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ABSTRACT

This paper provides evidence on the role of corruption in mitigating the effect of electricity outages on firm performance across the six geo-political zones in Nigeria. In addition, this study also assessed effect of self-generation on firm performance across the six geo-political zones and comparison were made as to whether it is more profitable for firms to self-generate electricity during outage periods or bribe electricity officials to mitigates the effect of electricity outages on their performance. Using the World Bank Enterprise Survey (WBES), the study employed a cross sectional Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) techniques and the results of the findings indicate that, bribery does not mitigate the effect of electricity outages on firms across all the geo-political zones in Nigeria with exception of the North-East and the South-East geo-political zones. Although, electricity outage is relatively low in the North-East region, further findings revealed that; firms in the south-east region experience the highest outage intensity of an average of 122.025 times in a typical month, while those in the South-South region experience the lowest outage intensity of an average of 25.845times in a typical month. Lastly, contrary to the arguments in the literature that self-generation during power holidays improves firm performance, evidence from this study suggests otherwise for some geo-political zones in Nigeria. For instance, this study discovered that self-generation is a form of indirect tax which has a negative effect on firm performance especially the North-West, South-West and South-South geo-political zones. Also, while it is more profitable for firms in the North-Central, North East, and South-East regions to self-generate during power holidays, the findings for North-West, South-West and South-South geo-political zones reveal that firms in the zones are better off by relying on electricity supply from the public grid.

Keywords: Electricity Outages; Bribery; Self-Generation; Firm Performance

JEL CLASSIFICATION: D20, Q41, L10

1.0 Introduction

1.1 Research Issues and Motivation for the Study

Access to quality and reliable electricity supply is regarded as the main conduits of economic growth and development in any part of the world. Unfortunately, in many developing countries today, access to quality and reliable electricity supply is abysmal. According to United Nations (2015) over 1.2 billion people globally live without electricity and 1 billion more people have access to poor and unreliable electricity supply. Out of these statistics the African continent constitute about 600million people living without access to electricity (WBES, 2016). In Nigeria, alone about more than 63 million people mostly in the rural communities live without access to electricity while the population with access to electricity endures frequent power outages which last for several hours or days (Leo et *al.*, 2014).

Poor access to quality and reliable electricity hampers or completely halt business and economic activities thereby leading to poor economic growth and development. On the other hand, access to quality and reliable electricity supply leads to sustainable economic growth, rapid industrialization, improved standard of living, decline in unemployment and poverty rate (Jorgenson, 1984; Toman & Jemelkoya 2003; Modi et *al.,* 2005; Ozturk, 2010; Bacon & Kojima, 2016; Stern et *al.*, 2017). Evidence from empirical studies, lend credence to these facts. For instance, Rud (2011) examined the effect of rural electricity provision on industrial output in India and found a significant positive relationship between rural electrification and industrial output. In the same light, Fisher-Vaden et *al.,* (2015) analysed the effects of electricity shortages on firm productivity in China and shows significant output and revenue losses due to outages. Doe and Emmanuel (2016) demonstrated that poor electricity leads to decline in output, revenue and firm's profit in Ghana; Abotsi (2016) also shows that power failure reduces the production efficiency of firms in most African countries; Mensah (2016) found power failure to have a negative effect on manufacturing output in Sub-Saharan Africa (SSA). In spite of these overwhelming evidence in the economic literature and government intervention in the sector for many decades, access to quality and uninterrupted electricity supply in Nigeria has continued remained poor. According to World Bank (2015), the average outage intensity in Nigeria is 32.8 in a typical month, which is adjudged to be the highest in SSA (Eifert et *al.,* 2008; Alby et *al.,* 2012; Mensah 2016).

Poor electricity supply is one of the major obstacle to economic growth and development in Nigeria. It is responsible for the loss of output amounting to US$470billion (N71 trillion) measured in terms of Gross Domestic Product (GDP) between 1999 and 2015 (Iwayemi, 2018). Also, poor access to electricity has been identified to be a major obstacle to business operations in Nigeria. For example, about 35.5% of firms reported to have identified electricity outages as a major setback to their business performance (WBES, 2014).

Unreliable electricity supply in Nigeria, is linked to poor power infrastructure facilities (Iwayemi, 2018). However, improving electricity supply from the grid does not entirely rest on investing in physical electrical infrastructures. The problems are much deeper which goes beyond the electricity industry and maybe closely linked to areas such as corruption, political institutions and governance (Pless & Fell 2017). Hence, what determines electricity outages are very complex and may be of interest to the policy makers, profit oriented enterprises and households. It is against this background that this paper will seek to investigate the role of corruption in mitigating the effect of electricity outages on firm performance across the six geo-political zones in Nigeria.

In this paper we further advance the literatures in the field of energy economics and industrial organizations by offering the following innovations. First, we account for the role of corruption in mitigating the effect of electricity outages on firm performance across the six geo-political zones in Ngeria and thereafter made comparison whether it is more profitable to bribe electricity officials or self-generate electricity during outage periods. A review of recent studies in the literature reveals three strands of literature which are categorised into the following. The first strand focuses on the relationship between electricity outages and firm performance (see for example Eifert et al, 2008; Steinbuks and Foster, 2010; Rud, 2011; Alby et al, 2012; Alam, 2013; Cissokho & Seck, 2013; Allcott, 2014; Doe & Emmanuel, 2014; Fisher-Vanden et *al.*, 2014; and Abeberese, 2016; Abotsi, 2016; Mensah, 2016; and Arlet, 2017). The second strand of the literature examined the relationship between corruption and firm performance (see for example Johnson et al, 2000; Fisman and Svesson, 2007; Vial and Hanoteau, 2010; Wu, 2008; Lee et al, 2010; De Rosa et al, 2010; Abudu, 2017 and Okafor, 2017). While the third strand examined the relationship between bribery and electricity reliability (Pless & Fell, 2017). In spite of the increasing number of literatures on this subject, there is no study yet at least to the best our knowledge that attempts to examine the role of corruption in mitigating the effect of electricity on firm performance.

