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TECHNOLOGICAL LINKAGE CAPABILITY AND 'PER CAPITA ELECTRICITY CONSUMPTION' IN THE NIGERIA POWER SECTOR: AN EVALUATION OF PRE AND POST PUBLIC PRIVATE PARTNERSHIP INITIATIVE PERIOD

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Abstract
This study evaluates how selected indicators of Technological Linkage Capability (TLC) such as investment in collaborative efforts via R&D and counterpart funding affects the 'per capita electricity consumption' in the Nigeria power sector for a period that can cover both the pre and post Public Private Partnership (PPP) initiative. The study adopted quantitative approach, a description via a trend analysis and expos facto research designs (to describe how the independent variable, present prior to this study, affects a dependent variable) was used in the quantitative approach. The data collected were analysed using descriptive statistics, regression analysis and coefficient of multiple determination. The finding of this research shows that technological linkage capabilities-investment in collaborative efforts, and research and development have a positive relationship with per capita electricity consumption in Nigeria between the year 2005 and 2012 ($R = 0.797$); The coefficient of multiple determinations ($R^2 = 0.991$) shows that 99.10% of the change in per capita electricity consumption in Nigeria is accounted for by the investment in collaborative efforts, and research and development between 2013 and 2017. It was concluded among others that the post PPP era exhibits a stronger strength of association between the independent and the dependent variables for the hypothesis. However, the study shows also that policy makers have to be careful with policy indicators that show an inverse proportion on the dependent variable. This is because investment in collaborative effort shows an expected decrease in per capital electricity consumption for every unit increase its investment before and after the PPP initiative. The study thus recommended among others, a need for periodic review of individual indicators and variable that are expected to add values to the performance as the policies changes.

Introduction
The Nigeria electric power sector has gone through series of technological advancement (Oladimeji, Elutunji, Ayodeji, & Joseph, 2019) since its inception in 1896. Nigeria is the fifth country in the world after USA, UK, Germany and Italy that electricity generating plants were installed. Momodu (2010), however, believes Nigeria is the third country in the world after USA and the UK. While many other countries have experienced improved performance especially in terms of stable electric power supply, there has been epileptic supply for major part of the years of its existence in Nigeria. This unstable power supply is not only peculiar to a particular part of the country, but also in many regions such as commercial states, urban or rural settlements and it persists until date (Oladimeji, Elutunji, Ayodeji, & Joseph, 2019). While some parts of the country have been experiencing unstable power supply, some experience power outage though there are a few exceptions. For example, the recent Federal Government announcement of a technological development has resulted in uninterrupted supply of electricity to two communities in Kaduna State for two straight years from the 90-kilowatt Solar PV off-grid system installed in the area (Okechukwu, 2017).

To improve the performance, there have been series of changes from the Public Works Department (PWD) in 1896 to the Nigeria Electricity Supply Company (NESCO) in 1929 to the structure of privatisation of Power Holdings Company of Nigeria (PHCN) to successor companies since 2013 (Edomah, Foulds, & Jones, 2016; Folorunso & Olowu, 2014; News Reports & Uninterrupted Power for Nigerians, 2014). All these processes have resulted in a change of nomenclature but no major change in services, from the authorised government agent/body for electric power generation and distribution (Elim Educational Agency, 2012).

By 2013, the authority implemented Public Private Partnership (PPP) initiative which divided most of the assets of the power agencies into 11 distribution companies and 7 generation companies while the transmission company is retained (Nwangwu, 2021).

The Pre PPP-initiative has posted a number of challenges which the PPP initiative could address with an expected increase in technological linkage capability (TLC) intensity in the power sector. This is based on Schumpeter's opinion that entrepreneurs in the PPP initiative are believed to be innovators and technologically driven. Other researchers like Alberto, et al., (2016); Hyun-Sun, (2016); Stern, (as cited in Alberto, et al., 2016) etc. attested to this assertion in their work.

The impact of TLC in the form of technological innovation (TI) intensity can be observed in a number of public enterprises especially in Nigeria. In Nigerian Ports Authority PLC for example, the recent processes of pilotage operation, towage operation, and other operations of the organisation have improved drastically as a result of technological transfer that was achieved through non concessioning programme (landlord arrangement). This has fostered better public and private initiative with improved service delivery in the Nigerian Port system.

The Nigeria aviation industry, in 2014, alerted the public of the adoption of an innovative financial mechanism (knowledge transfer) to promote an improved health and safety standards within and around the environment. Though the new service policy involves imposition of levy on the air ticket through the policy of Official Development Assistance (ODA), reviewed by UNITAID a subdivision in World Health Organisation (WHO). This cutting-edge model enables developing countries like Nigeria to increase their financial capacity and generate the funds for greater access to diagnose and treat health related diseases like fever, cough, tuberculosis malaria, HIV/AIDS, etc. This mechanism according to the federal government of Nigeria representative has improved the stability of the industry by increasing and sustaining the financial base of the Nigerian Civil Aviation Authority. It has also helped in the realisation of the mandate giving to the management of the aviation industry.

However, the Nigerian power sector has defiled expectation with the level of service delivery and the consumers having a mixed opinion on the outcome of the PPP initiative.

