ENERGY AND INDUSTRIAL PRODUCTIVITY IN NIGERIA: A DISAGGREGATED CASE

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ABSTRACT

Energy has been seen as a major driver, and pivotal to industrial productivity as well as economic growth. But, the extent to which this is true within the Nigerian context is unascertainable due to the challenges the sector faces. Stemming from this, this study empirically examined the influence of energy, and industrial productivity in Nigeria between the periods of 1981 to 2018. In addition to the aggregate energy supply, the Energy variable was disaggregated into; petroleum, electricity natural gas, coal consumption, and energy (electricity) prices. Data collected were analysed with descriptive statistics, correlation analysis, unit root, and co-integration tests as well as the Error Correction Model (ECM). The estimated results revealed the existence of a positive relationship between petroleum consumption, coal consumption, energy price, physical capital stock, and industrial output. Coal, energy price and physical capital tend to significantly impact industrial output. However, an inverse relationship exists between industrial output, Natural gas, electricity, and human capital. On the whole, following the inconsistencies in the nature of relationship between industrial output, and some of the disaggregated energy products, the overall impact of energy components cannot be predetermined. Consequently, the study therefore recommends among others the adoption of sectorial-based energy policies in favour of the variables that significantly impact industrial output growth in matters bothering on energy and growth.

Key Words: Energy, Economic growth, Human capital, capital stock, Industrialization

JEL Classification: P28; F18; J24; H54; O14.

1.1 INTRODUCTION

It is a truism that industrialization is the bedrock of any nation. This is due to its non-overemphasized role in economic growth and development. Becoming an industrialized nation has been one of the major pursuits of Nigeria as a country. Looking at the role of high industrial productivity can play towards the actualization of industrialization in Nigeria, successive administrations have adopted various policies, schemes, and incentives like the import substitution and indigenization policies (1972), the 1986 Structural Adjustment Programme (SAP), the Bank of Industry and Small and Medium Equity Investment Scheme (2000), the Electricity Power Sector Reform Act (EPSRA) of (2005), the National Integrated Industrial Development (NIID) blueprint (2007) and others, in the bid to achieving this goal. Despite these policies and measures, data has it that the industrial sector is still bedevilled by stunted and hindered growth. A situation that has been attributed to the poor/epileptic energy supply to a large extent.

According to Okafor 2008, Adegbamigbe 2007, Udeaja 2006 and Oke, 2006 the non-competitive nature of Nigeria's export stemming from inadequate infrastructure has been the bane of industrialization in Nigeria. They found that only 10 percent of manufacturing companies were able to operate at less than 50 percent of their installed capacity, the other 60 percent only struggled to cover the average variable cost whereas about 30 percent of the companies were completely shut down. The topmost on the list of the infrastructure deficiency in Nigeria happens to be electricity supply due to its ability to push the running cost of firms out of proportion. Shortage in energy supply is the missing link between the huge productivity gap between the developed and developing countries (Ogunjobi, 2015). Despite the huge gap as presented above, electricity supply has been found to have great positive implication for economic growth and development even in developing economies (Odell, 2005). The household sector appeared to have the highest share of energy usage of about 65% as compared to other sectors including the industrial sector (Oyedepo, 2012). This may be blamed on the development drag in all other sectors.