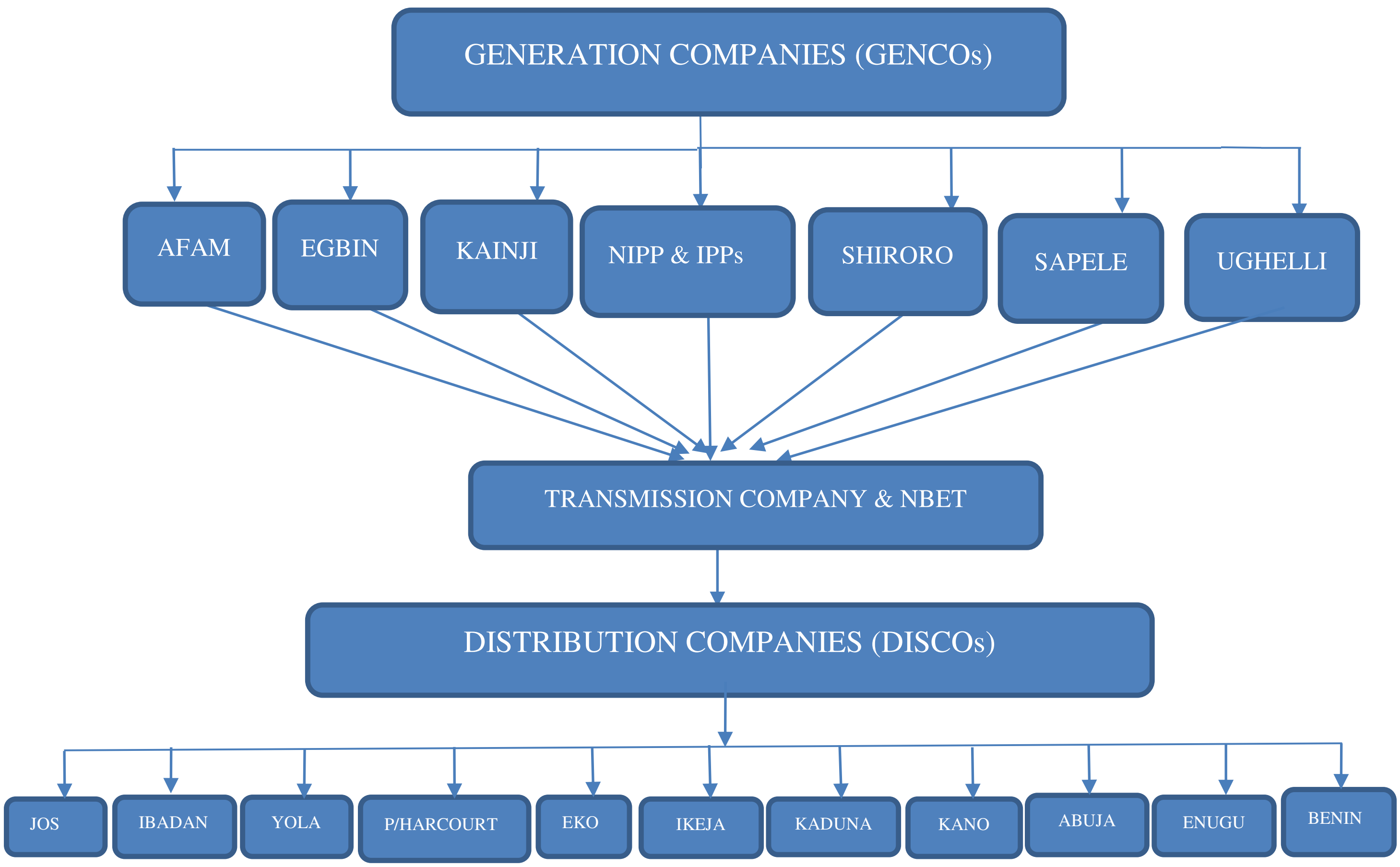
In addition, we control for endogeneity effect which has been neglected by previous studies. The problem of endogeneity biasness arises when an endogenous variable correlates with the error term in a model. For this study, we suspect that there may be need to control for any potential endogeneity problem that may result from our predictors of firm performance (self-generation and electricity outages). The problem of endogeneity is expected for convenience and to separate the predictors of self-generation and electricity outage in firm performance. It is essential to suspect such biasness especially where there is strong relationship between the regressors and the error terms in our regression model. Thus, given the significance of the endogeneity effect on the dependent variable, accounting for it becomes very necessary in this paper.

1.2 The Structure of the Nigerian Electricity Sector

The structure of the Nigerian electricity constitutes the Generation Companies (GENCOs), Distribution Companies (DISCOs), Transmission Company of Nigeria and the Nigeria Electricity Regulatory Commission (NERC). The structure of the electricity GENCOs comprises six companies out of which four are gas power plants and two are hydro power plants. The gas power plants include: Afam, Egbin, Sapele and Ughelli power plants and the hydro power plants include the Kainji and Shiroro power plants as observed in Figure 2.1 below. From the forgone it can be said that the structure of the GENCOs is largely dominated by gas power plants. In 2016 it was reported that the gas power plants constitute about 86% of the total electricity generation while the remaining 14% is generated from hydroelectric power plants. The dominance of gas power plants in the Nigerian electricity industry indicates the massive investment in gas generating power plants capacity as a results of the large deposit of natural gas in the country. For instance, natural gas reserves in Nigeria has been estimated to be around 192 trillion standard cubic feet, making it the ninth largest natural gas reserves in the world. However, in recent years' gas supply to power stations for electricity generation, has declined significantly due to frequent gas pipeline vandalization mostly driven by militancy activities within the Niger Delta region. Similarly, the electricity generation from hydro power has been reported to have dwindled in recent times as a result of the global climate change which affect the water cycle (Iwayemi, 2018).

On the other hand, the structure of the electricity DISCOs comprises eleven companies namely, Abuja, Benin, Eko, Enugu, Ibadan, Ikeja, Jos, Kano, Kaduna, Port Harcourt and Yola DISCOs covering the entire 36 states of Nigeria including the FCT. The DISCOs are separate entities but are responsible in buying electricity units in bulk from the transmission company and selling in smaller units to households and industries within their respective regions. While the transmission and regulatory activities is carried out by the government through the Transmission Company of Nigeria (TCN) and the Nigerian Electricity Regulatory Commission (NERC) respectively (Iwayemi, 2018).

