Impact of Energy Consumption on Industrial Growth in a Transition Economy: Evidence from Nigeria

Kassim, Fatima and Isik, Abdurrahman

Nile University of Nigeria, Nile University of Nigeria

10 July 2020

Impact of Energy Consumption on Industrial Growth in a Transition Economy: Evidence from Nigeria

KASSIM FATIMA ABDULKADIR

AND

PROF. ABDURRAHMAN ISIK

DEPARTMENT OF ECONOMICS

NILE UNIVERSITY OF NIGERIA

JULY, 2020

ABSTRACT

This research investigates the impact of energy consumption on industrial growth. Variables used are; manufacturing vale added (dependent variable, electricity consumption, per capita income, exchange rate, import, and export by using yearly time series data from 1985 through 2017 in Nigeria. 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. Results show a negative and insignificant relationship between electricity consumption and industrial growth. The unit root test shows that all variables are integrated of order one except for the exchange rate, which is stationary at level. The Co-integration test indicates that there exists the presence of long-run relationships. The granger causality indicates the growth hypothesis from industries in Nigeria. Generally, this paper stresses the dangers of 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.

1. 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 crises. 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). Here energy is not treated as a form of capital as done in the previous models rather as an engine to productive work in both labor and capital, i.e. machinery in production.

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 model used given the selected variables, which are highly crucial in the industrial sector. Previous studies have focused generally on the entire economy with few research on the industrial sector. Hence, the main objective of this paper is to examine the impact of energy consumption on industrial growth in Nigeria.

2. 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, Gungor, and Tagdoga (2019) researched the asymmetric effects of renewable energy consumption on the economic growth of Turkey form 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, Shahbaz, and Sbia (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, Obeh, and Erakpoweri (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, Idrissu, and Twum, 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, Paraschiv, and Lupu (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, Vo, and Le (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, Dike, and Elekwa (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, Akekere, Yousuo, and John (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, Manu, and Bala (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, Ijuo, and Apochi (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.

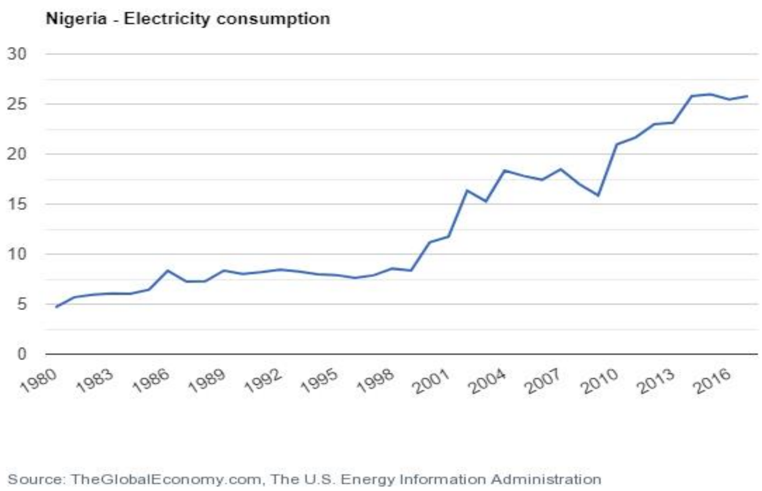
Also, investigations on other country research have been carried out as such. Abokyi, Konadu, Sikayena, and Abayie (2018) researched solely on Ghanian economy and found that electricity consumption impacts negatively on industrial growth in both the long-run and the short-run. Results show the presence 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, Ahmed, and Mudassar (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.

3. Materials and Methods

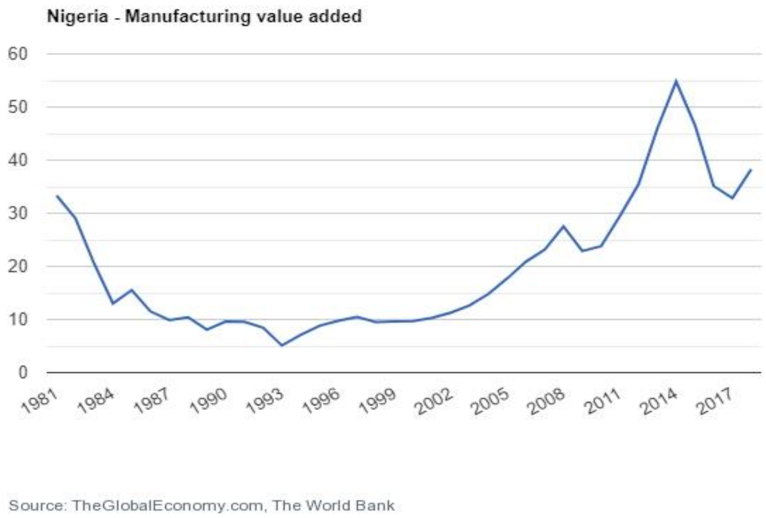
3.1. Definition of Energy and Industrial Growth

Energy is regarded as the primary factor that facilitates the efficiency and productivity of other factors of production, mainly labor and capital (Yakubu, Manu, and Bala, 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.



