industrial growth in Nigeria.

Literature Review

The existing literature on the relationship between energy consumption and economic or industrial growth has focused on the short run, long run, causal relationships between the variables. Studies have had differences of data sets, periods, regression methods, and countries of research, which translated to differences of results over time. Below discusses some of these papers.

In the study of energy and economic growth, the four central hypotheses are worth mentioning. These are; growth hypothesis, conservation hypothesis, feedback hypothesis, and neutrality hypothesis. The growth hypothesis depicts the importance of energy for economic growth. For an economy exhibiting the hypothesis, it is said to be energy-dependent. In conservation hypothesis, the economy is what drives energy, so reducing energy demand may not necessarily affect economic growth. The feedback hypothesis implies a bidirectional relationship between energy and economic growth, while the neutrality hypothesis suggests no relationship between the two variables i.e. seen as independent factors.

A group of researchers has conducted single country studies on the relationship between energy consumption and economic growth as follows. Kasperowicz (2014) investigated the Polish economy on the relationship between electricity consumption and economic growth of the country from 2000 to 2012. After having analyzed the data, he found the presence of a causal relationship between electricity consumption and economic growth of Poland to be bidirectional. An estimate on a one-sector aggregate production function proves that the economic growth of Poland is dependent on its electricity consumption. Apaydin et al. (2019) researched the asymmetric effects of renewable energy consumption on the economic growth of Turkey from 1965 to 2017 using a nonlinear autoregressive distributed lag model. Results show that there is a direct correlation between renewable energy consumption and economic growth. They found that one percent increase in renewable energy consumption increases economic growth by approximately 0.4 percent, while the one percent fall decreases growth by 0.7 percent. For the Lebanese economy, Abosedra et al. (2015) investigated the relationship between financial development, energy consumption, and economic growth from 2000 to 2010. Findings show that there exists the presence of Co-integration with a significant positive impact of energy consumption on economic growth in the country. Also, the result of the Granger causality test shows the presence of bidirectional causality, indicating the feedback hypothesis. Meidani and Zabihi (2012) studied the causal relationship between real GDP and energy consumption in the Iranian economy. The study considered the effect of energy consumption in different sectors on GDP from 1967 to 2010 using the Toda-Yamamoto method. Results show that there is a strong unidirectional causality from energy consumption in industrial sector to real gross domestic product.

For the Nigerian research-based, Olarinde and Omojolaibi (2014) used the bound test approach to VAR in investigating the relationship between institutional quality, electricity consumption, and economic growth from 1980 to 2011 in Nigeria. The result for co integration shows the presence of long-run relation. Causality test shows a bidirectional causality between electricity consumption and economic growth, and the RDL and Wald test depicts a positive direct relationship between the variables. Ohwofasa et al. (2015) examined the relationship between electricity consumption and per capita income in Nigeria. By employing and error correction model, the result shows that was no presence of co-integration and a positive relationship between per capita and electricity consumption. Another paper on the causal relationship between manufacturing productivity and electricity consumption in Nigeria was written by (Danmaraya and Hassan, 2016). Their work constituted a time frame of 1980 to 2013 using the autoregressive distributed lag technique. Results confirm the presence of co-integration as well as a bidirectional causal relationship between manufacturing productivity and energy consumption. On another research for Nigeria, Okoligwe and Ihugba (2014) examined the causal relationship between electricity consumption and economic growth from 1971 to 2012. The result shows no presence of causality, i.e., supporting the neutrality hypothesis.

Arminen and Menegaki (2019) examined the causal relationship between economic growth, carbon dioxide emission, and energy consumption in high and upper-middle income countries from 1985 to 2011. Using the simultaneous equations framework, they found that there is a presence of a bidirectional causal relationship between energy consumption and economic growth. Fatai (2014) focused his research on 18 sub-Saharan African countries. He studied the causal relationship between energy consumption and economic growth in these countries from 1980 to 2011. The Co-integration test result shows the presence of a stable long-run equilibrium relationship. The causality test for East and Southern African countries support the growth hypothesis, and a neutrality hypothesis in Central and West African Sub-region. An analysis of energy consumption and economic growth in the West Africa sub-region from 1980 to 2015 produced the followings results; the presence of co-integration and a causality running from growth to electricity consumption, i.e., indicating the conservation hypothesis in the region (Twerefoul et al, 2018). Hassine and Harrathi (2017) examined the causal relationship between renewable energy consumption and economic growth in the Gulf Cooperation Council countries from 1980 to 2012. Co-integration result shows the presence of long-run relationship between the variables and causality running from all the variables to output, i.e., economic growth. Using panel data research, Bercu et al. (2019) analyzed the lantern relationship between energy consumption, economic growth, and good governance from 1995 to 2017 in 14 Central and Eastern European countries. Their empirical findings show the presence of a causal relationship between electricity consumption and economic growth. Research by Vo et al. (2019) investigated the causal link between carbon dioxide emissions, energy consumption, renewable energy, population growth, and economic growth in 5 ASEAN countries from 1971 to 2014. Results show the presence of co-integration in 3 of the countries. Feedback hypothesis for the granger causality test is seen in 3 of the countries, the conservation hypothesis is observed in one of the countries and feedback hypothesis in the other country.