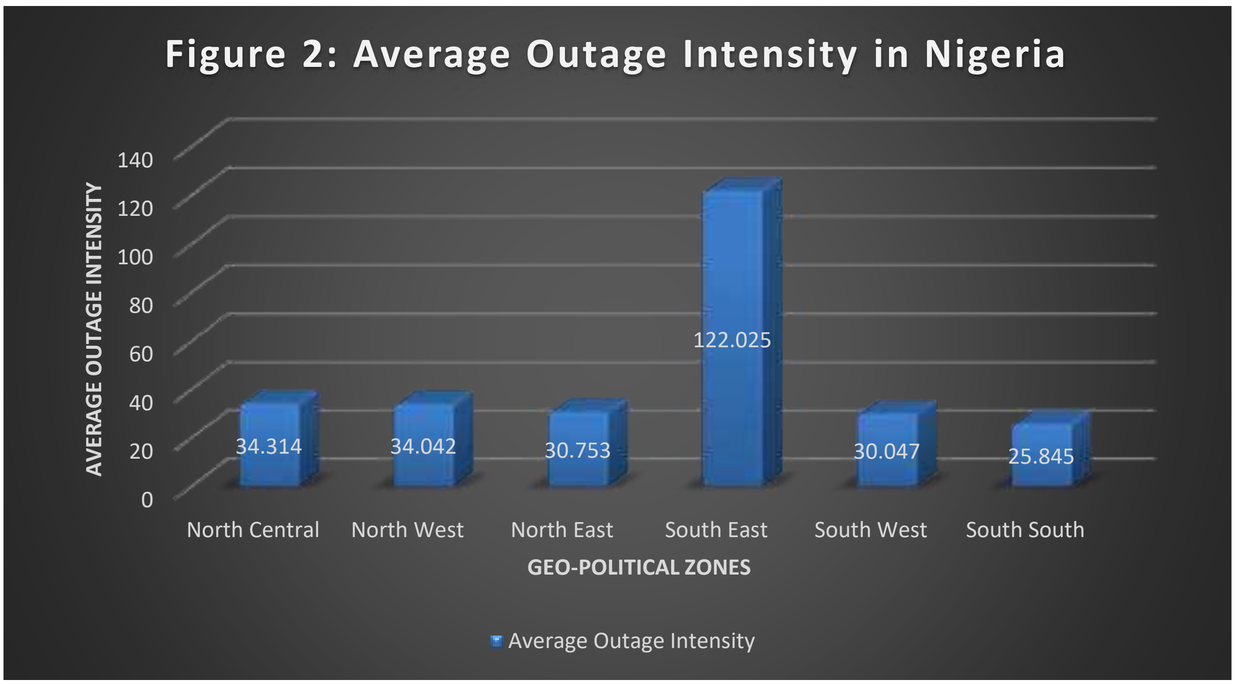
Figure 1: The Structure of the Nigerian Electricity Market-The Supply Side



Source: NERC, 2016

1.3 Overview of Outage Intensity in Nigeria

Over the years, electricity outages have continued to remain a major constrain to business activities across the nooks and crannies of Nigeria. Unreliable power supply has completely halted many businesses and also contributed to the mass exodus of firms from Nigeria to other neighbouring West African countries where electricity supply is relatively stable. The poor electricity supply in Nigeria is further shown in Figure 2 below. The figure reported the average outage intensity in a typical month for some selected firms across the six geo-political zones. It is observed that the South-East region has the highest outage intensity with an average outage intensity of about 122.025 in a typical month when compared to 34.314 in North-Central, 34.042 in North-West, 30.753 in North-East, 30.047 in South-West and 25.845 in South-South regions. This is not surprising because the region reported to have recorded the highest outage intensity of about 2000 as compared to 1000 in the North-Central, 630 in the North-West, 372 in the South-West, 200 in the North-East and lastly 100 in the South-South region.



Source: Authors' Computation from World Bank Enterprise Survey, 2014

2.0 Literature Review

A review of empirical literature reveals that studies on electricity outages, corruption and firm performance have occupied a substantial body of energy and industrial economics literature in recent times. Several studies have been carried out on the relationship between electricity outages and firm performance for both single and cross country in which their findings agreed with each other. For example, Adenikinju (2005) investigated the impact of electricity failure in developing countries using Nigeria as a case study. He reported that frequent power outages affect business firms negatively but the impact is severe on Small and Medium Scale Enterprises (SMEs). Similarly, in more recent study, Arlet (2017) examined the impact of electricity tariffs, power outages on firm performance using firm level survey data from 190 countries, the study found power outage to have a negative impact on firm performance across the globe. However, the impact is severe on small and medium scale enterprises. Other studies in the literature (see for example Eifert et al, 2008; Steinbuks and Foster, 2010; Rud, 2011; Alby et al, 2012; Alam, 2013; Cissokho & Seck, 2013; Allcott, 2014; Doe & Emmanuel, 2014; Fisher-Vanden et *al.*, 2014; and Abeberese, 2016; Abotsi, 2016; Mensah, 2016) also found electricity outages to have a negative impact on firm performance.

On the other hand, studies on corruption and firm performance reveals mixed findings. Some studies (see for example Johnson et al, 2000; Fisman & Svesson, 2007; Wu, 2008; Lee et al, 2010; De Rosa et al, 2010; Abudu, 2017 and Okafor, 2017) found corruption to have a negative impact on firm performance for both single and cross country analysis. In contrast, Vial and Hanoteau (2010) found corruption to have a positive effect on the firm performance in Indonesia. Their findings endorse the "grease to the wheels" hypothesis where firms that give higher financial inducement have improved performance.
Empirical studies on corruption and electricity are very scarce and recent. The only study so far to the best of our knowledge is by Pless and Fell (2017) on the effect of bribery on electricity reliability. The study found that frequent power outages increase the tendency of firms to give bribe to electricity officials. The findings revealed that the likelihood to bribe for an electricity connection is associated with an increase of about 14 power outages per month. Further findings also reveal that frequent power failure has significant negative impact on firms' sales revenue. Thus, the revenue loss due to frequent power outages is average to about 22% globally.

3.0 Theoretical Framework and Methodology

3.1 Theoretical Framework

This study is built on the theories of production, revenue and cost which combines to measure firm's profit. Profit in economics is the difference between the revenue a firm receives and the costs a firm incurs to produce its goods and services. The theory emphasizes the need for firms to take into account all the cost (both implicit and explicit cost) incurs as well as all the revenue received in the calculation of profit. Both revenues and costs of a firm largely depends on the actions taken by the firm. These actions may take many forms: actual production activities, purchase of factors, advertisement are all examples of actions taken by firms in its daily routine (Varian, 1992). Following the definition of profit, a representative firm will measure profit as the difference between its total revenue and total cost as specified below:

$$\boldsymbol{\pi_i = R_i - C_i} \qquad \textbf{(1)}$$

Where $\boldsymbol{R_i}$ is the total revenue function and $\boldsymbol{C_i}$ is the total cost function
The revenue and cost functions are specified in an explicit form as follows:

Total Revenue function = $\mathbf{R}(\boldsymbol{P_y}\mathbf{Y})$ **(2)**

Total Cost function = $\mathbf{C}(\boldsymbol{P_i}\mathbf{Y})$ **(3)**

Where $\boldsymbol{P_y}$ is the unit price of output; $\boldsymbol{P_i}$ is the unit price of input; and **Y** represent the quantity
Substituting equation 4.2 and 4.3 into equation 4.1 we obtain the following profit function:

$$\boldsymbol{\pi_i} = \mathbf{R}(\boldsymbol{P_y}\mathbf{Y}) - \mathbf{C}(\boldsymbol{P_i}\mathbf{Y}) \qquad \textbf{(4)}$$

Holding the price of product and input constant, equation 4.4 is re-specify as follow:

$$\boldsymbol{\pi_i} = \mathbf{R(Y) - C(Y)} \qquad \textbf{(5)}$$

But, R(Y) - C(Y) is also equivalent to $\boldsymbol{\pi_i}\mathbf{(Y)}$

Therefore, the profit function can also be specified as follows

$$\pi_i = f(\mathrm{Y}) \qquad (6)$$

Where Y = f (A, K, L, M)