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.



3.2.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 1985 to 2017, spanning 32 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 electricity consumption, per capita income, exchange rate, import, and export 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 electricity consumption, which was generated from US energy information administration. All variables are expressed in millions of USD except for electricity expressed in billion-kilowatt-hours and exchange rate expressed in naira per US Dollar. All variables are further converted to a natural logarithm for more accurate results.

The nation of 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, Tvaronavičienėa and Smaliukienėa 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, Jumah, and Phillips 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. However, the shortcomings resulted from its underdevelopment deepened by corruption and mismanagement in the nations.

3.3. 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 Sankaran, Kumar, Arjun, and Das (2019) for ten industrialized countries to arrive at the model function. Hence, the functional relationship between industrial growth and other variables is as follows;
$mnva = (ec, exr, pc, imp, exp)$…………………………………… (1)
$mnva_t = \beta_0 + \beta_1 ec_t + \beta_2 exr_t + \beta_3 pc_t + \beta_4 imp_t + \beta_5 exp_t + \mu_t$………… (2)

Where;
mnva= manufacturing value-added, ec= electricity consumption, exr= exchange rate, pc= per capita income, imp= import, and exp= export. $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ and β_5 = Coefficients, t = time, μ = Stochastic disturbance term. $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ and $\beta_5 > 0$; All coefficients are expected to be greater than zero. This is because the variables are expected to impact on industrial output positively.

4. Results and Discussion

4.1. Unit Root Test

Variables	ADF test statistics @ stationarity	Test critical value @ 5%				Order of integration	Remarks
		Level	Prob	1st diff	Prob		

LN_MNVA	-4.670406	-2.957110	0.8992	-2.960411	0.0008	*I(1)*	Stationary @ 1st difference
LN_EC	-7.686167	-2.957110	0.8557	-2.960411	0.0000	*I(1)*	Stationary @ 1st difference
LN_EXR	-3.205643	-2.957110	0.0289	-	-	*I(0)*	Stationary @ level
LN_PC	-4.611740	-2.957110	0.9096	-2.960411	0.0009	*I(1)*	Stationary @ 1st difference
LN_IMP	-5.743710	-2.957110	0.6489	-2.960411	0.0000	*I(1)*	Stationary @ 1st difference
LN_EXP	-7.078982	-2.957110	0.5559	-2.960411	0.0000	*I(1)*	Stationary @ 1st difference

Source: Author's computation using E-Views 8.0

The unit root test result on the table above shows that exchange rate is integrated of order 0, i.e., stationary at level while all other variables; manufacturing value-added, electricity consumption, exchange rate, per capita income, import, and export are integrated of order 1, in other words, stationary at first difference.

4.2. Johansen Co-Integration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.799236	121.7850	95.75366	0.0003
At most 1 *	0.615174	72.01069	69.81889	0.0331
At most 2	0.586633	42.40680	47.85613	0.1476
At most 3	0.253652	15.02078	29.79707	0.7787
At most 4	0.097859	5.951304	15.49471	0.7013
At most 5	0.085148	2.758778	3.841466	0.0967

Trace test indicates 2 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

The result above shows the presence of two co-integrating equations 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.

4.3. Ordinary Least Squares

Dependent Variable: LN_MNVA
Method: Least Squares
Date: 05/04/20 Time: 01:08
Sample: 1985 2017
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.44534	1.448139	13.42781	0.0000
LN_EC	-0.053793	0.214488	-0.250798	0.8039
LN_EXR	0.018799	0.057314	0.327998	0.7454

LN_PC	0.916868	0.135874	6.747923	0.0000
LN_IMP	0.121416	0.097627	1.243662	0.2243
LN_EXP	-0.211679	0.085847	-2.465780	0.0203
R-squared	0.964573			
Adjusted R-squared	0.958013			
Durbin-Watson stat	0.646789			

Source: Author's computation using E-Views 8.0

The result in table 4.3 above shows that there is a negative and insignificant relationship between electricity consumption and manufacturing value-added, a positive and insignificant relationship between exchange rate and manufacturing value-added, a positive and significant relationship between per capita income and manufacturing value-added, a positive and insignificant relationship between import and manufacturing value-added, and finally a negative and significant relationship between export and manufacturing value-added.