Ironically, Nigeria which happened to possess sustainable energy resources like crude oil, national gas, lignite, coal as well as other common energy sources such as wood, solar, hydropower, and wind in large quantity has been grouped among the categories of countries with the lowest energy consumption rate (Okafor & Joe-Uzuegbu, 2010). The long-lasting energy-related problem in Nigeria is attributed to equipment, generation, transmission shortages as well as high aggregate technical, and commercial losses stemming from decades of neglect, mismanagement, and inadequate funding. Another major trigger of this problem is the increase in demand for electricity due to population growth in the face of the shortage in supply (Udoudoh and Umoren, 2015). The frequent load-shedding and outages have been attributed to the low grid power and its inability to service the demand thereby limiting a large proportion of the Nigeria population from accessing energy products. This situation has compelled many to adopt alternative energy sources or self-generation of energy like the use of generators which caused the use of petroleum products or production cost to increase by 75% in 2012 (Udoudoh and Umoren, 2015). The cost of energy and power outage happens to be detrimental to firms in Nigeria because the use of alternative sources appears to be very expensive and they translate into increasing the cost of production, the final selling price of the outputs and in the long run hinder the industries as they may lose their competitive strength. This may in no doubt posse adverse effect on the level of productivity in the industrial sector. Quite a number of studies on the how energy consumption impact the economy have emerged but the focus has been on economic growth (Aguegboh and Madueme, 2013;Bamidele and Mathew, 2013;Liew, Nathan and Wong, 2012; Jiang, Chen and Zhou, 2011; Velasquez and Pichler, 2010;), a few other studies that attempted to examine how energy consumption impact the economy through industrial output growth channel have either used the aggregate energy consumption value (Chebbi & Boujelbene, 2008; Liew, Nathan & Wong 2012), some others used electricity consumption values as a proxy for energy (Forkuoh and Li (2015) Aboyki *et.al*., 2018, Sankaran *et.al.*, 2019) and most of them are either cross-country studies for highly industrialized countries with stable energy supply or outside the context of the Nigeria economy. This study differs from others in that it seeks to examine the industrial productivity implications of energy consumption in Nigeria using a disaggregated data approach with an extension to 2018. Because electricity is just one out of many other sources of energy in Nigeria. This will provide us with the results of the different sources may impact industrial productivity. The idea of disaggregating the energy source stems from the fact that the few studies that even attempted to examine the impact of energy on industrial productivity have mostly done so by using an aggregated sample that has produced generalized results which happens to be too generic and maybe at best for a country with few or single source(s) of energy.

2. LITERATURE REVIEW

2.1 Theoretical Review

Inthe literature, there is quite some theories that tried to explain the link between energy and economic growth and its components such as investment or industrial growth. They include; Second Law of Thermodynamics, Stern Model, and the Endogenous growth theory**.**

The second law of thermodynamics states that a minimum quantity of energy is required to carry out the transformation of matter. Therefore there must be limits to the substitution of other factors of production for energy (Stern, 2012). Since all production involves the transformation of inputs into output in some way, it, therefore, means that all such transformations require energy. In this way, ecological economists also consider energy as an essential factor of production. According to the law of thermodynamics, no mechanized production can occur without the conversion of energy. For this reason, we expect the respective energy source to have a positive relationship with industrial output.

The neoclassical growth theory is an economic theory that describes how economic growth is fostered via the consolidation of three key forces; capital, labour and technology. The theory indicates that technological change majorly influences the economy, but economic growth becomes impossible without technological advances. Building on the neoclassical growth theory, possession and usage of more advanced technology is essential to economic growth. The impact of improvement in technology may be reflected in the economic growth of a country through the industrial output channel. The performance of industries is increased through the usage of more advanced technology which tends to augment labour productivity. Improvement on technology in the face of stable energy supply will in no small measure help labour to function optimally. In this light, technology is said to complement labour productivity as well as increase the output capacities of labour (Banton, 2019).

2.2 Empirical Review

In the literature, there is much concentration on how energy consumption and supply impact economic growth which has produced some contradictory results (Aguegboh and Madueme, 2013; Bamidele and Mathew, 2013; Liew, Nathan and Wong, 2012; Jiang, Chen and Zhou, 2011; Velasquez and Pichler, 2010; Noor and Siddiqi, 2010; Gbadebo and Okonkwo, 2009). In the aspect of how energy impacts industrial productivity which happens to be a tenable economic growth channel, there is a growing literature, the focus has been on the impact of aggregate energy consumption on industrial output (Chebbi & Boujelbene, 2008; Liew, Nathan & Wong 2012), a few studies have viewed this topic from the disaggregated approach but they have produced some inconsistent results. For instance Akomolafe, Danladi and Babalola (2012) examined the relationship between energy consumption and industrial growth in Nigeria using Granger causality test method on a time series between the period of 1971 and 2010. Found a two-way causality between electricity consumption and GDP, a one-way causality running from foreign direct investment to GDP, electricity consumption to foreign direct investment and energy used to foreign direct investment. In the work of Olumuyiwa (2013) on the relationship between industrial growth, domestic energy consumption and energy prices in Nigeria using the error correction method, the three variables were found to have strong interactions with each other. Focusing on oil price differential effect on industrial productivity within the context of Nigeria data from 1970 to 2017, Nwosu, Ihugba and Osmond (2019) found that a positive oil price rise tends to influence industrial output growth positively. Omosebi, Aladejana, Ajetunmobi, and Asagunla, (2019) found industrial output to be positively related to Premium motor spirit, diesel consumption, and human capital. Electricity, kerosene, and capital stock were inversely related to industrial output-this was attributed to the inadequate and epileptic supply nature that they possess in Nigeria.