By using an extended Cobb-Douglas production function, we assume a representative firm *i* in an industry *j* operating in a perfectly competitive market produces output Y_i at time *t* by employing factor inputs such as *Capital* "K", *Labor* "L", *Materials* "M", and *Electricity* "E" with production efficiency of the firm represented by A. The function is specified as follow:

$$Y_{it} = f\,(A_{it}\,, K_{it}^{\beta_1}\,, L_{it}^{\beta_2}\,, M_{it}^{\beta_3}, E_{it}^{\beta_4}) \qquad (7)$$

Where $\beta_1, \beta_2, \beta_3,\ and\ \beta_4$ are factors share of Capital "K", Labor "L", Materials "M", and *Electricity* "E" respectively. While "A_{it} represent the *factor productivity.*

Substituting equation (7) in to equation 4.6 we obtain:

$$\pi_i = f\,(A_{it}\,, K_{it}^{\beta_1}\,, L_{it}^{\beta_2}\,, M_{it}^{\beta_3}, E_{it}^{\beta_4}) \qquad (8)$$

In reality no firm operates in a perfectly competitive environment, but in an imperfect market where access to factor inputs such as electricity is limited. Therefore, this study denotes the probability of having access to electricity input as ψ, such that ψ ϵ (0, 1). Hence, ψ < 1 when there is no reliable electricity supply from the national grid; while ψ = 1 implies the case where there is perfect supply of electricity as assumed by the production function in equation (7) above. Hence, this study ignored the case where ψ = 0 in this analysis as its represent a situation where there is absolutely no access to electricity supply.

During power outages, firms are usually faced with three options: stop production; generate their own electricity using generators or bribe electricity officials to secure constant electricity supply from the grid. Thus, the total electricity inputs to firms can be said to be equal to the linear combination of electricity inputs from the national grid (E_{NG}) and self-generation (E_{SG}). Thus, this is expressed as follows:

$$E_{it} = [\psi E_{NG,it} + (1-\psi)E_{SG,it}] \qquad (9)$$

Where E_{it} represent the *total electricity supply inputs* to firms; $E_{NG,it}$ is the electricity inputs from the *national grid;* while $E_{SG,it}$ is the inputs from *self-generation.* The equation of firms operating under electricity constrain, is obtained by modifying equation (8) to incorporate electricity access constraint in equation (9) and *vector of control variables* "Z_{it}" as follows:

$$\pi_{it} = A_{it}\, K_{it}^{\beta_1}\, L_{it}^{\beta_2}\, M_{it}^{\beta_3}[\psi E_{NG,it} + (1-\psi)E_{SG,it}]^{\beta_4}\, Z^{\Phi} \qquad (10)$$

Where time "t" is equal to zero in a cross sectional study. Thus, Equation (10) can be re-specified as follows:

$$\pi_i = A_i\, K_i^{\beta_1}\, L_i^{\beta_2}\, M_i^{\beta_3} E_i^{\beta_4}\, [\frac{\psi E_{NG,i}+(1-\psi)E_{SG,i}}{E_i}]^{\beta_4}\, Z^{\Phi} \qquad (11)$$

If we set $D_i = [\frac{\psi E_{NG,i}+(1-\psi)E_{SG,i}}{E_i}]^{\beta_4}$; where $0 \le D_i \le 1$ and D_i measures the weighted sum of self-generation and national grid share of the total electricity supply raise to power β_E. If we substitute D_i in equation (4.4) we obtain:

$$\pi_i = A_i\, K_i^{\beta_1}\, L_i^{\beta_2}\, M_i^{\beta_3} E_i^{\beta_4} D_i Z^{\Phi} \qquad (12)$$

To ascertain the impact of poor electricity supply on firm performance, we linearized equation (12) by taking the natural logarithm of all the variables in the model, with the exception of profit, since negative series cannot be logged.

$$\pi_i = LogA_i + \beta_1\, LogK_i + \beta_2 LogL_i + \beta_3 LogM_i + \beta_4 LogE_i + LogD_i + \phi LogZ_{1,i} + \varepsilon_{1,i} \qquad (13)$$

By representing the log of variables in equation (13) in a lower case form, we obtain equation (14) as specified below

$$\boldsymbol{\pi_i = a_i + \beta_1 k_i + \beta_2 l_i + \beta_3 m_i + \beta_4 e_i + d_i + \phi z_{1,i} + \varepsilon_{1,i}} \quad \textbf{(15)}$$

The Total Factor Productivity (TFP) from equation (7) is equal to a_i+ d_i, where a_i> 0 and $d_i \epsilon$ (-∞, 0). To ascertain the role of bribery in mitigating the effect of electricity outages on firm performance, we considered the following scenarios.

Case 1: Bribery for Electricity Supply: - Assume a firm experience unreliable power supply and choose to bribe electricity officials to increase its share of electricity supply from the grid than self-generate such that ψ = 1, $E_{SG,i}$= 0, $E_{NG,i}$= E_i and D_i= 1, then d_i= 0 and the total factor productivity will be equal to a_i. In this scenario, firm level output is unaffected, however, the firm incurs additional cost which directly affects its profit, since bribery is like a form of tax.

Case 2: Unreliable Electricity Supply without Self-generation: - Assume a firm experience frequent power outages and does not generate its own electricity, such that ψ < 1, $E_{SG,i}$= 0, $E_{NG,i}$< E_i and D_i< 1, then d_i< 0 and the Total Factor Productivity (TFP) will be less than a_i. Thus, when firms do not self-generate to augment for the absence of electricity, their output level decreases within the period and consequently revenue and profit of the firm in question declines.

Case 3: Unreliable Electricity Supply with Partial Self-generation: - Assume another scenario where firms generate their own electricity during power outages, nevertheless, the quantity generated is not sufficient to compensate for the shortages created by the outages such that ψ < 1, $E_{SG,i}$> 0, but $\psi E_{NG,i} + (1-\psi)E_{SG,i} < E_i$, thus D_i< 1. This implies that d_i will be greater than zero but still be less than one and the firm level output will also be less than a_{it}, however the output losses will be less than case 2. In this case, both the revenue and cost are affected and the profit depends on the magnitude of the revenue and the associated cost of partial self-generation by firms.

Case 4: Unreliable Electricity Supply with full Self-generation: - Lastly**,** this study assumes a case whereby firm experience power outages but self-generate to compensate for this shortages such that ψ < 1, $E_{SG,i}$> 0, and $\psi E_{NG,i} + (1-\psi)E_{SG,i}$= E_i, hence, D_i= 1. Consequently, d_i=1 and the firm level output is equal to a_i. This implies that firm level output is not affected by the frequent electricity outages. In this scenario, firm performance may be sustainable in the short run, however due to the rapid increase in the cost of self-generation, profit is likely to decline in the long run. This has been confirmed by past literatures who argued that self-generation is rarely sustainable beyond the short run. According to Steinbuks & Foster (2010) in their study revealed that in many developing countries such as Nigeria, the cost of self-generating an in-house electricity is very high when compared to the cost of purchasing electricity from the public grid. For example, the cost of in-house electricity generation in Africa has been estimated to fall within US$ 0.30-0.70 per kilo watt-hour as against the cost of purchasing electricity from the public grid at US$ 0.14 per kilo watt-hour (Steinbuks & Foster 2010; AfDB, 2013; Mensah, 2016).