Ifeanyieze, Nwarieji and Aneke (2017) argue that the intensity of TLC of a system determines the rate of knowledge transfer that aid the improvement of performance and boost outputs. But a recurrent problem identified by Madukwe (as cited by Ifeanyieze, et al., 2017) is the poor technological linkage capacity policy adoption that has affected the performance of different sectors in Nigeria. This shows that the investment policy on TLC is one of the possible indicators of Tl that can influence key performance indicator like per capita electricity consumption.

Thus, this study examined the technological linkage capability of the Nigeria electric power sector and how it has influenced the per capita electricity consumption of Nigerians between 2005 and 2017. This is eight years before the PPP initiative and five years after.

In view of the above, this study examined TLC in terms of investment in collaborative efforts via R&D, counterpart funding etc. against 'per capita electricity consumption 'in a public-private partnership (PPP) enterprise like the Nigeria electric power sector. This study, therefore, evaluates the relationship between TLC and the 'per capita electricity consumption' in the Nigeria power sector.

Literature Review

Existing literature on the concept of technological innovation (TI) has initially been concerned with technological linkage capabilities (TLC) among clustered organisation especially within the private sector. TLC is believed to be central to collective learning and knowledge spillover within an industrial cluster (George, Cassandra, Yu, Yifei, & Yehua, 2011; Oluwale, Ilori, & Oyebisi, 2013). But George et, al. (2011) further stress that though the notions of localised knowledge spillover and external technology transfer have contributed to the understanding of the dynamism of TI in the developed and developing world, there exist important theoretical issues that require further studies for better understanding. Faridah-binti and Yuserrie-bin (2016) in their observation of the study of Shan & Jolly, TLC is an important indicator of TI, to improve productivity and firm overall performance. TLC enables collaboration whether within the organisations or inter-organisations or with research institutions for developing TI and technological development. As it makes it easier and relatively cheaper to obtain information, skills, expertise, assets, and technologies and hence influence the internal resources of the system. This makes such industry healthy as most organisations cannot depend on their internal limited resources alone to improve technology innovation base. Oluwale, et al. (2013) extends the concept of TLC beyond the link or collaboration with institutes, enterprises and organisations, to vendors, service suppliers and standards bureaus. Though Oluwale, et al. (2013) observe these links are lacking in Nigerian and Sub-Saharan African (SSA) enterprises.

The phrase Per capita is a Latin term that means "by head," basically meaning "average per person." Per capita can take the place of saying "per person" in any number of statistical observances (Investopidia, n.d.). Thus per capita electricity consumption measures the average kilowatt-hours (kWh) of electrical power generated per person in a particular country or region (Investopidia, n.d.). To Kandel, Sheridan and McAuliffe (2008), per capita electricity consumption provides an indication of electricity attributed to the population in a system. Davis and Durbach (2010); Tewathia (2014) distinguish between the amount of electricity demanded (or perhaps apparent electricity consumption) and the amount of electricity consumed (or actual electricity consumption). The former measures the consumption of electricity-consuming services, rather than the consumption. The latter measures the actual amount of electricity consumed. But from literatures and observations, since the total electricity generated and supply in Nigeria is less than demand, this study assumes that the total electricity supply equal to consumption. This make it easier to determine the per capital through past records of electricity supplied where the data is not available and needs to be determined from other available data. The assumption also assists to merge into a quantifiable unit the components of electricity consumption as classified by Wood and Newborough (2003 as cited by Tewathia, 2014).

This, in order to evaluate the power gap in Nigeria and align it with the projected goal-current and future needs and focus-of the Nigeria government between now and 2025, this study has selected ‘power consumption per capita’ as a suitable indicator of performance measurement. This is because power consumption per capita depicts the end impact to the consumer. In the study of David and Omontuemhen (2016) Nigeria currently has a per capita power consumption of only 151 kWh annually. This is regarded as very poor when compared with countries with a per capita GDP (at 2015 prices) between US$2,000 and US$4,000 (see 7able 2.4). This ensured that the study of David & Omontuemhen, (2016) which compared Nigeria to other countries with a similar range of economic capacity, a population more than 20 million and have also adapted the PPP initiative relevant.

To address the significant bottleneck, the level of electricity per capita has on broader economic growth, the Nigeria power sector is expected to have enough fund at its disposal to develop and enhance new and existing capabilities across the value chain through TI diffusion i.e. TIC via R&D, collaborative efforts with other organisations both internally and/or externally. This is because the PPP agreement has passed major financial and risk burden on the private investors. This allowed the management of the power sector to strategical divert the available funds to more innovative needs of the sector.
Thus, a proportional relationship between the two indicators in per capita electricity consumption and TLC can shows management of the sector how investment policy in R&D and other collaborative effort that aid TI diffusion can be developed. Such policy results in technological transfer that improves the productivity of the system or region under observation. This is an indication of an indicator that can improve performance as described by HyunSun (2016) with the opportunity provided by the PPP initiative.

PPP may be viewed as "an informal and short-term engagements of nongovernmental organizations, the private sector and/or government agencies that join forces for a shared objective; to more formal, but still short-term private sector engagements for the provision of specific services, for example, annual outsourcing arrangements for janitorial services for a school or operations of the school cafeteria; to more complex contractual arrangements, such as build, operate, transfer regimes, where the private sector takes on considerable risk and remains engaged long term; or to full privatizations" (IMF 2005; OECD 2013). But this study adopted the definition of International Monetary Fund (2005) – An arrangement where the private sector supplies assets and services that traditionally have been provided by the government. In addition to private execution and financing of public investment, PPPs have two other important characteristics: there is an emphasis on service provision, as well as investment, by the private sector; and significant risk is transferred from the government to the private sector

The performance of an organisation in a competitive environment is compared against others. But the performance of those in a monopolistic environment is measure with either a base period or level of usefulness and productivity. This can only be done by comparing its progress with previous results and benchmarks. In this study since the Nigeria power sector before and after the reform exhibit a monopolistic environment, performance is measured against relative past services which should predict the level of service delivery to the consumers as benchmark.