Sari, Ewing and Soytas (2008), employed time-series data on energy consumption and industrial production in the United State to examine the relationship between disaggregated energy consumption and industrial production. The Auto-Regressive Distributed Lag model was used. Variable employed in the model are both renewable and non-renewable energy sources in the form of fossil fuel, conventional hydroelectric power, solar, waste and wind energy, coal, natural gas and industrial output. They nearly all the disaggregated energy consumption components to be related to both GDP and employment. Ziramba (2009) examined the energy consumption impact on industrial output and employment in South Africa for a period of 1980 to 2005, using the co-integration and Toda-Yamamota (1995) technique to Granger causality test. A strong correlation was found between industrial output and employment. Both industrial output and employment were also seen as strong driving forces for electricity consumption in South Africa. A bi-directional causality was observed between oil consumption and industrial output as well as between electricity consumption and employment in South Africa. From the negative relationship angle also, Forkuoh and Li (2015) carried out a similar study using Ghanaian's data and found that, power outages negatively impact SMEs growth, due to the push up in the cost of operating businesses that accompanied the power outages and the cost of alternative sources of power.

3. METHODOLOGY

3.1 Theoretical Framework

This study anchor on the neoclassical growth theory with some modification. The neoclassical growth theory describes how economic growth is fostered via the consolidation of three key forces; capital, labour, and technology. According to this theory, while technological advancement influences growth, lack of technological advancement tends to hamper economic growth. This theory is presented with the conventional production function below:

$$Y = AF(L, K) \tag{3.1}$$

Where: Y- income or the economy's Gross Domestic Product (GDP), K represents capital stock, L is labour stock while A, represents technological progress parameter that captures the endogenous growth determinant in the new growth model that seems to have some relationship with energy. The A parameter happens to be necessary since some level of energy is required for technological advancement per unit of time. From the above suffice to say that technological advancement which is made possible by adequate supply and consumption of energy is essential for economic growth. Suffice also to say that, the impact of developed technology on economic growth is not a direct link rather it goes through an indirect channel (that is, a transmission mechanism) via a better performance in the industrial sector. Economic growth is only guaranteed in the face of higher level of efficiency in industries that may arise from advanced technologies that requires stable energy to function well and sometimes complemented by highly equipped labour.

By extension, the energy element can be added to the above production function as the third parameter that drives growth through the industrial productivity channel in equation 3.2 and 3.3 as follows:

$$Y = AK^{\alpha}L^{\beta}E^{(1-\alpha-\beta)} \tag{3.2}$$

Taking energy as an independent component, the above model can be rewritten as:

$$Y = f(K, L, E) \tag{3.3}$$

Where: E is the energy infrastructure vector, K represents capital, and L, Labour.

The introduction of the E into the production function is predicated on the law of thermodynamic which posits that production is impossible in the absence of energy conversion. This, therefore, places energy as an essential requirement for productivity and the higher the productivity level, which can culminate into economic growth. From the argument of industrial output growth being a channel of growth, the models were further modified by taking Y in models 3.2 and 3.3 above as industrial output or productivity to be a function of energy, capital, and labour. We further modified the model by adding the disaggregated energy components such as electricity, petroleum, natural gas, coal, etc. into the model as the explanatory variables to capture their impact on industrial productivity rather than lumping all of them together.

3.2 Model Specification

The empirical model of this study emanated from the theoretical submission as revealed in the theoretical framework above. The model and the modification Stems from the works of Ziramba (2009); and Bernard and Adenuga (2016).