On the relationship between electricity consumption and industrial output in Nigeria, Ugwoke et al. (2016) analyzed the data using a double-log linear formulation and found that electricity supply and trade openness insignificantly brings about a negative impact industrial production in Nigeria. Olufemi (2015) analyzed the relationship between electricity consumption and industrial growth in Nigeria from 1980 to 2012. Using co-integration and error correction techniques, he found a long-run positive relationship that is significant between industrial growth and electricity consumption, labor employment, electricity generation, and foreign exchange rate with a negative relationship between capital input and industrial growth. Nwajinka et al. (2013) employed multiple regression analyses and found that national energy supply does not have a significant impact on industrial productivity in Nigeria. Nwosa (2012) analyzed the effect of the aggregate energy consumption on sectoral output in Nigeria. By utilizing a bi-variate Vector Auto-regressive (VAR) model, the study noticed bidirectional causality between total energy consumption and agricultural production and unidirectional causality from service output to total energy consumption. Biodun (2011) focused on researching the power sector and industrial development in power holding company of Nigeria. The findings show the presence of the positive relationship between the power sector and industrial development in Nigeria. Yakubu et al. (2015) assessed the relationship between electricity supply and manufacturing sector's output in Nigeria from 1971 to 2010 using the ARDL bounds testing approach. The results showed a long-run relationship between the variables. Manufacturing production was found to be positively dependent on electricity in both the short-run and significant in the long-run. Bernard and Oludare (2016) investigated energy consumption on industrial sector output from 1980 to 2013. Using an error correction mechanism, the result shows that all variables in the study have a positive trend with a long-run relationship between energy consumption and industrial output in Nigeria. Another work by Akiri et al. (2015) examined the impact of electricity supply on manufacturing industries' productivity in Nigeria. For the period of 1980 to 2012, they employed the ordinary least square multiple regression to analyze the data. The result of the study shows that electricity generation and supply positively impacts on manufacturing productivity growth. Danmaraya and Hassan (2016) used the autoregressive distributed lag technique for the period of 1980 to 2013 to analyze manufacturing productivity and electricity consumption in Nigeria. They found proof of co-integration among electricity consumption, capital, and manufacturing productivity. The findings showed bidirectional causality between manufacturing productivity and energy consumption.

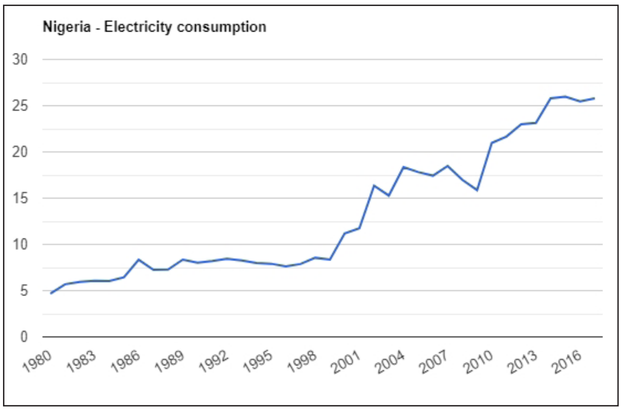
Also, investigations on other country research have been carried out as such. Abokyi et al. (2018) researched solely on Ghanian economy and found that electricity consumption impacts negatively on industrial growth in both the long-run and the short-run. Results show the presence of co-integration and unidirectional causality from the consumption of electricity to industrial growth, supporting the growth hypothesis in Ghana. Another research by Abid and Mraihi (2015) based their investigation on the causal relationship between energy consumption and industrial production in Tunisia for the period, 1980 to 2007. The result from Granger causality test shows that industrial production granger causes gas consumption, but there is no causality between oil consumption and industry GDP. However, in the short-run, Granger causality runs from industry GDP from to total energy consumption and from electricity consumption to industry GDP in the short-run with no causality on both sides in the long run. Tugcu (2013) analyzed the disaggregate energy consumption and total factor productivity growth in Turkey. Using the ARDL bounds testing approach, the results showed the presence of co-integration and bi-directional causal relationships among the variables in consideration. Upon utilizing the Johansen Method of Co-integration, Qazi et al. (2012) researched the disaggregate energy consumption effect on industrial output in Pakistan and found the presence of co-integration and a positive relationship between disaggregate energy consumption and industrial production. Granger causality test shows the presence of unidirectional causality from electricity consumption to industrial output, industrial output to coal consumption, bidirectional causality between oil consumption and industrial growth, and no causality between gas consumption and industrial output. From 2005 to 2015 in Uganda, Mawejje and Mawejje (2016) examined the causal relationship between electricity consumption and sectoral output growth. From the macro level, the result shows the presence of causality running from electricity consumption to GDP. On the sectoral level, long-run causality runs from electricity consumption to industry, i.e., indicating growth hypothesis for the sector, short-run causality from the services sector to electricity consumption, and no causality for agriculture.

Materials and Methods

Definition of Energy and Industrial Growth

Energy is regarded as the primary factor that facilitates the efficiency and productivity of other factors of production, mainly labor and capital (Yakubu et al, 2015). Energy results from the following forms; nuclear energy, electrical energy, thermal energy, motion energy, sound energy, elastic energy, gravitational energy, radiant energy, and chemical energy, amongst others.

The graph below shows electricity consumption data for Nigeria from 1980 to 2017. Value for electricity consumption at billion kilowatts.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

Ekpo (2014) defined industrialization as a process of building up a country's capacity to produce many varieties of products – extraction of raw materials and manufacturing of semi-finished and finished goods. Industrial development therefore, represents a deliberate and sustained application suitable for technology, management techniques, and other resources to move an economy from the traditional low level of production to a more automated and efficient system of mass production of goods and services (Biodun, 2011).