The R-squared indicates that the model has a good fit. It shows that the independent variables in the model explain 96% of the dependent variable. Thus, only 4% of other variables outside the model affect manufacturing value-added. In reference to the coefficient of determination, the adjusted r-squared also indicates the goodness of fit of the model at 95%.

The Durbin Watson result shows 0.646789. There is an absence of autocorrelation in a model if the Durbin Watson value is 2. Thus, the model exhibits a presence of autocorrelation as it nears 0 rather than 2.

4.4. Pairwise Granger Causality Test

Pairwise Granger Causality Tests
Date: 05/04/20 Time: 01:10
Sample: 1985 2017
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LN_EC does not Granger Cause LN_MNVA	31	5.15743	0.0130
LN_MNVA does not Granger Cause LN_EC		0.17948	0.8367
LN_EXR does not Granger Cause LN_EC	31	6.45795	0.0053
LN_EC does not Granger Cause LN_EXR		0.75737	0.4790
LN_IMP does not Granger Cause LN_PC	31	0.99056	0.3850
LN_PC does not Granger Cause LN_IMP		5.17987	0.0128
LN_EXP does not Granger Cause LN_PC	31	0.99792	0.3823
LN_PC does not Granger Cause LN_EXP		3.75864	0.0368

Source: Author's computation using E-Views 8.0

From the above result, the granger causality test shows a unidirectional causal relationship from electricity consumption to manufacturing value-added, exchange rate to electricity consumption, per capita income to import, and finally, per capita income to export. However, the remaining variables do not exhibit a causal relationship.

5. 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 electricity consumption on industrial growth in the Nigerian economy. The study employs the variables; manufacturing value added (as dependent variable), electricity consumption, exchange rate, per capita income, imports, and exports. The study spans a period of 32 years from 1985 to 2017, 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 carried out shows the stationarity of exchange rate at level while all other variables, manufacturing value-added, electricity consumption, per capita income, imports, and exports 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 two co-integrating equations. The granger causality result shows a unidirectional causal relationship from electricity consumption to manufacturing value-added, exchange rate to electricity consumption, per capita income to import, and finally, per capita income to export.

The final results of the study are in line with the outcome of some previous researchers. Firstly, the result of Granger causality test shows the presence of unidirectional causal relationship from electricity consumption to industrial growth, thus in line with (Abokyi, Konadu, Sikayena, and Abayie, 2018). Secondly, an insignificant negative relationship between electricity consumption and industrial growth which follows the work of (Ugwoke, Dike and Elekwa, 2016). Thirdly, the result of the co-integration test shows the presence of long-run relationship as found in the work of (Danmaraya and Hassan, 2016).

Given the final results, the study shows that electricity consumption has an insignificant negative impact on industrial growth. However, electricity is a driver of industrial growth, as shown in the causality test depicting growth hypothesis for the industrial sector. The state of electricity in the country is poor, which fails to adequately translate to the growth of industries in Nigeria.

In line with the above, the following policy recommendation has been proposed to protect the industries from being further worsened as a result of the electricity shortages and thus induce growth in the sector to channel in other areas of the economy at large;

a. Since it is shown that electricity consumption is a driver of growth in the industries, the government should invest productively in the energy sector to improve the electricity generation in the economy. Adequate supply will enable the efficient and effective functioning of the industries, thereby enhancing growth.
b. There should be provision for a pathway for better diversification of the economy from the oil sector. Investing in other sectors, most especially the industries and businesses, would reduce the country's overdependence on a single sector for revenue and its vulnerability to external shock as the one we are presently experiencing due to the COVID and Oil crises. Having a desired industrial operations 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.
c. In order to have a long term solution to the bad state of our economy, all stakeholders, government, business owners, civilians, households need to work together to achieve a common goal of overall economic growth. Policymakers should have effective policies and strategies set for the government and private sector to work towards stabilizing the electricity in the country. Corruption and wastage need to be managed appropriately. Having achieved this, the country will

now be free of cases where the domestic production becomes inadequate for the citizens as businesses become less costly and more profitable to operate further, being able to compete 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

A. Sankaran, Sanjay Kumar, Arjun K, Mousumi Das. (2019). Estimating the Causal Relationship between Electricity Consumption and Industrial Output: ARDL bounds and Toda-Yamamoto Approaches for Ten Late Industrialized Countries. *Heliyon, 5*.

Adenikinju, A. (2008). Efficiency of the Energy Sector and its Impact on the Competitiveness of the Nigerian Economy. *International Association for Energy Economics*, 27-31.

Ahmer Qasim Qazi, Khalid Ahmed, and Muhammad Mudassar. (2012). Disaggregate Energy Consumption and Industrial Output in Pakistan: An Empirical Analysis. *Economics: The Open-access, Open-assessment E-journal*, 1-14.