Thus, the functional form of the model is specified as:

$$IP = f(KAP, HCP, E) \quad (3.4)$$

E = energy infrastructure index which is further disaggregated into (Natural Gas, Electricity, Coal and Oil/Petroleum) being the explanatory variables with other control macro variables like the stock of capital (KAP) and human capital or stock of labour (HCP). The disaggregated version of the functional model is given as

$$IPR= F(ESup, PetCon, EleCon, NgCon, CCon, EPr, Kap, Hcp) \quad (3.5)$$

The above function can be expressed in an econometric linear form as follows:

$$IPR_t = \alpha_0 + \alpha_1 ESup_t + \alpha_2 PetCon_t + \alpha 3EleCon_t + \alpha_4 NgCon_t + \alpha_5 CCon_t + \alpha_6 EPr_t + \alpha_7 KAPt + \alpha_8 HCP_t + \mu \quad (3.6)$$

The Error Correction Model (ECM) form of the above model which includes changes (the differenced variables), time, the random term and the lag error correction mechanism, is expressed as:

$$IPR_t = \alpha_0 + \alpha_1 \Delta ESup_t + \alpha_2 \Delta PetCon_t + \alpha_3 \Delta EleCon_t + \alpha_4 \Delta NgCon_t + \alpha_5 \Delta CCon_t + \alpha_6 \Delta EPr_t + \alpha_7 \Delta KAPt + \alpha_8 \Delta HCP_t + ECMt\text{-}1 + \mu \quad (3.7)$$

Where;

IPR = Industrial output/Production measured as industry (including construction), value added (% of GDP) productivity, ESup = Energy supply proxy by electricity production from oil and coal (% of Total), PetCon = Petroleum (Oil) consumption (thousand barrel per day), EleCon= Electricity consumption (Kwh), NgCon= Natural gas consumption (billion cubic feet), CCon = Coal consumption (thousand short tonnes), EPr = Energy prices proxy by average annual OPEC crude oil price per barrel, KAP = physical capital proxy by the gross fixed capital formation, HCP = Human capital, measured by expenditure/investment on education in % of GNI, μ = error term.

$\alpha_{0} - \alpha_{8}$ = are the parameters to be estimated.

Based on economic theories, adequate supply of energy, adequate petroleum, coal, natural gas as well as electricity consumption are expected to contribute significantly to industrial output. This holds since increased energy is one of the essential materials that is required for the operating of the physical capital and development of technology as stated by the law of thermodynamics. Whereas, energy price is expected to impact industrial output negatively. Mathematically the expected signs are expressed as follows:

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_7$, and $\alpha_8 > 0$ and $\alpha_6 < 0$

3.3 Method of Analysis

To capture both the short and long-run dynamics of the model, the Co-integration and Error Correction Mechanism (ECM) approach following the two-steps Engel and Granger approach was adopted in this study. Before the above, the time series were subjected to the necessary preliminary screening which includes the unit root test following the Augmented Dickey Fuller (ADF) approach; the co-integration test using the Engel and Granger testing approach intending to ascertain the presence of unit root in the residual to identify whether the long-term economic relationship existing among variables is stable (Okungbowa and Eburajolo, 2014).Co-integration and Error Correction Mechanism (ECM) was adopted due to its ability to overcome spurious regression problems, and its ability to induce flexibility by combining the short-run and long-run dynamics in a unified system, and also, the fact that its estimates are generally consistent and efficient.. The study spans from 1981 to 2018 which is 38 years and the time-series secondary data were extracted from the National Bureau of Statistics, World development indicator, and Central Bank of Nigeria Bulletin. Apart from the above sources, relevant information was also sourced from previous studies, and literature on the effect of energy on industrial productivity.

4. RESULTS AND DISCUSSION OF FINDINGS

4.1. Unit Root Test

From the unit root result, while ESUP, PETCON, ELECON, NGCON, EPR, and HCP were not stationary at levels but became stationary at the first difference, IPR, CCON, and KAP were stationary at levels. The unit root test results at first difference and levels can be seen in Table 4.1.