Below is a graphical representation of Nigeria's manufacturing value added at billion USD from 1980 to 2018.

Source: TheGlobalEconomy.com, The World Bank

Description of Variables and Country of Research

This study focuses on empirical analysis of the impact of energy consumption on industrial growth in Nigeria with particular references to the performance of the industrial sector. Data is secondary in its source and was extracted from the World Bank data and US energy information administration. The data covers the period from 1990 to 2018, spanning 29 years. The period was carefully chosen, given the availability of data. The estimated variables are; manufacturing value-added a proxy for industrial growth used a dependent variable while having energy consumption, labor, and capital as independent variables. All selected given their contribution to the production process and industrial sector. All data used in the study were extracted from World Bank data except energy consumption, which was generated from US energy information administration. Manufacturing value added is expressed in millions of USD, labor and capital are expressed in rate while energy consumption is expressed in quadrillion btu. The variables manufacturing value added and energy consumption are further converted to a natural logarithm for more accurate results.

The nation Nigeria, currently in economic transition is the most population in Africa, and abundantly blessed with lots of natural resources. These are in the form of; crude oil and gas, coal, rubber, palm oil, cotton, steel, amongst others. However, given the high amount of fossil fuels evident in the Nigerian soil, the government is still yet to efficiently manage these resources, which brought about an inadequate power generation and optimization failure in industrial production. In Nigeria, it started with the crude oil discovery in 1956 in Delta; this news initially came with tremendous opportunities and revenue to the Nigerian economy, most notably in the 1970s as a result of the peak in world crude oil prices. As time went by, the negatives effects start to become apparent. This is most notably in the neglect of the agricultural sector, which was the mainstay and pride of Nigeria at the time. Oil in Nigeria has a history characterized by almost an equal measure of progress and retardation, hope and hopelessness, blessings and curse, wealth and poverty, and inability to translate the good luck of oil to build a productive modern society (Adenikinju, 2008). The shift in inputs to the energy sector created issues of unemployment, poverty, and increased corruption as everyone struggled to have his share of the proceeds. The fall in oil prices after some time left Nigeria in a loss. The revenue generated from the crude oil it over depended on became insufficient to finance government projects and thus became one of the most challenging issues in Nigeria. The country has since then been trying to balance its growth in other sectors by reviving the abandoned agricultural sector, channeling and fueling industrialization as well as improving its services.

In the growth of industrial sectors, energy is seen as a vital input as such its competitiveness is stressed in modern economies (Korsakienėa et al, 2013). Nigeria finally discovered that the collapse of the industrial sector, small and medium scale enterprises, and economic downturn was a result of the inadequate and inconsistency of the electricity market in the country (Olugbenga et al, 2013). Sadly, Companies continue to bear the significant losses as outages often occur when goods are in the middle of production (Nkalo and Agwu 2018). As mentioned in Yakubu and Jelilov (2017), the IEA's comprehensive analysis stated that the whole region of sub-Saharan Africa has enough energy resources that are more than sufficient to meet the demands of its population.

Methodology

The technique of Regression applied in the study is the ordinary least square OLS. The study analyzed the data and model using the descriptive statistics, economic "a-priori," statistical tests, i.e., t-test, F-test, R-squared as well as unit root test, co-integration test, and granger causality test. Ordinary Least Squares is a linear regression generally known as the best form of all regression techniques that has the following BLUE properties, i.e., best, linear, unbiased, estimator. The goal of this method is to minimize the sum of squares in the difference between the predicted and observed values of the dependent variable organized as a straight line to fit a function with the data closely. To test for the stationarity in the time series, we undertook the unit root test developed by Dickey and Fuller (1979). To check for the long-run relationship, the Johansen (1988) co-integration technique was used. And lastly, Granger (1969) causality is used in investigating the causal relationship between variables in time series. The Apriori assumes that all variables will have a positive relationship with industrial growth.

The study adapts and adjusts a model on the empirical work of Ahmed and Shimada (2019) in order to arrive at the model function. Hence, the functional relationship between industrial growth and other variables is as follows;

$$mnva = (l, ec, k) \qquad (1)$$

$$mnva_t = \beta_{0} + \beta_1 l_t + \beta_2 ec_t + \beta_3 k_{t} + \mu_t \qquad (2)$$

Where;

mnva= manufacturing value-added, ec= energy consumption, l= labor, k= capital. $\beta_0, \beta_1, \beta_2$ and β_3 = Coefficients, t = time, μ = Stochastic disturbance term. $\beta_0, \beta_1, \beta_2$ and $\beta_3 > 0$; All coefficients are expected to be greater than zero. This is because the variables are expected to impact on industrial output positively.

Results and Discussion

Unit Root Test

Table 1.Unit Root Test

Variables	ADF test statistics @ stationarity	Test critical value @ 5%				Order of integration	Remarks
		Level	Prob	1st diff	Prob		
LN_MNVA	-3.853993	-2.981038	0.8665	-2.991878	0.0077	I(1)	Stationary @ 1st difference
L	-2.961799	-2.976263	0.8676	-2.976263	0.0515	I(1)	Stationary @ 1st difference
LN_EC	-6.313165	-2.971853	0.6847	-2.976263	0.0000	I(1)	Stationary @ 1st difference
K	-9.611403	-2.976263	0.0000	-	-	I(0)	Stationary @ level

Source: Author's computation using E-Views 8.0

The unit root test result on the table above shows that capital is integrated of order 0 i.e., stationary at level while all other variables; manufacturing value-added, energy consumption, and labor are integrated of order 1; in other words, stationary at first difference.