This study adopts the 3Es equation developed by Ristea in its choice of identifying suitable indicators to measure performance in the objective of the study as follow;

The choice of per capita electricity consumption in the objective assisted the study to identify the optimal use of knowledge transfer as a resource before and after the reform that adapted the PPP initiative in the Nigeria power sector. If the change in investment in TLC courses a commensurate improvement in the average consumption of electricity and invariably service delivery

Public-Private Research Partnerships: Underlying Theoretical Conceptions

The study adopts the following three theoretical views: transaction cost economics and innovation economics discussed by Koschatzky (2017). Transaction cost economics explore governance, control, regulation and coordination, with trust and cooperation relations' hierarchy, opportunistic behaviour, and the absorptive capacities of the partners. Innovation economics can be utilised in the analysing of the kind of innovation processes' distribution, the openness of innovation, exploitation processes and knowledge generation, the essence of human asset, and market orientation.

Transaction costs perspective

Koschatzky (2017) model examines the circumstances under which cooperation agreements are the most efficient form of organisation. In this theoretical approach, industrial innovative linkages can be explained by the increasing vertical disintegration (as adopted in Nigeria power sector to reduce the bureaucracy that has hindered private participation), the necessity of exchange processes increase and the number of required transactions. This is because differentiation, technological complexity and interdependence led to the increase in costs of activity coordination within organisation especially public entity, so that the pressure to search for external arrangements (private participation) rises as well. Hence, the most cost-effective variant should be sought. In this interpretation, transaction cost efficiency can be regarded as a motivation for public private partnerships. For example, the level of efficiency expected by the Nigeria government can be determined by the investment in collaborative and R&D efforts between the Nigeria power sector MDAs and its environment.

Innovation Economics

Bathelt and Glückler (2012) opine that innovation creates novelties. These novelties (inventions) become an innovation via its commercialisation as a result of value added which can be technological or non-technological. A major difference to traditional interpretations of the innovation concept (e.g. as identified by the push and pull model) is that nowadays innovation is regarded as a non-linear and cumulative process

which is influenced by socio-cultural factors and which is characterised by interactivity between many stages and many agents contributing to the realisation of an innovation. As a matter of fact, innovation can also be interpreted as a distributed knowledge sourcing and combining process between different agents. Both tangible and intangible (social) interactions with firms, research institutes, intermediaries, clusters, linkages, networks and others play a prominent role in the transfer of information, implicit and explicit knowledge to new technological, social and organisational solutions to add value to the system (Oluwale, et al., 2013).
Hence, taking a clue from the concept of performance identified earlier, innovation economies provide the bases necessary to believe technological linkage capabilities will provide necessary resource for performing operations at the minimum cost and invariably improving the per capital electricity consumption.
The study is based on both the transaction cost economics, and innovation economics. In the transaction cost economics approach, the essence of PPP collaboration in project based organisational linkages are explained by the need to reduce the ever-increasing costs of activity coordination within projects due to differentiation, technological complexity and interdependence. As the Nigeria electric power is experiencing a rise in internal transaction costs and an increase in information asymmetries, resulting from production segmentation and bounded rationality of economic agents. The market, through the price mechanism, is no longer an efficient form of resource coordination (Nnodim, 2017; Vanguard, 2017). Then the most cost-effective variant should be sought. In this interpretation, transaction cost efficiency can be regarded as a motivation for public private partnerships (Koschatzky, 2017; Okigbo, 2015).

Based on the above, this study will examine the relationship between technological linkage capabilities and cost of electricity generation. But the innovation economics theory approach as explained by Koschatzky (2017) further stressed that irrespective of the cost effect, a novelty only become an innovation when it adds value to the system under observation i.e. improve the per capital electric consumption of Nigeria. Hence the need to determine the relationship between technological linkage capabilities and per capita electricity consumption in the Nigeria power sector between 2005 and 2017.

Research Design

The study adopted quantitative approach, a description via a trend analysis and expos facto research designs (to describe how the independent variable, present prior to this study, affects a dependent variable) was used in the quantitative approach. This is because researchers on innovation have identified the importance of both expos' facto and descriptive research designs and its objectives of assisting to search deep into valid information about the specific area of study when using secondary data (Dzifa, Nina, & Robert, 2015**)**. The descriptive research design provides a clear, detailed and vivid trend of the characteristics of the phenomenon that this study examines over the study period.

The trend analysis was adopted to examine the changes that has happened to the attributes/characteristics of each of the indicators over the study period. It assists to express graphically the pattern of the distribution for each of the indicators. Hence, the trend analysis of this study is based on graphical representation of historically collected data of the variables given the overall trends of the power sector under observation and the particularity of the variables for the sector. The trend analysis of the descriptive research design further provides answers to this study research questions.
This study covers the data from all ministry of power and all departments and agencies under the ministry as recognised in the annually Nigeria appropriation bills between 2005 and 2017. This is because, the structure/organogram of the power sector changes at irregular periods. Though, this change depends on the change in policy at the different period. For example, it was ministry of power and steel in the 2005 appropriation bill but ministry of power in the 2010 appropriation bill.