Ali A. Naji Meidani and Maryam Zabihi. (2012). Energy Consumption and Real GDP in Iran. *International Journal of Energy Economics and Policy, 4*(1), 15-25.

Ana-Maria Bercu, Gigel Paraschiv, and Dan Lupu. (2019). Investigating the Energy–Economic Growth–Governance Nexus: Evidence from Central and Eastern European Countries. *Sustainability, 11*(3555), 1-21.

Anh The Vo, Duc Hong Vo, and Quan Thai-Thuong Le. (2019). CO2 Emissions, Energy Consumption, and Economic Growth: New Evidence in the ASEAN Countries. *Journal of Risk and Financial Management, 12*(145), 1-20.

Bernard, O. A. and Adenuga Oludare. (2016). Is Energy Consumption Relevant to Industrial Output in Nigeria?. *European Journal of Research in Social Sciences, 4*(4), 1-14.

Biodun, A. A. (2011). The Power Sector and Industrial Development in Nigeria: Power Holding Company of Nigeria. Lahti: *Lahti University of Applied Sciences*.

Bright O. Ohwofasa, Henry O. Obeh, and Joseph Erakpoweri. (2015). The Impact of Electricity Supply on Economic Growth, 1980-2010: An Error Correction Method. *Research Journal of Finance and Accounting, Volume 6*(issue 5), 124-128.

D. A. Dickey and A. W. Fuller. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association, 74*, 427-431.

D. K. Twerefou, K. S. Iddrisu, and E. A. Twum. (2018). Energy Consumption and Economic Growth: Evidence from the West African Sub Region. *West African Journal of Applied Ecology, 26*, 217 - 233.

Ekpo, U. N. (2014). Nigeria Industrial Policies and Industrial Sector Performance: Analytical Exploration. *IOSR Journal of Economics and Finance, 3*(4), 1-11.

Eric Abokyi, Paul Appiah-Konadu, Isaiah Sikayena, and Eric F. Oteng-Abayie. (2018). Consumption of Electricity and Industrial Growth in the Case of Ghana. *Journal of Energy, 2018*, 1-11.

Fatai, B. O. (2014). Energy Consumption and Economic Growth Nexus: Panel Co-integration and Causality Tests for Sub-Saharan Africa. *Journal of Energy in Southern Africa, 25*(4), 93-100.

Granger, C. W. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica*, 429-438.

Gükrü Apaydin, Afgin Gungor, and Celal Taġdoga. (2019). The Asymmetric Effects of Renewable Energy Consumption on Economic Growth in Turkey. *Journal of Mehmet Akif Ersoy, 6*(1), 117-134.

Heli Arminen and Angeliki N. Menegaki. (2019). Corruption, Climate, and the Energy-Environment-Growth Nexus. *Energy Economics, 80*, 629-634.

Ismail Aliyu Danmaraya and Sallahuddin Hassan. (2016). Electricity Consumption and Manufacturing Sector Productivity in Nigeria: An Autoregressive Distributed Lag-bounds Testing Approach. *International Journal of Energy Economics and Policy, 6*(2), 195-201.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 231-254.

Joseph Mawejje and Dorothy N. Mawejje. (2016). Electricity consumption and sectoral output in Uganda: an empirical investigation. *Journal of Economic Structures, 5*(21), 1-16.

Kasperowicz, R. (2014). Electricity Consumption and Economic Growth: Evidence from Poland. *Journal of International Studies, 7*(1), 46-57.

Maryam Abdu and Bassey E. Anam. (2018). 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, 3*(1), 49-59.

Mehdi Abid and Rafaa Mraihi. (2015). Energy Consumption and Industrial Production: Evidence from Tunisia at Both Aggregated and Disaggregated Levels. *Journal of the Knowledge Economy, 6*, 1123–1137.

Muhammad Maimuna Yakubu and Gylych Jelilov. (2017). Effect of Energy Consumption on GDP Evidence from (Ten) Sub-Saharan Africa Countries. *Nile Journal of Business and Economics, 5*, 3-14.

Mustapha Ben Hassine and Nizar Harrathi. (2017). 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, 7*(2), 76-85.

Nwajinka, Chibundu Chiazoka Akekere, Jonah Yousuo, and Purumaziba Odokpon John. (2013). National Electric Energy Supply and Industrial Productivity in Nigeria from 1970 to 2010. *Journal of Economics and Sustainable Development, 4*(14), 122-129.

Nwosa, P. I. (2012). Aggregate Energy Consumption and Sectoral Output in Nigeria. *An International Multidisciplinary Journal, Ethiopia, 6*(4), .206-215.