Ordinary Least Squares

Table 2.Estimated Model

Dependent Variable: LN_MNVA				
Method: Least Squares				
Date: 10/03/20, Time: 13:15				
Sample: 1990-2018				
Included observations: 29				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-32.88419	27.15130	-1.211146	0.2372
L	-0.036706	0.074978	-0.489563	0.6287
LN_EC	1.696945	0.666883	2.544591	0.0175
K	0.002009	0.005681	0.353727	0.7265
R-squared	0.707101	Durbin-Watson stat		0.446575
Adjusted R-squared	0.671954			
F-statistic	20.11793			
Prob(F-statistic)	0.000001			

Source: Author's computation using E-Views 8.0

The R-squared indicates that the model has a good fit. It shows that 70% of the dependent variable is explained by the independent variables in the model. Thus, only 30% of other variables outside the model affect manufacturing value-added. With regards to the coefficient of determination, the adjusted r-squared also indicates the goodness of fit of the model at 67%. The F statistic value shows that the variables are jointly statistically significant.

The result in Table 3, shows that there is a positive and significant relationship between energy consumption and manufacturing value-added, a negative and insignificant relationship between labor and manufacturing value-added, and finally, a positive and insignificant relationship between capital and manufacturing value-added. As such, a unit increase in energy consumption will bring about 1.70 increase in manufacturing value-added. Also, a unit increase in labor will bring about 0.03 decrease in manufacturing value-added. Lastly, a unit increase in capital will bring about 0.002 decrease in manufacturing value-added.

Further, the result for Durbin Watson shows 0.446575. There is an absence of autocorrelation in a model if the Durbin Watson value is 2. Thus, the model reveals a presence of autocorrelation as it approaches 0 rather than 2. As a result, it is imperative to test for autocorrelation in the errors in the model using the Breusch-Godfrey Test. This is because the Durbin Watson test is restricted to first-order autoregression detection.

Table 3.Breusch-Godfrey Test I

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	22.15978	Prob. F(2,23)	0.0000
Obs*R-squared	19.09203	Prob. Chi-Square(2)	0.0001

Source: Author's computation using E-Views 8.0

The table above uses the Breusch-Godfrey Test to check for autocorrelation. The serial correlation test results with 2 lags in the test equation shows the significance of the presence of auto correlation. Hence, the residuals and the equation should be re-specified. In a bid to wipe out the presence of autocorrelation, an auto regressive component of order 1 was introduced shown in *Appendix D.* As a result, the problem of serial correlation has been wiped out as shown in the table below;

The result above shows the presence of one co-integrating equation from the regression. As such, we reject the null hypothesis at the 0.05 level of significance, which states that there is no long relationship between the variables.

Table 4.Breusch-Godfrey Test 2

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.800008	Prob. F(2,21)	0.4626
Obs*R-squared	1.982320	Prob. Chi-Square (2)	0.3711

Source: Author's computation using E-Views 8.0

Johansen Co-Integration Test

Table 5.Johansen Co-Integration Test

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.877670	56.72784	27.58434	0.0000
At most 1	0.443761	15.83707	21.13162	0.2345
At most 2	0.136945	3.976480	14.26460	0.8618
At most 3	0.042864	1.182865	3.841466	0.2768
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: Author's computation using E-Views 8.0

Table 6.Error Correction Mechanism

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.067237	17.53159	-0.174955	0.8626
L	-0.102982	0.047328	-2.175922	0.0401
LN_EC	0.946197	0.432263	2.188940	0.0390
K	0.002849	0.003539	0.805045	0.4290
ECM(-1)	0.847207	0.128802	6.577609	0.0000
R-squared	0.895875	Durbin-Watson stat		1.781193
Adjusted R-squared	0.877766			

Source: Author's computation using E-Views 8.0

Given the presence of long-run relationship from the co-integration model, it is therefore necessary to estimate both short-run and long-run levels. Table 4.7 indicates the error correction model result. It shows that the estimate of the ECM_t-1 is positive and significant at 5% level. The ECM_t-1 term is 0.84; hence, it does not return to short-run equilibrium by 84%. It does not have short-run dynamics.

Pairwise Granger Causality Test

carried out shows the stationarity of capital at level while all other variables, manufacturing value-added, energy consumption, and labor are stationary at first difference. The Johansen co-integration test carried out to check for the presence of long-run relationships in the model indicates the presence of one co-integrating equation. Lastly, the granger causality result shows no presence of causal relationship between energy consumption and industrial growth.

Table 7.Granger Causality Test

Pairwise Granger Causality Tests			
Date: 10/03/20, Time: 14:27			
Sample: 1990-2018			
Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
L does not Granger Cause LN_MNVA	27	0.46911	0.6317
LN_MNVA does not Granger Cause L		1.78922	0.1906
LN_EC does not Granger Cause LN_MNVA	27	0.01642	0.9837
LN_MNVA does not Granger Cause LN_EC		1.38273	0.2719
K does not Granger Cause LN_MNVA	27	0.03633	0.9644
LN_MNVA does not Granger Cause K		0.57269	0.5722
LN_EC does not Granger Cause L	27	3.02425	0.0691
L does not Granger Cause LN_EC		5.01867	0.0160
K does not Granger Cause L	27	0.31915	0.7301
L does not Granger Cause K		0.43648	0.6518
K does not Granger Cause LN_EC	27	2.24881	0.1292
LN_EC does not Granger Cause K		0.23818	0.7901

Source: Author's computation using E-Views 8.0

From the above result, the granger causality test shows a unidirectional causal relationship from labor to energy consumption. However, the remaining variables do not exhibit a causal relationship.