Since this study used an entirely secondary data, records of the identified indicators-Technology Linkages Capabilities, per capita electricity consumption-from the MDAs as recognised in the Nigeria appropriation bills between 2005 and 2017 were extracted This study further adopted data from the website of Budget office of the federation, federal republic of Nigeria proposed budgetary allocation to such MDAs and recognised institutions website like the world bank, CIA, index mundi, etc. for each of the year under observation where the freedom of information is hindered by government officials

A non – probability sampling method of convenience sampling technique was used since secondary data was entirely used. The data obtained from the Ministry of Power, Works and Housing was limited to only what the ministry are ready to release for the study while others were gotten as stated above. Hence, this study develops some basic assumption in the extraction of data from the sources available and in view of the enormous financial and time resources required

In this study the following regression equation was used to test the significance of the study hypotheses.

To determine the relationship between technological linkage capabilities and per capita electricity consumption in the Nigeria power sector between 2005 and 2017

The basic assumption is technological linkage capabilities equal investment in collaborative effort such as R&D, counterpart funded projects, level of investment in research tools and equipment and other activities that involved cross fertilization of technical ideas. This is because this study may not be able to identify the level of ideas numerically but can extract the financial implications. Hence it is assumed that, the intensity of collaborative effort is directly proportional to the level of investment and invariably:

Technological Linkage Capabilities = summation of individual investment in collaborative and research effort thus, *Per Capita Electricity Consumption* $= \beta_{01} + \beta_{11}X_1 + \beta_{21}X_2 + \varepsilon$; Where

X1 = Investment in counterpart funding/collaborative efforts with other institutions (foreign and local)

X2 = R&D

Total investment in counterpart funding and collaborative R&D were measured in Nigeria naira value. The independent variables consist of; various identifiable investment in counterpart funding and collaborative R&D. with local academic institution, foreign bodies, sister or allied organisation etc. They are represented by X_1 and X_2, while β_0 is the constant or intercept while β_1, and β_2 are the corresponding coefficients for the respective independent variables corresponding to objective one. While ε is the error term which represents residual or disturbance factors or values that are not captured within the regression model. The interpretation of X, β and ε is the same for the subsequent independents variables in equations for testing the other study objectives. Interpretations are as stated above.

However, to determine if the hypothesis testing is statistically significant, the standard error test was used. The method was used because the hypothesis examined relationship between the independent and dependent variables and the numbers of years under observation thirteen (13) is less than twenty-five (25) which Koutsaris considered as relatively small. In view of this, Koutsaris identifies that;

each variable is statistically significant, if:

$$\beta/2 > \text{Std Error},$$

where β = constant coefficient

Basic Research Assumptions

1. The relationship between investment in TI indicators and the intensity are proportional except proven otherwise by this research findings
2. Any financial and/or risk commitment by two or more parties includes cross fertilization of ideas between all the parties involved
3. Data collection are not subject to manipulation.
4. The allocated financial commitment by the federal government to the power sector in the appropriation bill for the period under study is 100% implemented.
5. Total investment in generation, Transmission and distribution technical project are basically infrastructural investment

6. Access to electricity only include power supply to household, and industry (public or private). But exclude solar power street light or blowhole
7. This study extracts data that are purely for technological based investment. But where technological and non- technical are presented jointly i.e. Consultancy fee for both legal and information technology IT. The entire investment is assumed to be spent on the technological investment and production investment
8. Only investment from the Power sector MDAs are considered relevant for this study. Investment from other sectors MDAs that contribute indirectly or directly, e.g. the ministry of science and technology, ministry of petroleum etc are not consider.
9. The percentage increase in all class of electric power tariff are the same. That is the classification of consumers into classes that resulted in different tariff for each class is not taken into consideration in this study

Descriptive Data Presentation

Descriptive Analysis for Investment in counterpart funding/collaborative effort. Figure 1 as shown below, depicts the investment the power sector made over the study period on TLC via counterpart funding. This is based on the assumption stated earlier in chapter three of this study. It shows that the intensity of investment by the ministry of power in counterpart funding dropped sharply in 2008 before the implementation of the PPP initiative in 2013 and remained relatively low afterward. This shows that the level of TLC via innovation diffusion between the ministry and its environment after the PPP initiative is relatively low.