Okoligwe, N.E and Okezie A. Ihugba. (2014). Relationship between Electricity Consumption and Economic Growth: Evidence From Nigeria (1971-2012). *Academic Journal of Interdisciplinary Studies, 3*(5), 137-152.

Olarinde Muftaudeen O and Joseph Ayoola Omojolaibi. (2014). Electricity Consumption, Institutions, and Economic Growth in Nigeria. *Journal of Economics and Sustainable Development, 5*(12), 40-55.

Olufemi, O. J. (2015). The Effects of Electricity Consumption on Industrial Growth in Nigeria. *Journal of Economics and Sustainable Development, 6*(13), 54-59.

Reiner Kümmel and Dietmar Lindenberger. (2014). How Energy Conversion Drives Economic Growth Far From the Equilibrium of Neoclassical Economics. *New Journal of Physics, 16*, 1-21.

Renata Korsakienėa, Manuela Tvaronavičienėa, and Rasa Smaliukienėa. (2013). Impact of Energy Prices on Industrial Sector Development and Export: Lithuania in the Context Of Baltic States. *Procedia - Social and Behavioral Sciences*, 461 – 469.

Romer, P. M. (1989). Endogenous Technological Change. *NBER Working Paper Series* (pp. 1-41). Cambridge: National Bureau of Economic Research.

S. E. Akiri, Odike Abraham Ijuo, and Maria Peace Apochi. (2015). Electricity Supply and Manufacturing Productivity in Nigeria (1980-2012). *IOSR Journal of Economics and Finance (IOSR-JEF), 6*(6), 90-94.

Salah Abosedra, Muhammad Shahbaz, and Rashid Sbia. (2015). The Links between Energy Consumption, Financial Development, and Economic Growth in Lebanon: Evidence from Cointegration with Unknown Structural Breaks. *Journal of Energy*, 1-15.

Samouel Beji and Aram Belhadj. (2014). What are the Determining Factors of Industrialization in Africa? *Federalismi.it*, 1-20.

Tapsın, G. (2017). The Link Between Industry Value Added and Electricity Consumption. *European Scientific Journal, 13*(13), 41-56.

Theophilus I. Ugwoke, Dr. Christopher K. Dike, and Paul O. Elekwa. (2016). Electricity Consumption and Industrial Production in Nigeria. *Journal of Policy and Development Studies, 10*(2), 8-19.

Titus Koledoye Olugbenga, Abdul-Ganiyu A. Jumah, and Phillips D. A. (2013). The Current and Future Challenges of the Electricity Market in Nigeria in the Face of Deregulation Process. *African Journal of Engineering Research, 1*(2), 33-39.

Tugcu, C. T. (2013). Disaggregate Energy Consumption and Total Factor Productivity: A Co-integration and Causality Analysis for the Turkish Economy. *International Journal of Energy Economics and Policy, 3*(3), 307-314.

Ukoima Kelvin Nkalo and Ekwe Ogbonnaya Agwu. (2018). Review of the Impact of Electricity Supply on Economic Growth: A Nigerian Case Study. *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), Volume 14*(issue 1), 28-34.

Yahaya Yakubu, Salisu Baba Manu, and Umar Bala. (2015). Electricity Supply and Manufacturing Output in Nigeria: Autoregressive Distributed Lag (ARDL) Bound Testing Approach. *Journal of Economics and Sustainable Development, 6*(17), 7-19.