Table 4.1: Unit Root at Levels and First Difference

	Unit Root at Levels			Unit Root at First Difference		
variable	adf	critical	remark	adf	critical	order of integration
IPR	-3.940490	-3.540328	Stationary	-6.768480	-3.544284	i(1)
ESUP	-1.582787	-3.536601	Non-stationary	-7.640698	-3.540328	i(1)
PETCON	2.326627	-3.536601	Non- stationary	-4.100967	-3.540328	i(1)
ELECON	-2.842052	-3.536601	Non-stationary	-8.205188	-3.540328	i(1)
NGCON	-3.354367	-3.544284	Non- stationary	-4.638134	-2.951125	i(1)
CCON	-3.894781	-3.536601	Stationary	-3.894781	-3.536601	i(1)

EPR	-2.621612	-3.540328	Non- stationary	-4.918153	-3.540328	i(1)
KAP	-3.645357	-3.536601	Stationary	-3.645357	-3.536601	i(1)
HCP	-3.287469	-3.536601	Non- stationary	-7.251331	-3.544284	i(1)

Source: Author's computation from E-views output

4.2. Co-integration Test

In the co-integration result, the absolute value of the ADF test statistics of the residual series from the long-run regression is 6.077953 which is greater than the absolute value of the critical statistics of 3.540328 at a 5% level of significance. This implies that the residuals series of the dependent variable (IPR) and the explanatory variables (ESUP, PETCON, ELECON, NGCON, CCON, EPR, KAP, and HCP) are co-integrated. Hence, we conclude that there exists a long-run equilibrium among the variables. See appendix for co-integration test result.

4.2 Parsimonious ECM Regression / Long run OLS Results

Dependent Variable = Industrial output growth (IPR)

Variables	ECM RESULT	Variables	LONG RUN OLS RESULT
C	-0.852366 (-1.568877)	C	22.03206 (2.194888)
D(ESUP)	0.140521 (0.848814)	ESUP	0.051470 (0.251659)
D(PETCON)	0.013799 (1.288494)	PETCON	0.008092 (1.069584)
D(ELECON)	-0.050169 (-1.405843)	ELECON	-0.013652 (-0.240051)
D(NGCON)	-0.001639 (-0.292164)	NGCON	-0.015366 (-2.723504)**
D(CCON)	0.030223*** (1.758824)	CCON	0.021129 (1.179712)
D(EPR)	0.092049** (2.744539)	EPR	0.020574 (0.594188)
D(KAP)	0.122191 (1.204649)	KAP	0.271432 (3.531216)*
D(HCP)	-5.229036** (-2.286312)	HCP	-3.021862 (-2.345668)**
ECM(-1)	-0.637260* (-3.369201)		

R-Square 0.559455 F-STAT 3.809752* F-PROB 0.003296 D-WATSON 1.821013 Diagnostic Tests B-P-G Heteroskedasticity TEST F-STAT 0.883760 (0.5516) B-G LM TEST F-STAT 1.312180 (0.2871)	R-Square 0.801106 F-STAT 14.60078* F-PROB 0.00000 D-WATSON 1.522648

***, ** and *** = significance at 1%, 5% and 10% respectively. Items in Parenthesis = t-statistics.** Source: Author's computation from E-views output

The long-run OLS result as presented on the two columns to the right of Table 4.2, we found that most of the energy variables were not significant except for natural gas component which appeared to be significant at a 5% level but inversely related to industrial output growth. The other significant variables were human and physical capital respectively**.** Following the fact that a long-run relationship was found to exist among the variables as obtained from the co-integration test on the residual that was generated from the long-run OLS result, we then conducted an ECM regression with the long-run component represented as ECM_{-1} to ascertain the speed with which the variables will adjust back to long-run equilibrium when they drift away.

The Error Correction Model (ECM) regression result as presented in the first two columns on Table 4.2 showed that in the short-run, all the explanatory variables except ELECON, NGCON, EPR, and HCP satisfy the a priori sign drawn from economic theory. Energy supply (ESUP) has a non-significant positive effect on industrial productivity judging from the associated probability value of 0.4034 which is greater than 0.05. This imply that a 1% increase in ESUP will lead to about 0.140521% increase in IPR. PETCON met the a-priori sign but appears to be statistically insignificant in driving industrial productivity going by the probability value of 0.2085 which is greater than 0.05. The result further shows that a 1% increase in PETCON will lead to about 0.013799% increase in IPR. The result revealed that ELECON has a non-significant negative effect on industrial productivity. Specifically, a 1% increase in ELECON was found to cause IPR to drop to a tune of 0.050169%. This insignificant impact of energy supply, PETCON, and ELECON could be attributed to the shortage, epileptic, inadequate supply as well as the high-cost implication of using electricity for industrial purposes which have compelled many firms to resort to alternative sources of energy in Nigeria. This result corroborates that of (Abokyi, *et.al*; 2018, Kasim and Isik, 2020) which revealed that electricity consumption has a negative impact on manufacturing/industrial sector output using Ghana and Nigeria data respectively.