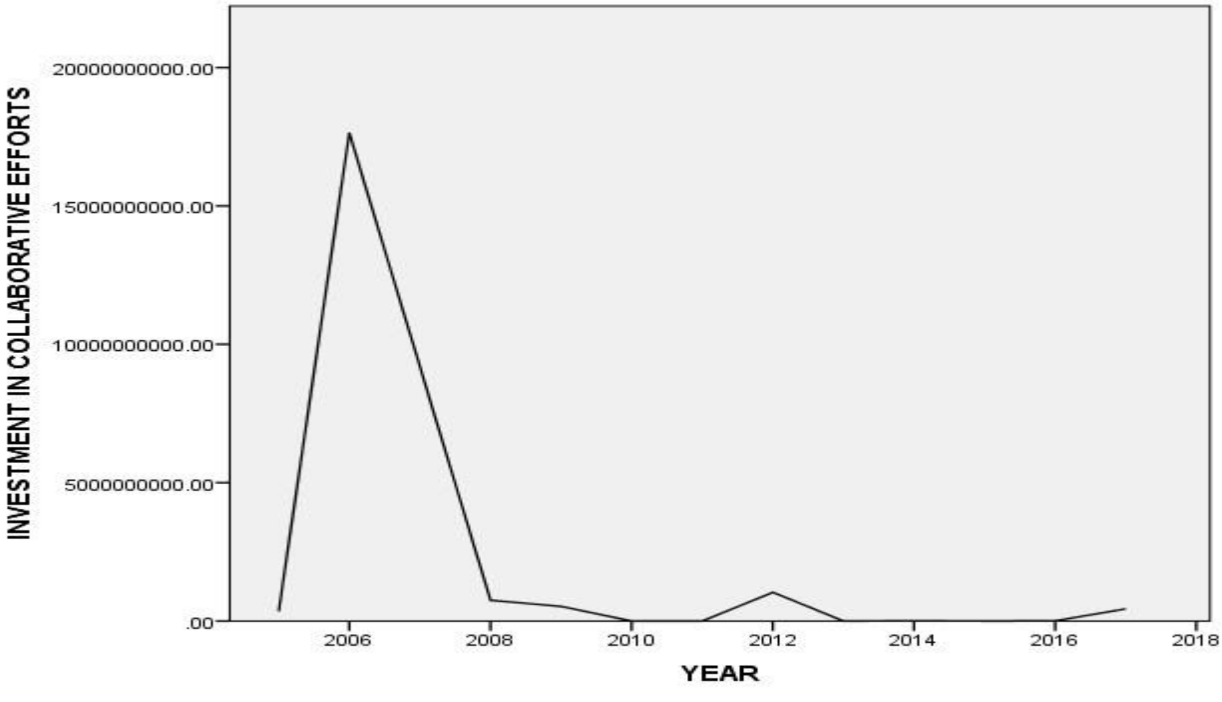

Figure 1: Investment in counterpart funding/collaborative effort
Source: Budget Office of the Federation (2005 – 2017)

Descriptive Analysis for Research and development.

Figure 2, as shown below, depicts the investment the power sector made over the study period on TLC via R&D. This investment includes direct and indirect allocations to R&D. The indirect allocation includes investment in research tools, equipment etc. to aid quality research. It shows that the intensity of investment by the ministry of power on R&D that was steadily raising till 2011, dropped for a few periods until the implementation of the PPP initiative in 2013 when the ministry increased allocation to R&D. This shows that the government believed in exploring new ideas via knowledge transfer (TLC) as an important component of developing better innovative process of managing the power sector

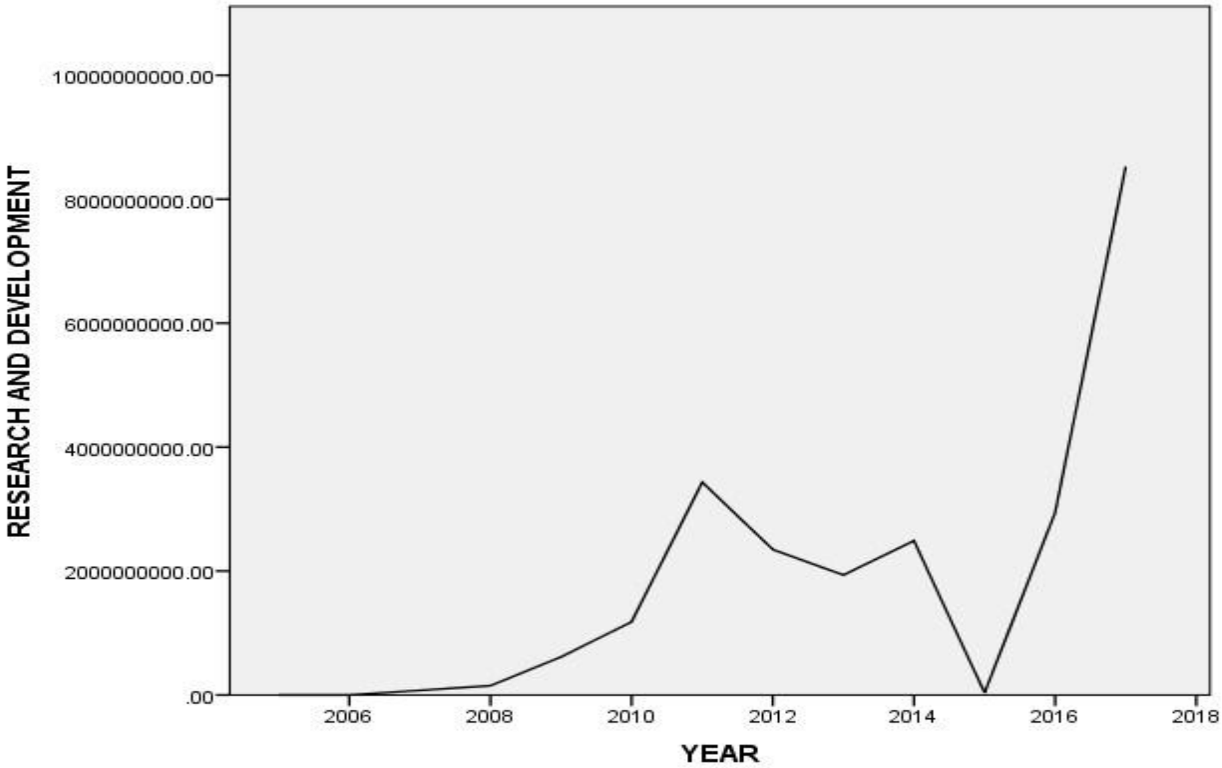

Fig 2: Research and Development
Source: Budget Office of the Federation (2005 – 2017)

Descriptive Analysis for Per capita electricity consumption.