Equation (4.15) shows that firm performance proxy by profit depends on capital (k_i), labor (l_i), material inputs (m_i), Poorer electricity supply (e_i) which is measured by power outage intensity and vector of control variables (z_i). Thus, the real impact of electricity outages β_4 on firm performance in equation (15) can only be estimated when the outage intensity variable in the model is *exogenous*. However, this is not the case because outage intensity is always *endogenous* as established by empirical studies (Mensah 2016; Pless & Fell 2017). Therefore, it is likely to correlate with the error term or other explanatory variables in model. For example, outage intensity could be correlated with other determinants of firm performance such as size, age, capital intensity, human capital, industry, business environment etc thereby yielding a bias and inefficient estimate.

Similarly, the model for electricity supply is rooted in the theory of production. The theory argued that a firm produces output from various combination of inputs in a given period of time. Since electricity supply is a form of output which depends on electricity supply from public grid and firm's ability to self-generate during power outage. Thus, the production function is modified to take the following functional form:

$$E_i = f(E_{sg,i}, E_{ng,i}) \quad \textbf{(16)}$$

Where E_i= Total electricity supply; $E_{sg,i}$= Electricity from self-generation; $E_{ng,i}$=electricity from grid.

Although, electricity supply from grid is a major determinant of the total electricity supply to a particular firm, its supply however could depend on the payment of bribe to electricity officials and other factors. The influence of bribery on electricity is clearly explained by institutional theory. The theory states that the business environment which a firm operates exert great influence on firm's decision to bribe in order to obtain a favorable service. Since electricity is expected to be endogenous, this study therefore, adopted and modified the simple model developed by Pless and Fell (2017) to include firm's ability to self-generate during outage hours and other vector of control variables. The model is presented as follows:

Hence, electricity supply from grid is specified as follows:

$$E_{ng,i} = f(BRIBE_i, Z) \quad \textbf{(17)}$$

Substituting equation (17) into equation (16) we obtain the following:

$$E_i = f(E_{sg,i}, BRIBE_i, Z) \quad \textbf{(18)}$$

To ascertain the impact of bribe on electricity supply, we linearized equation (18) by taking the natural logarithm as expressed below:

$$LogE_i = \alpha_0 + \alpha_1 \, Log\, BRIBE_i + \alpha_2 E_{sg,i} + \lambda LogZ_{2,i} + \varepsilon_{2,i} \quad \textbf{(19)}$$

By representing the log of variables in equation (19) in a lower case form, we obtain equation (20) as specified below:

$$e_i = \alpha_0 + \alpha_1 bribe_i + \alpha_2 e_{sg,i} + \lambda z_{2,i} + \varepsilon_{2,i} \quad \textbf{(20)}$$

Where e_i represent *electricity supply intensity;* $e_{sg,i}$ represent self-generation electricity by firms; "$bribe_i$" represent *bribe payment for electricity supply* and "z" is the *vector of control variables*.

In order to solve for the direct and indirect effects of bribery and electricity outages on firm performance we estimate equation (15) and (20)

$$\pi_i = a_i + \beta_1 k_i + \beta_2 l_i + \beta_3 m_i + \beta_4 e_i + d_i + \phi z_{1,i}$$

$$e_i = \alpha_0 + \alpha_1 bribe_i + \alpha_2 e_{sg,i} + \lambda z_{2,i}$$

From the above set of equations, we obtained:

The direct effect of electricity outages on firm performance $= \frac{\partial \pi_i}{\partial e_i} = \beta_4$

The direct effect of bribery on electricity outages $= \frac{\partial e_i}{\partial bribe_i} = \alpha_1$

Thus, the role of bribery in moderating the effect of electricity outage on firm performance is

$$\frac{\partial \pi_i}{\partial bribe_i} = \frac{\partial \pi_i}{\partial e_i} * \frac{\partial e_i}{\partial bribe_i} = \beta_4 * \alpha_1$$

3.1.1 Research Hypothesis

In line with our model, the following research hypothesis will be tested:

H_1: Power outage intensity is significant in determining the level of firm performance

$\boldsymbol{H_2}$: Bribe payment plays a significant role in determining the impact of power outages on firm performance

$\boldsymbol{H_3}$: Self-generation of electricity is significant in determining firm performance

$\boldsymbol{H_4}$: Self-generation of electricity plays a significant role in firm performance than bribe payment for electricity supply

3.2 METHODOLOGY

3.2.1 Model Specification

This study specified two models. The first model estimates the role of bribery in mitigating the effect of electricity outages on firm performance, while the second model estimates the effect of self-generation on firm performance.

Model 1 shows the linkage between bribery and firm performance via power outage channel. The model explains the role of bribery in mitigating the effect of electricity outages on performance of firms across the six geo-political zones. Evidence from empirical studies reveals that electricity outage in equation (21) is endogenous as it is determined by bribery for electricity supply and electricity self-generation. Thus, to estimate the effects of electricity outage and bribery on firm performance, the study specified model 1 as follows:

$$\boldsymbol{\pi_i = \beta_0 + \beta_1 k_i + \beta_2 l_i + \beta_3 m_i + \beta_4 e_i + \phi_1 fsz_i + \phi_2 age_i + \phi_3 com_i + \phi_4 exp_i + \phi_5 fow_i + \phi_6 Sec_i + \phi_7 bribe_i + \phi_8 sales_i + \varepsilon_{1,i}} \quad \textbf{(21)}$$

$$\boldsymbol{e_i = \alpha_0 + \alpha_1 bribe_{it} + \alpha_2 e_{sg,i} + \lambda_1 sales_i + \lambda_2 fsz_i + \varepsilon_{2,i}} \quad \textbf{(22)}$$

Where π_i is a measure of *firm performance*; k_i represent *capital intensity* which measures the amount of money invested in *physical assets*; $l_i$is a measure of the percentage of *skilled labor* employed; m_i is the cost of *material inputs*; e_i measures *outage intensity*; fsz_i is *firm size*; com_i is the *degree of competition*; exp_i represent percentage of *firm share of export* to total goods produced; fow_i measures the percentage *of foreign ownership*; sec_i is the *percentage of sales spent on security*; $bribe_i$ represent *bribe payment for electricity connection*; $e_{sg,i}$ measures the percentage of *electricity from generator*; $sales_i$ measures firms' *total annual sales revenue*; and finally $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are the error terms.