Appendices

Appendix A

Data

Year	ln MNVA	EC	EXRate	ln GDP PC	ln IMP	ln EXP
1985	23.46583	1.86408	-0.1123	6.782781	21.61117	22.37837
1986	23.16689	2.119863	0.562197	6.459925	21.47947	21.77995
1987	23.01524	1.981001	1.390296	6.394034	21.97652	22.63542
1988	23.06852	1.985131	1.512259	6.308531	21.77599	22.43622
1989	22.8122	2.122262	1.996703	6.161697	22.09198	23.13121
1990	22.98596	2.083185	2.084216	6.341291	22.40531	23.15106
1991	22.98247	2.102914	2.293493	6.220419	22.5598	23.20062
1992	22.85601	2.131797	2.850615	6.167889	22.64196	23.16202
1993	22.35247	2.112635	3.094011	5.599251	22.05539	22.44046
1994	22.68058	2.079442	3.090861	5.77244	21.89188	22.24586
1995	22.89912	2.068128	3.08627	6.011711	22.63629	23.08823
1996	23.00115	2.032088	3.085775	6.134524	22.89823	23.18797
1997	23.07036	2.064328	3.085849	6.173752	23.24278	23.47067
1998	22.97758	2.145931	3.085847	6.15152	23.16911	23.01655
1999	22.99048	2.123458	4.525457	6.210282	22.77633	23.26225
2000	22.99297	2.414126	4.622001	6.341999	22.9215	23.94285
2001	23.05628	2.46215	4.711611	6.380769	23.48734	23.7637
2002	23.14513	2.793616	4.792298	6.609009	23.49713	23.82189
2003	23.26116	2.726545	4.861535	6.678828	23.88844	24.0578
2004	23.41882	2.910174	4.889507	6.915599	23.48821	24.04193
2005	23.59802	2.880321	4.877289	7.145498	23.77637	24.33548
2006	23.76311	2.858193	4.857108	7.412417	24.15119	24.9673
2007	23.86554	2.916689	4.834758	7.540866	24.63308	24.79285
2008	24.03862	2.832036	4.775301	7.715512	24.65475	25.18361
2009	23.85348	2.7638	5.003287	7.545038	24.65254	24.71923
2010	23.89338	3.043093	5.01262	7.737374	24.8848	25.25845
2011	24.10513	3.075929	5.036054	7.832175	25.21058	25.58876
2012	24.29237	3.135494	5.059422	7.918262	24.81182	25.69943
2013	24.55149	3.141563	5.058226	8.005725	24.92707	25.25534
2014	24.72658	3.250374	5.066087	8.077973	24.98282	25.37535
2015	24.56554	3.256557	5.259786	7.912215	24.70045	24.688
2016	24.2821	3.237109	5.535332	7.685243	24.56385	24.34229
2017	24.21515	3.249987	5.722899	7.585057	24.62541	24.62507

Appendix B
Regression Result

Dependent Variable: LN_MNVA
Method: Least Squares
Date: 05/04/20 Time: 01:08
Sample: 1985 2017
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.44534	1.448139	13.42781	0.0000
LN_EC	-0.053793	0.214488	-0.250798	0.8039
LN_EXR	0.018799	0.057314	0.327998	0.7454
LN_PC	0.916868	0.135874	6.747923	0.0000
LN_IMP	0.121416	0.097627	1.243662	0.2243
LN_EXP	-0.211679	0.085847	-2.465780	0.0203

R-squared	0.964573	Mean dependent var	23.45302
Adjusted R-squared	0.958013	S.D. dependent var	0.624603
S.E. of regression	0.127986	Akaike info criterion	-1.110827
Sum squared resid	0.442271	Schwarz criterion	-0.838734
Log likelihood	24.32864	Hannan-Quinn criter.	-1.019276
F-statistic	147.0273	Durbin-Watson stat	0.646789
Prob(F-statistic)	0.000000		

Appendix C

Co integration Test

Date: 05/04/20 Time: 01:09
Sample (adjusted): 1987 2017
Included observations: 31 after adjustments
Trend assumption: Linear deterministic trend
Series: LN_MNVA LN_EC LN_EXR LN_PC LN_IMP LN_EXP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.799236	121.7850	95.75366	0.0003
At most 1 *	0.615174	72.01069	69.81889	0.0331
At most 2	0.586633	42.40680	47.85613	0.1476
At most 3	0.253652	15.02078	29.79707	0.7787
At most 4	0.097859	5.951304	15.49471	0.7013
At most 5	0.085148	2.758778	3.841466	0.0967

Trace test indicates 2 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 No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.799236	49.77434	40.07757	0.0030
At most 1	0.615174	29.60389	33.87687	0.1488
At most 2	0.586633	27.38601	27.58434	0.0530
At most 3	0.253652	9.069480	21.13162	0.8268
At most 4	0.097859	3.192526	14.26460	0.9331
At most 5	0.085148	2.758778	3.841466	0.0967

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	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
-0.950559	5.380669	-0.984391	-4.507064	1.660070	1.495151
1.457506	-7.831853	2.882542	3.375887	-4.640403	1.882915
7.810112	1.769328	-1.424028	-9.141098	-1.792152	4.945976
-0.657173	-8.602315	0.665243	3.070724	2.870011	-1.995760
-5.492675	-0.582314	-0.602241	4.061289	-1.535217	2.754746
0.011976	-2.459502	0.634194	3.644584	-0.294743	-1.102925

Unrestricted Adjustment Coefficients (alpha):

D(LN_MNVA)	0.055620	0.014300	-0.068311	-0.027210	0.025046	-0.025359
D(LN_EC)	0.032482	0.051693	-0.015097	0.028191	0.000856	-0.000338
D(LN_EXR)	-0.099157	-0.103419	0.056580	0.076453	-0.014945	-0.032408
D(LN_PC)	0.040682	0.039032	-0.084767	-0.016276	0.004292	-0.030628