Figure 3, as shown below, depicts the trend observed with the dependent variables' indicator 'per capita electricity consumption'. This shows that there has been a lightly gradual increase in the per capita electricity consumption over the study period both before and after the PPP initiative. Though there was a decease between 2013 and 2015. This may be due to the period to gain stability during the transfer of shares of the investment responsibility to private investors.

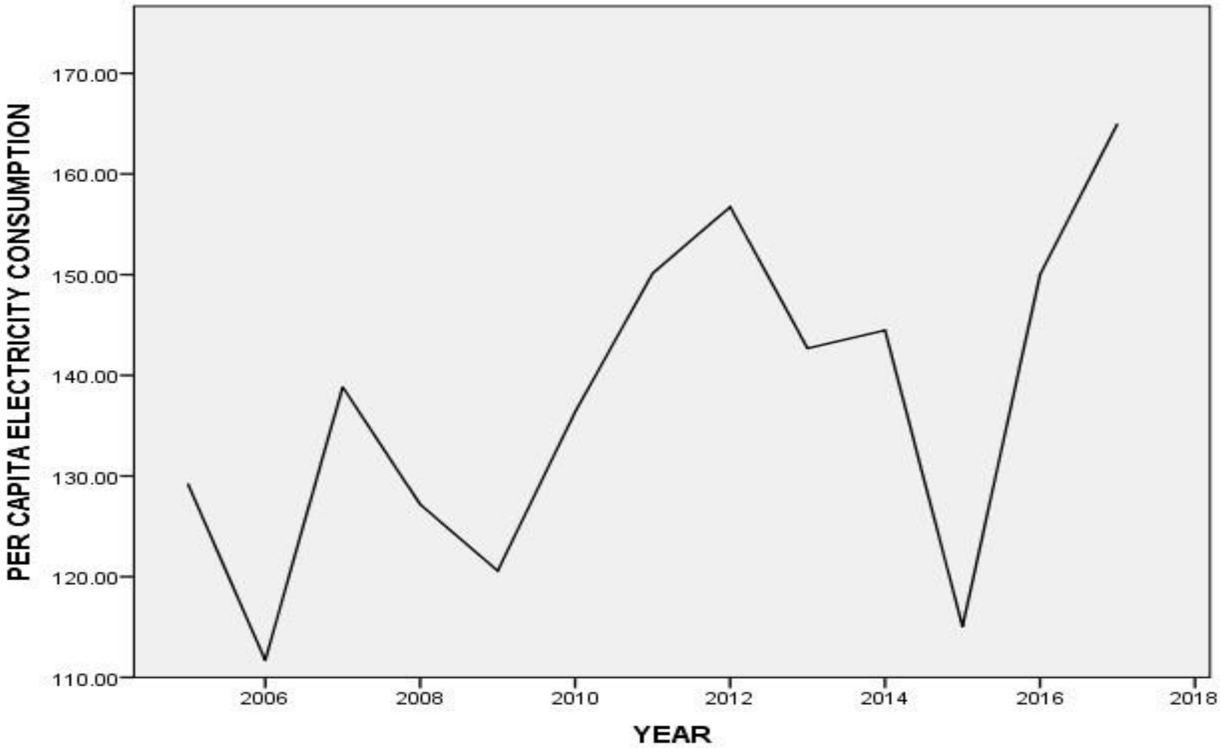

Figure 3: Per capita electricity consumption
Source: David and Omontuemhen (2006); Federal Ministry of Power, Works and Housing (2017); International Trade Administration (2015); World Bank Group **(2005 – 2014)**

Test of Hypotheses

H_O: Technological Linkage Capabilities do not influence the per capita electricity consumption in the Nigeria power sector between 2005 and 2017

For 2005 – 2012

Table 1: Model Summary

Model Summary

R	R	R Square	Adjusted R Square	Std. Error of the Estimate
.797[a]	.797[a]	.636	.490	10.63505

a. Predictors: (Constant), RESEARCH AND DEVELOPMENT, INVESTMENT IN COLLABORATIVE EFFORTS ***Source: Researcher's Computation, 2018***

Table 1 above shows that technological linkage capabilities-investment in collaborative efforts, and research and development have a positive relationship with per capita electricity consumption in Nigeria between the year 2005 and 2012 (R = 0.797). This means that, Technological Linkage

Capabilities influence the per capita electricity consumption in the Nigeria power sector between 2005 and 2012. The table further shows the extent to which investment in collaborative efforts, and research and development account for variation in per capita electricity consumption in Nigeria between 2005 and 2012. The coefficient of multiple determinations (R^2 = 0.636) shows that 63.60% of the change in per capita electricity consumption in Nigeria is accounted for by the investment in collaborative efforts, and research and development between 2005 and 2012. The result also shows that the Adjusted R-squared is 0.490 which means that, 49% of the variability of per capital electricity consumption is accounted for by the model, considering the number of predictor variables investment in collaborative efforts, and research and development-in the model. This result is statistically significant because the p-value of the result (0.030) is less than 0.05 level of significance used for this study as shown in Table 4.2. This implies there's a 0.030 probability of finding this sample regression, or a larger one if the actual population regression is zero. This study null hypothesis is therefore rejected for the year 2005-20012.