In like manner, the estimate showed that natural gas consumption (NGCON) has an adverse non-significant effect on industrial output growth as a 1% increase in NGCON triggers a 0.001639% decrease in IPR with a probability value of 0.7724 which is greater than 0.05. However, from the result, Coal consumption (CCON) has a positive significant effect on industrial productivity at a 10% significance level. Implying that a 1% increase in CCON will lead to about 0.30223% increase in IPR. EPR with a coefficient value of 0.092049; the t-statistic value of 2.744539 and associated probability value of 0.0106 which is less than 0.05 shows that EPR (energy price) even though it appears not to meet its expected sign but it significantly drives IPR (industrial productivity) which confirms the study of (Ai, *et. al*; 2020) that found electricity price to be a significant driver of total factor productivity. Physical capital (KAP) has a non-significant positive effect on the IPR with a coefficient value of 0.122191; t-statistic value of 1.204649 and associated probability value of 0.2388 which is greater than 0.05 shows that KAP. HCP with a coefficient value of -5.229036; t-statistic value of -2.286312 and associated probability value of 0.0303 which is less than 0.05 shows that HCP has a significant negative effect on the IPR.
The coefficient of the ECM is negative and significant at a 1% significance level showing that the short-run deviation are adjusted to the long-run equilibrium position at a speed of 63% judging by the coefficient (-0.637260) of the ECM. The R-squared statistic which measures the goodness of fit of the model shows that about 55.9455% explanation capacity of IPR was vested on the selected variables in the model. F-statistics value of 3.809752 with the probability value of 0.003296 reveals that the entire model has a linear relationship and a 1% level of significance in explaining industrial output growth over the period of the study. The Durbin-Watson value of 1.821013 which is approximately 2.00 indicates an absence of serial autocorrelation, hence, no need for a higher order autocorrelation tests. Judging by the probability values of the post-diagnostic tests above as, 0.5516 and 0.2871 for heteroskedasticity and serial correlation tests respectively which appeared to exceed 0.05 (5%) we do not reject the null hypotheses which state that heteroskedasticity and autocorrelation problems are not present in the model. The CUSUM stability test shows that the model lies between the 5% significance level region.

5. CONCLUSIONS AND RECOMMENDATIONS (POLICY IMPLICATIONS)

The study empirically evaluated how energy impacts industrial productivity in Nigeria over the time frame of 1981 to 2018 in a disaggregated manner. The co-integration and error correction mechanism approach alongside the necessary pre and post-diagnostic tests were adopted. Away from the popular practice, we disaggregated the Energy consumption variable into; petroleum consumption, coal consumption, electricity consumption, and natural gas consumption. Generally, the estimated Error Correction Model result displayed that energy supply, petroleum consumption, coal consumption, physical capital, and energy prices were positively related to industrial productivity. Among these variables with direct relationship energy prices, coal consumption, and human capital were significant at a 1%, 10%, and 5% levels of significance respectively. This result therefore supports (Nwosu et.al;

2019; Ayeomoni *et.al*, 2019; Ugwoke, Dike and Elekwa, 2016; Chiazoka, Jonah and John, 2013; Oyedepo, 2012; Orazulike, 2012; Liew *et.al*, 2012; Iwayemi, 2008; and Adenikinju, 2005) and it negates (Bernard, & Adenuga, 2016; Olumuyiwa, 2013; Akomolafe, *et.al*, 2012; and Ziramba, 2009). The result also revealed an inverse relationship between electricity consumption, natural gas consumption human capital, and industrial productivity. Since the co-integration result also affirmed the presence of a long-run relationship we can conveniently conclude that on the aggregate, energy impacts industrial productivity in Nigeria. Stemming from the non-uniformity in the a-priori signs of the various energy components and their statistical strength, we therefore conclude that the overall impact of energy components on Industrial Productivity cannot be predetermined but this can be done separately. Consequently, the following has been recommended to boost the role of energy and its components in industrial productivity of industries in Nigeria. First, government should adoption a sectorial-based energy policies in favor of the variables that significantly impact industrial output growth in matters bothering on energy and growth rather than judging from the holistic perspective, again, government and the appropriate stakeholders should subsidize the cost of consuming electricity especially for industries to hedge against the negative impact of increased energy price on industrial output growth, again, appropriate institutions should be put in place that will ensure adequate supply of energy, government should ensure the availability of petroleum and other energy resources for consumption; government should ensure that coal is readily available for consumption, as more consumption of coal will result will trigger industrial productivity. Also, the financial sector should try to increase industries capital stock by making credit available at low interest rate.