Model 2 simulates the effects of self-generation of electricity on firm performance by adopting and modifying the model developed by Mensah (2016). The model demonstrates a case whereby firms, instead of bribing to increase their share of electricity supply from the national grid, choose to generate in-house power to compensate for electricity shortage during outage periods. Self-generation in equation (23) is endogenous. This is expected because it self-generation is determined by the outage intensity, fuel cost and vector of control variables. The model is thus, presented below:

$$\boldsymbol{\pi_i = \beta_0 + \beta_1 k_i + \beta_2 l_i + \beta_3 m_i + \beta_4 e_{sgi} + \phi_1 fsz_i + \phi_2 age_i + \phi_3 com_i + \phi_4 exp_i + \phi_5 fow_i + \phi_6 Sec_i + \phi_7 sales_i + \varepsilon_{3,i}} \quad \textbf{(23)}$$

$$\boldsymbol{e_{sgi} = \alpha_0 + \alpha_1 e_i + \lambda_1 fuel\ Cost_i + \lambda_2 sales_i + \lambda_3 fsz_i + \varepsilon_{4,i}} \quad \textbf{(24)}$$

Where π_i is also a measure of *firm performance*; k_i is the *capital intensity* which measures the amount of money invested in *physical assets*; $l_i$is a measure of the percentage of *skilled labor* employed; m_i is the cost of *material inputs*; e_{sgi} represent *self-generation of electricity*; fsz_i is *firm size*; com_i is the *degree of competition*; exp_i represent *firm share of export* to total goods produced; fow_i measures the percentage *of foreign ownership*; sec_i is the *percentage of sales spent on security*; e_i measures electricity *outage intensity;* $sales_i$ measures the firms' *total annual sales revenue;* and finally, $\varepsilon_{3,i}$ and $\varepsilon_{4,i}$ are the error terms.

3.2.2 Definition and Measurement of Variables

The key variables used in this study are firm performance, capital intensity, percentage of skilled labor, cost of material inputs, power outage intensity, self-generating firms, and bribery for electricity connection. While control variables are: firm size, degree of competition, firm share of export, foreign ownership, difficulty in accessing finance, cost of security, research and development, generator ownership, private ownership and total annual sales.

Firm Performance: This study considers the economic approach to measuring firm performance. This approach measures the profitability of firms which is very essential because it allow us to view firm performance in terms of financial viability. Additionally, this measure can be used for all kinds of businesses to ascertain their performance. Also, since profit is the main objective of every firms, this approach tends to measure the firm performance as compared to other approaches.

Electricity Outage Intensity: Outage intensity in this study measures the average number of outage in a typical month a firm goes without electricity supply from the grid. Firms that experience frequent power holidays and do not produce their own electricity for the shortage are bound to make huge losses in output and profit. In contrast firms that experience constant and reliable electricity supply perform better in terms of output and their profitability.

Skilled Labor: This measures the percentage of workers with special skills or knowledge in a particular firm. This is because according to human capital theory, workers with skills and experience contribute to positively to firm's output, revenue and profit (Bryan, 2006). In addition, firms with higher percentage of skilled labor enjoys economic rent compares to their counterparts with lower proportion of skilled workforce.

Capital Intensity: This variable measures the total amount of money expended by firms to acquire physical assets for production of goods and services. This is because firms that are capital-intensive are viewed to be more profitable due to their superior technique of production which allows them to enjoy lower cost production per unit (Shaheen & Malik, 2012).

Cost of Material Inputs: This measures the amount of money spent in acquiring material inputs used by firms to produce goods and services. Material inputs can contribute to firm performance, because an increase in the unit cost of inputs will lower the output produced and consequently lead to reduction of firm's profit. In contrast, a fall in the unit cost of inputs will affects output and profit positively.

Firm Size: This study measure firm size using the number of employees a firm has. We assign zero (0) to firms with less than 5 employees; one (1) to firms with employees between 5 and 19; two (2) to firms with employees between 20 and 99; and three to firms with employees greater than 99 as used in the World Bank enterprise survey. It is said that firm size plays a significant role in determining their performance. This is because large firms enjoy economics of large scale which allows them to produced goods and services at a lower cost per unit of output which small firms cannot. In addition, large firms have access to credit facilities at a lower interest rate due to their high bargaining power (Okafor, 2017).

Firm Age: This measures the number of years a firm has been in existence. We categorized firm's age into two: the older and younger firms. The older firms are said to have existed for a period of at least 10 (ten) years and thus, are more experienced and profitable in tough business environment compared to younger firms that have only existed for a shorter period of time, usually not up to 10 (ten) years.

Degree of Competition: This measures the perceived level of competition among firms in an industry. Following World Bank enterprise survey criteria, we measure the degree of competition in a 0-4 scale. The study assigns 0 (zero) to imply no competition and 4 (four) to firms that faced intense competition in their industry. In the theory of monopolistic competition, it is said that firms maximize profit through their pricing behavior. The lesser the entry barrier into an industry the harder it is for existing firms to adjust their price above the market price thereby making it difficult for them break even.

Share of Export: This variable measures the percentage of firm's participation in foreign trade outside the local market. It measures the percentage of the share of firm's export to total goods and services produced. Firms that produced and sale part of their goods at the foreign markets are said to be more exposed to better marketing strategy which increase their turnovers than firms who sell all their good and services locally (Wagner, 2007).

Foreign Ownership: This variable measures the percentage of foreign ownership or degree of foreign control in a particular firm. For instance, according to existing studies, firms with a minimum of 10% of foreign control are likely to be more profitable than their domestic counterparts that are completely owned by the locals. The reason is that the high percentage of foreign control and ownership exposes the firm to certain special expertise and technical know-how in operation which reduced their cost of production while increasing their profitability and productivity. Therefore, we assign a dummy variable of one (1) to firms with at least 10% foreign control and zero (0) otherwise (Halkos & Tzeremes, 2007).

Security: This variable measures the percentage of total annual sales spent on securing the firm's premises. Cost of providing security service is a form of cost which reduce firm's profit and thus, affect firm performance negatively. Firms that operate in an environment that is prone to political instability, terrorism and theft invest so much on providing security which undermines its profits and performance.

Bribe Payment: This variable measures the percentage of firm's sales revenue paid to public officials as bribes. Corruption in form of bribe payment contribute to raising firm's transactions cost, thereby affecting its profits. Additionally, bribe payment diverts firm's scarce resources away from profitable investment, and thus, affect their performance in the long run (Okafor, 2017).

Self-Generation: This variable measures the percentage of electricity supply from generators. Firms that self-generate to compensate for electricity shortages minimize losses associated with frequent power outages. In contrast, firms who do not self-generate during power holidays are said to records massive loss in output, revenue and productivity.

Sales: This variable measures the total annual revenue generated by individual firms. We used this, to proxy for large firms that receive preferential treatment from electricity officials due to their huge contribution to the national economy. Firms in this category possess high bargaining power to ensure the get regular and reliable electricity supply. Thus, a firm with higher volume of sales revenue indicates huge contribution to the economy and thus, has higher potential for receiving better treatment in electricity supply. On the other hand, firm's lower sales figure, contributes little or nothing to the economy and therefore, the firm does not have any potential to receiving supply of electricity from the grid (Pless & Fell, 2017).