The final results of the research indicate that all variables are in line with the A-priori expectations except labor.

Conclusions, Limitations and Further Scope of the Study

This research work has provided more insight into the industrial sector of Nigeria. The study has successfully come through in analyzing the impact of energy consumption on industrial growth in the Nigerian economy. The study employs the variables; manufacturing value added (as dependent variable), energy consumption, labor and capital. The study spans a period of 29 years from 1990 to 2018, constituting a time series data extracted from World Bank data and US energy information administration. The research carried out a unit root test, co-integration test, and granger causality test as pre-diagnostic tests. The unit root test

According to the result of the regression analysis, the study finds out that there exists a significant positive relationship between energy consumption and industrial growth. This is in line with the findings of Bernard and Oludare (2016) on the impact of energy consumption on industrial sector output from 1980 to 2013.

Given the final results, the study shows that energy consumption has a significant positive impact on industrial growth. Insufficient power generation from energy sources leading to inadequate power supply has left businesses with no option but to provide their source of electricity using generators. However, the high cost of fuel to power up generators have made it very costly and wasteful to run an industry. Given the result above, investing more to improve the generating capacity and stabilizing power supply would further strengthen the growth of industries.

In line with the above, the following policy recommendations have been proposed to protect the industries from being further worsened due to inadequate power generating capacity from energy sources. Growth in the industries could be channeled in other sectors of the economy at large;

- Since it is shown that energy consumption is a driver of growth in the industries, there should be productive investments in the energy sector and the transmission process in order to improve the power generation in the economy. Adequate supply will enable the efficient and effective functioning of the industries, thereby enhancing growth.
- There should be provision for a pathway for better diversification and balanced growth of the economy. Diversifying revenue sources would shield the country from vulnerability to external shock like the one we are presently experiencing due to the COVID-oil crisis. Having a desired industrial operation would have made the situation in Nigeria less damaging. However, we largely depend on the importations of processed goods, which is devastating amidst the crisis.
- As the government is currently disbursing loans for the growth of businesses, business owners should, in turn, play actively in effectively managing their businesses and boost productivity in order for the country to be self-sufficient. In the long run, after having achieved self-sufficiency, the country could be an active player in the international market.

As an extension to this study, further investigations and analysis should focus on measures to achieve sustainable industrialization in Nigerian Economy 1990-2020. The paper should assert manufacturing value-added to proxy industrialization while gross capital formation, human capital development, financial development, and labor participation rate are to be used as independent variables using the OLS technique of regression. These variables are carefully chosen, given their contribution to the operation of the industrial sector.

References

1. Abdu M, Anam BE. Evaluation of the Nigerian Industrial Sector and Economic Growth in the Face of Sustainable Development Goals. *International Journal of Advance Research in Public Policy, Social Development, and Enterprise Studies* 2018; 3(1): 49-59.
2. Abid M, Mraihi R. Energy Consumption and Industrial Production: Evidence from Tunisia at Both Aggregated and Disaggregated Levels. *Journal of the Knowledge Economy* 2015; 6: 1123-1137.
3. Abokyi E, Appiah-Konadu P, Sikayena I et al. Consumption of Electricity and Industrial Growth in the Case of Ghana. *Journal of Energy* 2018; 1-11.
4. Abosedra S, Shahbaz M, Sbia R. The Links between Energy Consumption, Financial Development, and Economic Growth in Lebanon: Evidence from Cointegration with Unknown Structural Breaks. *Journal of Energy* 2015; 1-15.
5. Adenikinju A. Efficiency of the Energy Sector and its Impact on the Competitiveness of the Nigerian Economy. *International Association for Energy Economics* 2008; 27-31.
6. Ahmed M, Shimada K. The Effect of Renewable Energy Consumption on Sustainable Economic Development: Evidence from Emerging and Developing Economies. *Energies* 2019; 12(2954): 1-15.
7. Akiri SE, Ijuo OA, Apochi MP. Electricity Supply and Manufacturing Productivity in Nigeria (1980-2012). *IOSR Journal of Economics and Finance (IOSR-JEF),* 2015; 6(6): 90-94.
8. Apaydin G, Gungor A, Tağdoga C. The Asymmetric Effects of Renewable Energy Consumption on Economic Growth in Turkey. *Journal of Mehmet Akif Ersoy* 2019; 6(1): 117-134.
9. Arminen H, Menegaki AN. Corruption, Climate, and the Energy-Environment-Growth Nexus. *Energy Economics* 2019; 80: 629-634.
10. Beji S, Belhadj A. What are the Determining Factors of Industrialization in Africa? *Federalismi.it*, 2014; 1-20.
11. Bercu A, Paraschiv G, Lupu D. Investigating the Energy–Economic Growth–Governance Nexus: Evidence from Central and Eastern European Countries. *Sustainability* 2019; 11(3555): 1-21.
12. Bernard OA, Oludare A. Is Energy Consumption Relevant to Industrial Output in Nigeria?. *European Journal of Research in Social Sciences* 2016; 4(4): 1-14.
13. Biodun AA. The Power Sector and Industrial Development in Nigeria: Power Holding Company of Nigeria. Lahti: *Lahti University of Applied Sciences*. 2011.
14. Danmaraya IA, Hassan S. Electricity Consumption and Manufacturing Sector Productivity in Nigeria: An Autoregressive Distributed Lag-bounds Testing Approach. *International Journal of Energy Economics and Policy* 2016; 6(2): 195-201.
15. Dickey DA, Fuller AW. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 1979; 74: 427-431.
16. Ekpo UN. Nigeria Industrial Policies and Industrial Sector Performance: Analytical Exploration. *IOSR Journal of Economics and Finance* 2014; 3(4): 1-11.
17. Fatai BO. Energy Consumption and Economic Growth Nexus: Panel Co-integration and Causality Tests for Sub-Saharan Africa. *Journal of Energy in Southern Africa* 2014; 25(4): 93-100.
18. Granger CW. Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica* 1969; 429-438.
19. Hassine MB, Harrathi N. The Causal Links between Economic Growth, Renewable Energy, Financial