D(LN_IMP)	-0.167251	0.116244	-0.078069	-0.044126	0.012036	-0.015524
D(LN_EXP)	-0.147454	0.012729	-0.242815	0.005208	0.010125	-0.026307

1 Cointegrating Equation(s): Log likelihood 106.3663

Normalized cointegrating coefficients (standard error in parentheses)

LN_MNVA	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
1.000000	-5.660529	1.035591	4.741486	-1.746414	-1.572917
	(1.44778)	(0.38732)	(0.95504)	(0.65547)	(0.65802)

Adjustment coefficients (standard error in parentheses)

D(LN_MNVA)	-0.052871
	(0.03193)
D(LN_EC)	-0.030876
	(0.01788)
D(LN_EXR)	0.094255
	(0.04974)
D(LN_PC)	-0.038670
	(0.03280)
D(LN_IMP)	0.158982
	(0.04492)
D(LN_EXP)	0.140163
	(0.06736)

2 Cointegrating Equation(s): Log likelihood 121.1683

Normalized cointegrating coefficients (standard error in parentheses)

LN_MNVA	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
1.000000	0.000000	19.61311	-43.08158	-30.08960	54.91675
		(6.41342)	(13.2011)	(17.4963)	(17.6518)
0.000000	1.000000	3.281940	-8.448515	-5.007162	9.979574
		(1.16122)	(2.39022)	(3.16791)	(3.19605)

Adjustment coefficients (standard error in parentheses)

D(LN_MNVA)	-0.032029	0.187283
	(0.05821)	(0.31788)
D(LN_EC)	0.044467	-0.230076
	(0.02683)	(0.14650)
D(LN_EXR)	-0.056479	0.276430
	(0.08296)	(0.45302)
D(LN_PC)	0.018220	-0.086801
	(0.05836)	(0.31866)
D(LN_IMP)	0.328408	-1.810328
	(0.07059)	(0.38550)
D(LN_EXP)	0.158716	-0.893091
	(0.12323)	(0.67292)

3 Cointegrating Equation(s): Log likelihood 134.8613

Normalized cointegrating coefficients (standard error in parentheses)

LN_MNVA	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
1.000000	0.000000	0.000000	-1.231966	-0.492263	0.921316
			(0.10211)	(0.14076)	(0.16149)
0.000000	1.000000	0.000000	-1.445651	-0.054521	0.944301
			(0.16961)	(0.23382)	(0.26826)
0.000000	0.000000	1.000000	-2.133757	-1.509059	2.753028
			(0.55871)	(0.77021)	(0.88363)

Adjustment coefficients (standard error in parentheses)

D(LN_MNVA)	-0.565546	0.066419	0.083744
	(0.24221)	(0.29257)	(0.10178)
D(LN_EC)	-0.073443	-0.256788	0.138531
	(0.12077)	(0.14588)	(0.05075)
D(LN_EXR)	0.385419	0.376539	-0.281072
	(0.36962)	(0.44647)	(0.15532)
D(LN_PC)	-0.643820	-0.236782	0.193177
	(0.22805)	(0.27546)	(0.09583)
D(LN_IMP)	-0.281318	-1.948458	0.610890
	(0.29735)	(0.35917)	(0.12495)
D(LN_EXP)	-1.737700	-1.322711	0.527620
	(0.39620)	(0.47858)	(0.16649)

4 Cointegrating Equation(s): Log likelihood 139.3960

Normalized cointegrating coefficients (standard error in parentheses)

LN_MNVA	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
1.000000	0.000000	0.000000	0.000000	-0.925845	0.231635
				(0.30242)	(0.32233)
0.000000	1.000000	0.000000	0.000000	-0.563308	0.134994
				(0.29726)	(0.31683)
0.000000	0.000000	1.000000	0.000000	-2.260020	1.558504
				(0.61880)	(0.65954)
0.000000	0.000000	0.000000	1.000000	-0.351943	-0.559822
				(0.27274)	(0.29070)

Adjustment coefficients (standard error in parentheses)

D(LN_MNVA)	-0.547665	0.300489	0.065642	0.338472
	(0.23872)	(0.38473)	(0.10192)	(0.33203)
D(LN_EC)	-0.091970	-0.499297	0.157285	0.252681
	(0.11161)	(0.17987)	(0.04765)	(0.15523)
D(LN_EXR)	0.335176	-0.281138	-0.230212	-0.184660
	(0.34808)	(0.56097)	(0.14860)	(0.48414)
D(LN_PC)	-0.633124	-0.096772	0.182349	0.673299
	(0.22719)	(0.36614)	(0.09699)	(0.31599)
D(LN_IMP)	-0.252319	-1.568870	0.581536	1.724373
	(0.28906)	(0.46586)	(0.12341)	(0.40205)
D(LN_EXP)	-1.741123	-1.367511	0.531084	2.943147
	(0.39744)	(0.64053)	(0.16968)	(0.55280)