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APPENDIX

ECM ANALYSES RESULTS

Long-run OLS Result

Dependent Variable: IPR
Method: Least Squares
Date: 06/19/20 Time: 16:08
Sample: 1981 2018
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PETCON	0.008092	0.007565	1.069584	0.2936
CCON	0.021129	0.017910	1.179712	0.2477
ELECON	-0.013652	0.056873	-0.240051	0.8120
NGCON	-0.015366	0.005642	-2.723504	0.0108
EPR	0.020574	0.034625	0.594188	0.5570
ESUP	0.051470	0.204524	0.251659	0.8031
HCP	-3.021862	1.288273	-2.345668	0.0260
KAP	0.271432	0.076866	3.531216	0.0014
C	22.03206	10.03790	2.194888	0.0363

R-squared	0.801106	Mean dependent var	29.59672
Adjusted R-squared	0.746239	S.D. dependent var	5.501864
S.E. of regression	2.771549	Akaike info criterion	5.080084
Sum squared resid	222.7631	Schwarz criterion	5.467933
Log likelihood	-87.52159	Hannan-Quinn criter.	5.218078
F-statistic	14.60078	Durbin-Watson stat	1.522648
Prob(F-statistic)	0.000000		

Co-integration Test

Null Hypothesis: Residual Series has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.077953	0.0001
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

Lag Length Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: IPR ESUP PETCON ELECON NGCON CCON EPR KAP HCP
Exogenous variables: C
Date: 06/19/20 Time: 17:49
Sample: 1981 2018
Included observations: 37

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1272.684	NA	9.90e+18	69.28024	69.67209	69.41839
1	-999.8954	398.1246*	3.53e+14*	58.91327*	62.83172*	60.29470*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

ECM Regression

Dependent Variable: D(IPR)
Method: Least Squares
Date: 06/19/20 Time: 18:08
Sample (adjusted): 1982 2018
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.852366	0.543297	-1.568877	0.1283
D(ESUP)	0.140521	0.165549	0.848814	0.4034
D(PETCON)	0.013799	0.010710	1.288494	0.2085
D(ELECON)	-0.050169	0.035686	-1.405843	0.1712
D(NGCON)	-0.001639	0.005609	-0.292164	0.7724
D(CCON)	0.030223	0.017183	1.758824	0.0899
D(EPR)	0.092049	0.033539	2.744539	0.0106
D(KAP)	0.122191	0.101433	1.204649	0.2388
D(HCP)	-5.229036	2.287105	-2.286312	0.0303
ECM(-1)	-0.637260	0.189143	-3.369201	0.0023

R-squared	0.559455	Mean dependent var	-0.444906
Adjusted R-squared	0.412607	S.D. dependent var	3.020795
S.E. of regression	2.315185	Akaike info criterion	4.742315
Sum squared resid	144.7221	Schwarz criterion	5.177699
Log likelihood	-77.73283	Hannan-Quinn criter.	4.895808
F-statistic	3.809752	Durbin-Watson stat	1.821013
Prob(F-statistic)	0.003296		

Residuals Diagnostics

Normality Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.312180	Prob. F(2,25)	0.2871
Obs*R-squared	3.515062	Prob. Chi-Square(2)	0.1725

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.883760	Prob. F(9,27)	0.5516
Obs*R-squared	8.419452	Prob. Chi-Square(9)	0.4925
Scaled explained SS	4.261747	Prob. Chi-Square(9)	0.8934

Stability Diagnostics