Table 2: Analysis of Variance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	986.927	2	493.463	4.363	.030[b]
	Residual	565.522	5	113.104		
	Total	1552.448	7			

a. Dependent Variable: PER CAPITA ELECTRICITY CONSUMPTION

b. Predictors: (Constant), RESEARCH AND DEVELOPMENT, INVESTMENT IN COLLABORATIVE EFFORTS

Source: Researcher's Computation, 2018

This Table 2 further indicates whether the regression model predicts the dependent variable-per capital electricity, consumption significantly well. The *p*-value (0.030) is less than 0.05, and indicates that, the overall regression model is statistically significant (i.e., it is a good fit for the data). The ANOVA result from same table suggests that there is a little significant difference between the means of investment in collaborative efforts, and research and development, and per capita electricity consumption in Nigeria between 2005 and 2012 through the F-ratio value (F= 4.363).

An evaluation of the unstandardized coefficients of investment in collaborative efforts, and research and development in the coefficient table (Table 4.3) and its associated p-values show that investment in collaborative efforts (β_{IC} = -4.579R-10, $p < 0.05$), and research and development (β R&D = 8.030E-9, $p < 0.05$) are statistically significant and can be used in predicting per capita electricity consumption in Nigeria between 2005 and 2012.

Per capital consumption = $127.703 - 4.579X_{11} + 8.030X_{12}$

Table 4.3: Regression Coefficient

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	127.703	6.320		20.207	.000
	INVESTMENT IN COLLABORATIVE EFFORTS	-4.579E-10	.000	-.198	-.658	.039
	RESEARCH AND DEVELOPMENT	8.030E-9	.000	.691	2.302	.040

a. Dependent Variable: PER CAPITA ELECTRICITY CONSUMPTION ***Source: Researcher's Computation, 2018***

2013 - 2017

Table 3: Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.996[a]	.991	.983	2.38079

a. Predictors: (Constant), RESEARCH AND DEVELOPMENT, INVESTMENT IN COLLABORATIVE EFFORTS

Source: Researcher's Computation, 2018

The model summary table (Table 3) above shows that technological linkage capabilities investment in collaborative efforts, and research and development have a positive relationship with per capita electricity consumption in Nigeria between the year 2013 and 2017-after the public private partnership arrangement (R = 0.996). This implies that as investment in collaborative efforts and investment in research and development improve, per capita electricity consumption in Nigeria increases between 2013 and 2017. The model further shows the extent to which investment in collaborative efforts, and research and development account for variation in per capita electricity consumption in Nigeria between 2013 and 2017. The coefficient of multiple determinations ($R^2 = 0.991$) shows that 99.10% of the change in per capita electricity consumption in Nigeria is accounted for by the investment in collaborative efforts, and research and development between 2013 and 2017. This result is statistically significant because the p-value of the result (0.009) is less than 0.05 (see Table 4.5) level of significance used for this study, which implies that there's a 0.009 probability of finding this sample regression (or a larger one) if the actual population regression is zero. The research null hypothesis is therefore rejected for the year 2013-2017.

Table 4: Analysis of Variance

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1304.750	2	652.375	115.094	.009[b]
	Residual	11.336	2	5.668		
	Total	1316.086	4			

a. Dependent Variable: PER CAPITA ELECTRICITY CONSUMPTION

b. Predictors: (Constant), RESEARCH AND DEVELOPMENT, INVESTMENT IN COLLABORATIVE EFFORTS

Source: Researcher's Computation, 2018

This Table 4 also indicates whether the regression model predicts the dependent variable (per capital electricity) consumption significantly well. The *p*-value (0.009) is less than 0.05, and indicates that, the overall regression model is statistically significant (i.e., it is a good fit for the data). The ANOVA result from same table suggests that there is a little significant difference between the means of investment in collaborative efforts, and research and development, and per capita electricity consumption in Nigeria between 2013 and 2017 through the F-ratio value (F= 115.094).

Table 5: Regression Coefficient

Coefficients[a]

Standardized Unstandardized Coefficients		Coefficients				
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	115.567	2.315		49.916	.000
	INVESTMENT IN COLLABORATIVE EFFORTS	-1.295E-7	.000	-1.397	-7.105	.019
	RESEARCH AND DEVELOPMENT	1.252E-8	.000	2.197	11.170	.008

a. Dependent Variable: PER CAPITA ELECTRICITY CONSUP CONSUMPTION

Source: Researcher's Computation, 2018

An evaluation of the unstandardized coefficients of investment in collaborative efforts, and research and development in the coefficient table (Table 4.4) and its associated p-values show that investment in collaborative efforts (β_{IC} = -1.295E-7, $p < 0.05$), and research and development (β R&D = 1.252E-8, $p < 0.05$) are statistically significant and can be used in predicting per capita electricity consumption in Nigeria between 2013 and 2017.