3.2.3 Estimation Techniques

This study employs a cross sectional Ordinary Least Squares (OLS) and Two-Stage Least Squares ((2SLS) technique to estimate equations (21-24). The 2SLS technique is preferred because its captures the potential effects of endogeneity in the relationship between bribery for electricity connection and firm performance (Pless & Fell, 2017) as well as the causal effect between power outage intensity and firm performance (Mensah, 2016; Allcott et al, 2016).

3.2.4 Data Description and Sources

The data for this study was drawn from the 2014 World Bank Enterprise Survey (WBES) database. The survey was conducted for 135,000 firms in 139 countries. The World Bank regularly conducts enterprise survey in order to collect information on business firms and to assess the constraint private investment in developing countries. The survey employs a stratified random technique to obtain its sample of firms which are mostly micro, small, medium, and large non-agricultural firms. The samples in the survey were stratified into firm size (micro firms, 1-4 employees; small firms, 5-19 employees; medium firms, 20-99; and large firms, 100 or more employees), sector, geographical location. The survey also contains information on firm characteristics such as age, competition, capital intensity, workforce, sales revenue, infrastructures, innovations, capacity utilization, and percentage of foreign, private, and female ownership. Additionally, the survey contains responses on obstacles faced by business firms which include but not limited to access to finance, land, business licensing, corruption, security issues, customs and trade regulations, electricity services, labor regulations, political instability, practices of competitors in the informal sector, tax issues and transportation network. These features and obstacles intertwine to shaping or undermine firm performance in the business environments in which they operate.

The study sample consists of 2,676 firms obtained from a population of firms across the six geopolitical zones in Nigeria. The data comprise 957 firms from North-West; 136 firms from North-East; 529 firms from North-Central; 531 firms from South-West; 397 firms from South-East; and 136 firms from South-South regions. The firms were selected to include all electricity intensive industries across the six geo-political zones. Thereafter a thorough data cleaning was carried out to ensure firms with missing data and relevant information, were dropped. At the data end of the data cleaning exercise, the following samples were obtained from each region: 406 firms for North-West, 85 firms for North-East, 259 firms for North-Central, 232 firms for South-West, 158 firms for South-East and 71 firms for South-South regions.

4.0 Empirical Results and Discussion of Findings

4.1 Preliminary Analysis

4.1.1 Summary Statistics

Table A1-A6 on the appendix reports the summary statistics indicating the mean, standard deviation, minimum and maximum values for all the variables used with respect to each of the six geo-political zones in Nigeria.

The summary statistics as reported in Table A1 (see Appendix) shows the mean, standard deviation, minimum and maximum values of the variables used for regression analysis for the North Central zone. Starting with mean, it can be observed that the average profit of firms within the sample is $US3,062,867 while the standard deviation values of the variables are smaller than their respective mean with the exception of the standard deviation of profit, outage intensity and fuel cost. Also, firms on average experience outage intensity of about 34.314 times in a typical month. Albeit, some firms experience an average outage intensity of about 1000 times in a typical month as reported in Table A1. In addition, it can be observed that firms within the sample spend an average of 14.777% of their sales revenue to bribe electricity officials to mitigate electricity outages within their premises. Also, it can be noted that firms within sample expend an average of $US9,734.662 to self-generate an average of 56.286% electricity during outage hours. The perceived degree of competition among firms in the sample is below average. The mean age of firms in the sample is 15years with the oldest firm being 46years old while the youngest firm is less than a 1year. The average skilled labor employed across firms in the sample is 32.789, while the average cost of raw materials is $US14,083.768. The average expenditure on capital equipment is $US3212.567 while the average share of firm's export is 4.332%.

Table A2 (see Appendix) shows the summary statistics of some key variables used for the regression analysis for the northwest geo-political zone. Beginning with mean, it can be observed that the average profit for all the firms in the sample is $US9,067,364. The standard deviation values of all the variables used are smaller as compared to their respective mean with the exception of profit, outage intensity, and fuel cost. From the statistics it can be said that firms in the region, experience outage intensity of an average of 34.042 times in a typical month and thus, expend 22.141% of their sales revenue to bribing electricity officials in order to boost their electricity supply from the grid. Additionally, firms in the region spent an average of $US268.443 to purchase fuel to power their generators in order to generate an average of 41.936% of their total electricity consumed. The perceived degree of competition is below average while the average age firms in the sample are 15.222years. The average skilled labor employed across firms in the sample is 151.123, while the average cost of raw materials is $US11,456.412. The average expenditure on capital equipment is $US13,876.234 while the average share of firm's export is 11.884%.

Table A3 (see Appendix) reports the summary statistics of the variables used for the analysis for the North East zone. Starting with mean, the average profit of firms within the sample for North-East geo-political is $US12,781 while the standard deviations of all the variables used are relatively larger than the mean with the exception of the standard deviation of self-generation, age of firm and firm size. On average, firms spent 5.571% of their total revenue to bribe electricity officials in order to mitigate power outage. Firms within the sample experienced electricity outage of an average of 30.753times in a typical month, while on the hand firms in the sample spent an average of $US137.175 to self-generate an average of 32.271% of their total electricity consumed. Also, an average of 4.341% of revenue is spent to provide security within the firm's premises. The mean age of firms in the region is 15years while the youngest and oldest in the sample are 2years and 44years respectively. The average sales revenue across firms in the sample is 30,345.254, while firm size is 1.235. Firms in the region spend an average of 4.341% of their sales revenue to provide security in their respective premises.

Table A4 (see Appendix) present the summary statistics of data of firms from the South-East geo-political zone. Commencing with mean, it can be observed that the average annual profit of all firms within the region is $US 302,909.80. The variation in the values of the standard deviation are substantially smaller than the mean across the variables in the samples with exception of profit, outage intensity, fuel cost, export, and foreign ownership. Firms, on average experienced outage intensity of 122.025 times in a typical month and thus, spent an average of 6.044% of their total sales to bribe in order to induce electricity supply from public grid. In addition, firms in the region spent an average of $US395.046 to fuel their generators in order to self-generate an average of 36.278% of their total electricity inputs. The perceived degree of competition among firms within the region is below average, while the average age of firms in the region is 17years old. The youngest firm in the region being 2years old while the oldest firm is 62years old. The average skilled labor employed across firms in the sample is 32.222, while the amount spent on capital assets is $US13,896.543. The average firm size in the sample is 0.968, while the average share of firm's export is 6.019%.