Development, and Foreign Trade in Gulf Cooperation Council Countries. *International Journal of Energy Economics and Policy* 2017; 7(2): 76-85.
20. Johansen S. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control* 1988; 231-254.
21. Kasperowicz R. Electricity Consumption and Economic Growth: Evidence from Poland. *Journal of International Studies* 2014; 7(1): 46-57.
22. Korsakienėa R, Tvaronavičienėa M, Smaliukienėa R. Impact of Energy Prices on Industrial Sector Development and Export: Lithuania in the Context Of Baltic States. *Procedia - Social and Behavioral Sciences* 2013; 461-469.
23. Kümmel R, Lindenberger D. How Energy Conversion Drives Economic Growth Far From the Equilibrium of Neoclassical Economics. *New Journal of Physics* 2014; 16: 1-21.
24. Mawejje J, Mawejje DN. Electricity consumption and sectoral output in Uganda: an empirical investigation. *Journal of Economic Structures* 2016; 5(21): 1-16.
25. Meidani AAN, Zabihi M. Energy Consumption and Real GDP in Iran. *International Journal of Energy Economics and Policy* 2012; 4(1): 15-25.
26. Muftaudeen OO, Omojolaibi JA. Electricity Consumption, Institutions, and Economic Growth in Nigeria. *Journal of Economics and Sustainable Development* 2014; 5(12): 40-55.
27. Nkalo UK, Agwu EO. Review of the Impact of Electricity Supply on Economic Growth: A Nigerian Case Study. *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)* 2018; 14(1): 28-34.
28. Nwajinka CC, Akekere JY, John PO. National Electric Energy Supply and Industrial Productivity in Nigeria from 1970 to 2010. *Journal of Economics and Sustainable Development* 2013; 4(14): 122-129.
29. Nwosa PI. Aggregate Energy Consumption and Sectoral Output in Nigeria. *An International Multidisciplinary Journal, Ethiopia* 2012; 6(4): 206-215.
30. Ohwofasa BO, Obeh HO, Erakpoweri J. The Impact of Electricity Supply on Economic Growth, 1980-2010: An Error Correction Method. *Research Journal of Finance and Accounting* 2015; 6(5): 124-128.
31. Okoligwe NE, Ihugba OA. Relationship between Electricity Consumption and Economic Growth: Evidence From Nigeria (1971-2012). *Academic Journal of Interdisciplinary Studies* 2014; 3(5): 137-152.
32. Olufemi OJ. The Effects of Electricity Consumption on Industrial Growth in Nigeria. *Journal of Economics and Sustainable Development* 2015; 6(13): 54-59.
33. Olugbenga TK, Jumah AA, Phillips DA. The Current and Future Challenges of the Electricity Market in Nigeria in the Face of Deregulation Process. *African Journal of Engineering Research* 2013; 1(2): 33-39.
34. Qazi AQ, Ahmed K, Mudassar M. Disaggregate Energy Consumption and Industrial Output in Pakistan: An Empirical Analysis. *Economics: The Open-access, Open-assessment E-journal* 2012; 1-14.
35. Romer PM. Endogenous Technological Change. *NBER Working Paper Series* (pp. 1-41). Cambridge: National Bureau of Economic Research. 1989; 1-41.
36. Sankaran A, Kumar S, Arjun K et al. Estimating the Causal Relationship between Electricity Consumption and Industrial Output: ARDL bounds and Toda-Yamamoto Approaches for Ten Late Industrialized Countries. *Heliyon,* 2019; 5.
37. Tapsın G. The Link Between Industry Value Added and Electricity Consumption. *European Scientific Journal* 2017; 13(13): 41-56.
38. Tugcu CT. Disaggregate Energy Consumption and Total Factor Productivity: A Co-integration and Causality Analysis for the Turkish Economy. *International Journal of Energy Economics and Policy* 2013; 3(3): 307-314.
39. Twerefou DK, Iddrisu KS, Twum EA. Energy Consumption and Economic Growth: Evidence from the West African Sub Region. *West African Journal of Applied Ecology* 2018; 26: 217-233.
40. Ugwoke TI, Dike CK, Elekwa PO. Electricity Consumption and Industrial Production in Nigeria. *Journal of Policy and Development Studies* 2016; 10(2): 8-19.
41. Vo AT, Vo DH, Le QT. CO2 Emissions, Energy Consumption, and Economic Growth: New Evidence in the ASEAN Countries. *Journal of Risk and Financial Management* 2019; 12(145): 1-20.
42. Yakubu MM, Jelilov G. Effect of Energy Consumption on GDP Evidence from (Ten) Sub-Saharan Africa Countries. *Nile Journal of Business and Economics* 2017; 5: 3-14.
43. Yakubu Y, Manu SB, Bala U. Electricity Supply and Manufacturing Output in Nigeria: Autoregressive Distributed Lag (ARDL) Bound Testing Approach. *Journal of Economics and Sustainable Development* 2015; 6(17): 7-19.