Per capital consumption = $115.567 - 1.295X_{11} + 1.252X_{12}$

As shown in Table 1 **to** 5, technological linkage capabilities-investment in collaborative efforts, and research and development have a positive relationship with per capita electricity consumption in Nigeria electric power sector in the pre and post PPP initiative. The pre-PPP study period (2005-2012) and post- PPP study period (2013-2017) show that (R = 0.797; p-value = 0.030 < 0.05) and (R = 0.096; p-value = 0.009 < 0.05) respectively and are thus statistically significant. This result agrees with the outcome of the study of (Lei Jin & Tang, 2018) as identified in the empirical framework.

Also based on the Unstandardized Coefficients (β) in Table 4.3, this study expected a decrease of 4.579E-10 in per capital electricity consumption for every unit increase in investment in collaborative efforts assuming research and development is held constant, and an increase of 8.030E-9. for every unit increase in research and development assuming investment in collaborative efforts is held constant for the pre-PPP study period. While for the post-PPP study period as shown in Table 4.6, this study expected a decrease of 1.295E-7 in per capital electricity consumption for every unit increase in investment in collaborative efforts assuming research and development is held constant, and an increase of 1.253E-8. for every unit increase in research and development assuming investment in collaborative efforts is held constant. This shows that policy makers have to be careful with indicators that show an inverse proportion on the dependent variable. For example, investment in collaborative effort that shows an expected decrease in per capital electricity consumption for every unit increase its investment before and after the PPP initiative. This analysis based on table 4.3 above, confirmed the study of Cerna (2013) that failed policies are sometimes due to wrong choice of variables or indicators in its formation. But it could also be the reason why researches like Veiko, Ole, Walter and Robert (2014) are of the opinion that the link between PPP and innovation is, not well clarified, as a variable that is expected to cause a drastic improvement could have an unexpected outcome.

Discussion of Results and Findings

The charts in Figure1 and Figure 2 shows that there is a decrease in the Nigeria government commitment to TLC intensity through financial commitment to collaboration effort after the PPP agreement was implemented. While investment in R&D shows otherwise. This shows that the government collaboration efforts after the PPP initiative decreases in the power sector of Nigeria This could be as a result of the transferred of the technology infrastructural development to the private investors while the management of the power sector divert its attention to developing innovative strategies through R&D. This form of agreement is based on the Transaction cost economics theory identified by Koschatzky (2017), as the management of the Nigeria power sector took advantage of the cooperate agreements with the private investors in the PPP initiative as the most efficient process of reorganising the organisation for effective service delivery. However, this is in contrast to the view of researchers like Oluwale, Ilori, and Oyebisi (2013) that believed such policy decision reduce the intensity of innovation diffusion and invariably technological linkage capability between a system and its environment. This may explain why an increase in investment in collaborative efforts assuming research and development is held constant based on the Unstandardized Coefficients (β) in Table 4.3, gives an unexpected decrease in per capital electricity consumption both in the pre and post PPP initiative. As innovation diffusion and invariably technological linkage capability can both be improve through collaborative efforts (Sten, 2021)

Table 6: Summary of R and R^2 for the Research Hypotheses

S/N	HYPOTHESES	MULTIPLE CORRELATION (R)		COEFFICIENT OF MULTIPLE DETERMINATION (R^2)	
		2005 – 2012	2013 – 2017	2005 – 2012	2013 – 2017
1	Hypothesis	79.70%	99.60%	63.60%	99.10%

Source: Researcher's Computation (2018)

The inferential statistical outcome of this study agrees with the finding of several other studies like Obembe, Ojo, and Ilori (2014); Oluwale, Ilori, and Oyebisi (2013); Siyanbola, Adeyeye, Olaopa, and Hassan (2016) etc. This outcome shows a positive significant relationship between TLC, indicators chosen and the corresponding capita electricity consumption in the Nigeria power sector over this study period. But a critical examination of the above summary Table 6 for the inferential statistics shows that the post PPP era exhibits a stronger strength of association between the independent and the dependent variables for the hypothesis. This should be expected because as the commitment of the management of the power sector to TI intensity reduces in the post PPP era, the performance improvement increased at approximately the same rate. This mean whatever TI effort the private investors added to the sector did not make an effect that surpassed what is achieved in the pre-PPP era for the study period. This is not in agreement with the view of Ugwu, (2012) who is of the opinion that PPP implementation results in a drastic improvement innovation and the systems where applied.

Also, the descriptive presentation of the performance data-charts shows that the PPP model did not have the same effect in Nigeria when compared with some per-set economies like Vietnam.
Neither does the initiative result in a drastic change in improved performance during this study period. This is because an observation of the performance indicators in Figure.4.3 shows a similar average positive change in performance during the pre and post PPP initiative implementation.
Hence, this study concluded that, though TLC as an indicator to measure TI has a positive effect on performance to collaborate past studies, the PPP initiative did not provide a better TI intensity based on the information available and the study period under observation. Thus, not all variables in policy formation have a good influence on the policy. This can be observed as the investment in collaborative effort shows a decrease in per capital electricity consumption for every unit increase its investment before and after the PPP initiative.

Policy implementation of the study

- Policy makers have to be careful with indicators that shows an inverse proportion on the dependent variable. This is to be able to develop TI investment policy that add value to the sector, the management of the power sector should identify the right/significant indicators that can cause a drastic change in performance.
- A need for periodic review of individual indicators and variable that are expected to add values to the performance.
- A need to develop the strategic balance between planning and implementation.
- A need to review the technical and the financial capabilities of existing and new investors

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