5 Cointegrating Equation(s): Log likelihood 140.9923

Normalized cointegrating coefficients (standard error in parentheses)

LN_MNVA	LN_EC	LN_EXR	LN_PC	LN_IMP	LN_EXP
1.000000	0.000000	0.000000	0.000000	0.000000	-0.753082
					(0.10262)
0.000000	1.000000	0.000000	0.000000	0.000000	-0.464133
					(0.07499)
0.000000	0.000000	1.000000	0.000000	0.000000	-0.845226
					(0.24313)
0.000000	0.000000	0.000000	1.000000	0.000000	-0.934144
					(0.06448)
0.000000	0.000000	0.000000	0.000000	1.000000	-1.063588
					(0.10712)

Adjustment coefficients (standard error in parentheses)

D(LN_MNVA)	-0.685232	0.285905	0.050559	0.440190	0.031858
	(0.28474)	(0.37913)	(0.10187)	(0.34782)	(0.18067)
D(LN_EC)	-0.096671	-0.499795	0.156770	0.256157	-0.079303
	(0.13521)	(0.18003)	(0.04837)	(0.16517)	(0.08579)

D(LN_EXR)	0.417266	-0.272435	-0.221211	-0.245358	0.456265
	(0.42065)	(0.56009)	(0.15049)	(0.51383)	(0.26690)
D(LN_PC)	-0.656699	-0.099271	0.179764	0.690730	-0.014978
	(0.27513)	(0.36633)	(0.09843)	(0.33607)	(0.17457)
D(LN_IMP)	-0.318428	-1.575879	0.574287	1.773254	-0.822276
	(0.34938)	(0.46519)	(0.12499)	(0.42677)	(0.22168)
D(LN_EXP)	-1.796734	-1.373406	0.524987	2.984265	0.130714
	(0.48111)	(0.64059)	(0.17212)	(0.58769)	(0.30526)

Appendix D

Granger Causality Test

Pairwise Granger Causality Tests
Date: 05/04/20 Time: 01:10
Sample: 1985 2017
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LN_EC does not Granger Cause LN_MNVA	31	5.15743	0.0130
LN_MNVA does not Granger Cause LN_EC		0.17948	0.8367
LN_EXR does not Granger Cause LN_MNVA	31	2.89528	0.0732
LN_MNVA does not Granger Cause LN_EXR		1.45157	0.2526
LN_PC does not Granger Cause LN_MNVA	31	2.79515	0.0795
LN_MNVA does not Granger Cause LN_PC		1.83499	0.1797
LN_IMP does not Granger Cause LN_MNVA	31	2.28063	0.1223
LN_MNVA does not Granger Cause LN_IMP		1.94669	0.1630
LN_EXP does not Granger Caus e LN_MNVA	31	2.80170	0.0791
LN_MNVA does not Granger Cause LN_EXP		1.19428	0.3190
LN_EXR does not Granger Cause LN_EC	31	6.45795	0.0053
LN_EC does not Granger Cause LN_EXR		0.75737	0.4790
LN_PC does not Granger Cause LN_EC	31	0.07844	0.9248
LN_EC does not Granger Cause LN_PC		2.42432	0.1083
LN_IMP does not Granger Cause LN_EC	31	1.62506	0.2163
LN_EC does not Granger Cause LN_IMP		2.57193	0.0957
LN_EXP does not Granger Cause LN_EC	31	1.57825	0.2255
LN_EC does not Granger Cause LN_EXP		0.80615	0.4574
LN_PC does not Granger Cause LN_EXR	31	0.87400	0.4292
LN_EXR does not Granger Cause LN_PC		2.78567	0.0801
LN_IMP does not Granger Cause LN_EXR	31	2.56432	0.0963
LN_EXR does not Granger Cause LN_IMP		2.26533	0.1239
LN_EXP does not Granger Cause LN_EXR	31	2.80698	0.0787
LN_EXR does not Granger Cause LN_EXP		0.68922	0.5109
LN_IMP does not Granger Cause LN_PC	31	0.99056	0.3850
LN_PC does not Granger Cause LN_IMP		5.17987	0.0128

LN_EXP does not Granger Cause LN_PC	31	0.99792	0.3823
LN_PC does not Granger Cause LN_EXP		3.75864	0.0368
LN_EXP does not Granger Cause LN_IMP	31	1.22004	0.3116
LN_IMP does not Granger Cause LN_EXP		0.32848	0.7230