Appendices

Appendix A

Data

Year	Ln_MNVA	L	Ln_EC	K
1990	22.99	61.199	34.1821	13.80424
1991	22.98	61.094	34.27741	-1.2394
1992	22.86	60.893	34.30305	0.512945
1993	22.35	60.781	34.31563	7.533617
1994	22.68	60.659	34.23767	-2.45882
1995	22.90	60.51	34.35245	-6.64314
1996	23.00	60.367	34.37626	6.793911
1997	23.07	60.239	34.37626	5.845782
1998	22.98	60.125	34.32806	1.393454
1999	22.99	60.065	34.34033	2.675391
2000	22.99	59.965	34.27741	7.285385
2001	23.06	59.945	34.39951	-23.7467
2002	23.15	59.795	34.44447	10.19303
2003	23.26	59.776	34.48748	21.40866
2004	23.42	59.738	34.52873	-19.9368
2005	23.60	59.755	34.61574	2.342505
2006	23.76	59.839	34.50832	40.38866
2007	23.87	59.905	34.42224	-21.8953
2008	24.04	59.956	34.59705	-2.60106
2009	23.85	59.97	34.1383	9.924205
2010	23.89	59.968	34.35245	4.01246
2011	24.11	60.024	34.70429	-8.24668
2012	24.29	57.555	34.70429	2.551734
2013	24.55	55.106	34.95749	7.864836
2014	24.73	54.795	35.04559	13.42649
2015	24.57	54.397	34.98985	0.609905
2016	24.28	53.906	34.9962	-6.66557
2017	24.22	53.893	34.97056	-2.97726
2018	24.37	53.828	34.98346	9.73767

Appendix B

Regression Result

Dependent Variable: LN_MNVA				
Method: Least Squares				
Date: 10/03/20, Time: 13:15				
Sample: 1990-2018				
Included observations: 29				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-32.88419	27.15130	-1.211146	0.2372
L	-0.036706	0.074978	-0.489563	0.6287
LN_EC	1.696945	0.666883	2.544591	0.0175
K	0.002009	0.005681	0.353727	0.7265
R-squared	0.707101	Mean dependent var		23.54517
Adjusted R-squared	0.671954	S.D. dependent var		0.661770
S.E. of regression	0.379031	Akaike info criterion		1.025046
Sum squared resid	3.591617	Schwarz criterion		1.213638
Log likelihood	-10.86317	Hannan-Quinn criter.		1.084111
F-statistic	20.11793	Durbin-Watson stat		0.446575
Prob (F-statistic)	0.000001			

ECM (short run) Analysis

Dependent Variable: LN_MNVA				
Method: Least Squares				
Date: 10/03/20, Time: 14:23				
Sample (adjusted): 1991 2018				
Included observations: 28 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-3.067237	17.53159	-0.174955	0.8626
L	-0.102982	0.047328	-2.175922	0.0401
LN_EC	0.946197	0.432263	2.188940	0.0390
K	0.002849	0.003539	0.805045	0.4290
ECM(-1)	0.847207	0.128802	6.577609	0.0000
R-squared	0.895875	Mean dependent var		23.56500
Adjusted R-squared	0.877766	S.D. dependent var		0.665084
S.E. of regression	0.232526	Akaike info criterion		0.080805
Sum squared resid	1.243574	Schwarz criterion		0.318698
Log likelihood	3.868736	Hannan-Quinn criter		0.153531
F-statistic	49.47216	Durbin-Watson stat		1.781193
Prob (F-statistic)	0.000000			

Appendix C

Serial Correlation Test Result

Breusch-Godfrey Test 1

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	22.15978	Prob. F(2,23)		0.0000
Obs*R-squared	19.09203	Prob. Chi-Square(2)		0.0001
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 10/04/20, Time: 12:30				
Sample: 1990 2018				
Included observations: 29				
Presample missing value lagged residuals set to zero.				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	29.69678	17.13686	1.732919	0.0965
L	-0.063903	0.046880	-1.363114	0.1860
LN_EC	-0.751345	0.421804	-1.781268	0.0881
K	0.000487	0.003504	0.139077	0.8906
RESID(-1)	0.759823	0.199638	3.805998	0.0009
RESID(-2)	0.115300	0.204665	0.563361	0.5786
R-squared	0.658346	Mean dependent var		8.58E-15
Adjusted R-squared	0.584073	S.D. dependent var		0.358151
S.E. of regression	0.230980	Akaike info criterion		0.089020
Sum squared resid	1.227091	Schwarz criterion		0.371909
Log likelihood	4.709206	Hannan-Quinn criter.		0.177618
F-statistic	8.863913	Durbin-Watson stat		1.578573
Prob(F-statistic)	0.000084			

Adjusted Autocorrelation Model

Dependent Variable: LN_MNVA				
Method: Least Squares				
Date: 10/04/20, Time: 11:37				
Sample (adjusted): 1991-2018				
Included observations: 28 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-30.03897	12.62943	-2.378489	0.0261
L	0.068666	0.036112	1.901465	0.0698
LN_EC	0.815062	0.324356	2.512865	0.0194
K	0.000365	0.002646	0.137896	0.8915
LN_MNVA(-1)	0.910663	0.093129	9.778560	0.0000
R-squared	0.941833	Mean dependent var		23.56500

Adjusted R-squared	0.931717	S.D. dependent var	0.665084
S.E. of regression	0.173794	Akaike info criterion	-0.501462
Sum squared resid	0.694699	Schwarz criterion	-0.263568
Log likelihood	12.02046	Hannan-Quinn criter.	-0.428735
F-statistic	93.10266	Durbin-Watson stat	1.763068
Prob(F-statistic)	0.000000		

Breusch-Godfrey Test 2

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.800008	Prob. F(2,21)		0.4626
Obs*R-squared	1.982320	Prob. Chi-Square(2)		0.3711
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 10/04/20, Time: 11:37				
Sample: 1991-2018				
Included observations: 28				
Presample missing value lagged residuals set to zero.				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.342539	14.07177	-0.024342	0.9808
L	0.005277	0.042975	0.122797	0.9034
LN_EC	-0.024516	0.341962	-0.071691	0.9435
K	0.000462	0.002712	0.170418	0.8663
LN_MNVA(-1)	0.037318	0.112566	0.331526	0.7435
RESID(-1)	0.106148	0.247148	0.429493	0.6719
RESID(-2)	-0.279001	0.247017	-1.129479	0.2714
R-squared	0.070797	Mean dependent var		3.75E-16
Adjusted R-squared	-0.194689	S.D. dependent var		0.160404
S.E. of regression	0.175325	Akaike info criterion		-0.432033
Sum squared resid	0.645516	Schwarz criterion		-0.098981
Log likelihood	13.04846	Hannan-Quinn criter		-0.330216
F-statistic	0.266669	Durbin-Watson stat		2.096642
Prob(F-statistic)	0.946374			

Appendix D

Cointegration

Date: 10/03/20, Time: 14:12				
Sample (adjusted): 1992-2018				
Included observations: 27 after adjustments				
Trend assumption: Linear deterministic trend				
Series: LN_MNVA L LN_EC K				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.877670	77.72425	47.85613	0.0000
At most 1	0.443761	20.99641	29.79707	0.3579
At most 2	0.136945	5.159345	15.49471	0.7917
At most 3	0.042864	1.182865	3.841466	0.2768
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.877670	56.72784	27.58434	0.0000
At most 1	0.443761	15.83707	21.13162	0.2345
At most 2	0.136945	3.976480	14.26460	0.8618
At most 3	0.042864	1.182865	3.841466	0.2768
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				
LN_MNVA	L	LN_EC	K	
0.107691	-0.628219	-6.157069	0.130020	
0.692869	-1.312486	-14.18586	-0.056350	
2.788234	0.496190	-2.769461	-0.004180	
1.005851	-0.548064	-2.817647	-0.009573	
Unrestricted Adjustment Coefficients (alpha):				
D(LN_MNVA)	0.008427	0.004819	-0.001284	-0.036304
D(L)	0.126581	0.148274	-0.169525	0.015817
D(LN_EC)	0.049664	0.048344	0.022919	-0.008825
D(K)	-15.32874	4.735082	-0.674808	0.085873

1 Cointegrating Equation(s):		Log likelihood	-77.57813	
Normalized cointegrating coefficients (standard error in parentheses)				
LN_MNVA	L	LN_EC	K	
1.000000	-5.833546	-57.17359	1.207345	
	(1.23420)	(10.8844)	(0.10687)	
Adjustment coefficients (standard error in parentheses)				
D(LN_MNVA)	0.000908			
	(0.00413)			
D(L)	0.013632			
	(0.01215)			
D(LN_EC)	0.005348			
	(0.00249)			
D(K)	-1.650765			
	(0.21891)			
2 Cointegrating Equation(s):		Log likelihood	-69.65959	
Normalized cointegrating coefficients (standard error in parentheses)				
LN_MNVA	L	LN_EC	K	
1.000000	0.000000	-2.826385	-0.701013	
		(2.82411)	(0.08988)	
0.000000	1.000000	9.316324	-0.327135	
		(0.94025)	(0.02993)	
Adjustment coefficients (standard error in parentheses)				
D(LN_MNVA)	0.004247	-0.011619		
	(0.02685)	(0.05572)		
D(L)	0.116366	-0.274128		
	(0.07581)	(0.15732)		
D(LN_EC)	0.038844	-0.094650		
	(0.01446)	(0.03000)		
D(K)	1.630026	3.415082		
	(1.22745)	(2.54717)		
3 Cointegrating Equation(s):		Log likelihood	-67.67135	
Normalized cointegrating coefficients (standard error in parentheses)				
LN_MNVA	**L**	**LN_EC**	**K**	
1.000000	0.000000	0.000000	11.52294	
			(1.50222)	
0.000000	1.000000	0.000000	-40.61971	
			(5.26010)	
0.000000	0.000000	1.000000	4.324943	
			(0.56190)	
Adjustment coefficients (standard error in parentheses)				
D(LN_MNVA)	0.000666	-0.012256	-0.116694	
	(0.11010)	(0.05887)	(0.60163)	

D(L)	-0.356310	-0.358245	-2.413269	
	(0.29209)	(0.15619)	(1.59608)	
D(LN_EC)	0.102749	-0.083278	-1.055057	
	(0.05750)	(0.03075)	(0.31423)	
D(K)	-0.251498	3.080249	29.07779	
	(5.01502)	(2.68166)	(27.4041)	