Further, Table A5 (see Appendix) report the summary statistics of key variables for the South-West geo-political zone. The mean annual profit of firms in the sample used is $US30,500,000, while the standard deviation is $US 2,565,850. With respect to other variables used, it can be observed that the standard deviation for other variables used across the samples are relatively smaller than their respective mean with the exception of profit, outage intensity, and fuel cost. The degree of competition among firms in the sample is below average. It can also be observed that firms in the sample experienced power outage of an average of 30.047 times in a typical month and hence, spent an average of 1.704% of their revenue to bribe electricity officials in order to mitigate electricity outage. Also, firms in the sample spent an average of $US103,328.60 to purchase fuel to power their generators in order to self-generate an average of 61.364% of their total electricity consumed. The average age of firm in the sample is 21years. The oldest being 168years old while the youngest firm is less than 1year. The average skilled labor employed across firms in the sample is 464.111, while the amount spent on capital assets is $US75,390.345. The average firm size in the sample is 1.691, while the average degree of competition is 1.708. The average sales revenue in the sample is $US 53,455,000, while the average degree of generator ownership is 0.844.

Lastly, Table A6 (see Appendix) displays the summary statistics of key variables for the South-South region. Beginning with the mean, the average annual profit of firms in the sample is $US19,900,000 while the standard deviation is $US162,000,000. Also, it is observed that, the values of the standard deviation for other variables in the samples are relatively smaller than their respective mean except for profit, outage intensity and degree of competition. The perceived degree of competition among firms in the sample region is below average. The average age of firms in the sample is 14.296years while the oldest and youngest firms are 51years and 2years respectively. Firms in the region experienced an average outage intensity of 25.845times in a typical month, which is the lowest as compared to other region in Nigeria. Thus, firms in the region are less likely to bribe electricity officials to increase their share of electricity supply from grid. Firms in the region self-generate an average of 70.873% of their total electricity consumption during outage hours. The average sales revenue in the sample is $US 20,000,000, while the average degree of competition and firm size is 1.000 and 1.042 respectively.

4.2 Results and Discussion of Findings

The discussion of the findings is structured into six regions. Findings on each region were discussed according to model 1 and 2. The results of the findings for the models were compared and conclusion was drawn on the best strategy for firms to adopt to mitigate the effect of electricity outages during power holidays.

5.3.1 North Central Region

The regression result for model 1 in Table 1 shows that bribery for electricity supply is negative, however the effect is insignificant to outage intensity in the North Central region. The insignificant effect of bribery suggests the fact that bribery for electricity supply does no mitigate the of effect electricity outages on firm performance in the North Central region, rather it is a form of indirect tax which contributes to firm's total cost. As a results most firms in the region do not bribe electricity officials to mitigate electricity outage. This is consistent with the model prediction in CASE 3 which is contrary to our expectations that bribery for electricity mitigates electricity outages. Another interesting fact in the relationship between outage intensity and firm performance in the sample, is the degree of heterogeneity of impacts among firms. For example, further evidence shows that electricity intensive firms are more likely to be affected during electricity outage than their counterparts that utilizes less electricity for production of goods and services. Thus, most electricity intensive firms, have over time devise means of self-generating electricity through the use of generators and mini power plants in order to mitigate the effects of electricity outages on their performance.

The result of model 2 explain the role self-generation in mitigating the effect of electricity outages on firm performance in the North Central region. The findings indicate that self-generation is positively significant to firm performance in the North-Central region. This validates the assumption that in-house electricity generation by firms during outage periods may help to boost their performance especially in the short run. However, in the long run it may reduce firm's marginal revenue due to the high marginal cost associated with self-generation during power holidays. This consistent with the model prediction in CASE 4 discussed in the previous chapter. Thus, it can be said that firms that self-generate electricity during outage periods outperform firms that bribe electricity officials to increase their electricity supply from the grid. This finding is consistent with Pless and Fell (2017), but contrary to the studies conducted by Stenbuks and Foster (2010) and Mensah (2016).

5.3.2 North-West Region

Also, the results of model 1 in the North-West region, reveal that bribery for electricity supply, does not mitigate the effect of electricity outage on firm performance. Contrary to our expectations, this study suggests that bribery for electricity supply is not a strong predictor of outage intensity among firms in the North-West region. The significant negative effect of outage intensity on firm performance suggests the fact that electricity outages is severe to most business firms in the region. This is consistent with the assumption stated in CASE 3. However, the result is not consistent with Pless and Fell (2017) and Okafor (2017).

The result for model 2 captures the effect of self-generation on firm performance. The findings show that, in-house electricity generation by firms is negatively related to its financial performance. However, the coefficient is statistically insignificant. This suggest that the effect of self-generation during power holidays on firm performance cannot be ascertain, given the sample of firms around the region. The rationale for this outcome is that, even though firms in the region may turn on their in-house generating plants during outage, they may not be able to generate the optimal capacity needed to break even, mainly because of the high cost associated with self-generation. Firms in this case would rather choose to partially generate their in-house electricity as predicted by the model in CASE 4, than embark on a full scale in-house generation to prevent electricity outages. Thus, comparing model 1 and 2, it can be said that it is more profitable for firms in the North-West region to partially self-generate during outage periods rather than offering to bribe electricity officials to mitigate outage intensity. Similarly, the findings for North West region is consistent with Pless and Fell (2017), however, the findings is in contrast to the studies conducted by Stenbuks and Foster (2010) and Mensah (2016).

5.3.3 North-East Region

From the results in Table 3 for North-East region, it is observed that outage intensity is negative but statistically insignificant in the sample of firms used. In line with our expectations, this study reveals that bribery for electricity supply plays a significant role in mitigating the effects of electricity outage on firm performance in the North-Eastern region. However, the study also noted that electricity outage in the region is minimal and as such does not have severe negative effect on firm performance. This is because firms in the region, seldom experience poor electricity supply. Further evidence also revealed that bribery for electricity connection is a form of indirect tax which has a negative effect on firm performance. This is because bribery diverts firm's limited resources away from productive ventures.

The regression results in model 2 for the North-East region indicate that, in-house electricity generation by firms has a positive relationship with firm performance which is contrary to our expectations. This is because we expected the coefficient of self-generation to be negative due to the rising cost of self-generation which affect firm performance negatively. Further, the insignificant effect of the coefficient of self-generation, suggests the fact that very few firms in the region self-generate electricity during outage hours. This could be due to the fact that electricity supply to firms within the region is reliable. As a result, most firms in the region rely on electricity supply from the grid with no incentives to self-generate. This finding consistent with the prediction by our model in CASE 4 and the study conducted by Mensah (2016). From the findings, it can be said that, it is more profitable for business firms in the North-East region to rely on electricity supply from the grid without self-generating or bribing electricity officials during outage periods.

5.3.4 South-East Region

In line with our expectations, the findings for South-East region indicate that bribery for electricity supply is negatively significant to outage intensity in the region. This is not surprising because outage intensity is said to be high in the South-East region. Thus, firms within the region have incentive to bribe electricity officials to mitigate outage hours. Also, the findings reveal that outage intensity is negative and significant to firm performance in the South-East region. This is not also surprising because poor electricity supply has been reported by firms in the sample to be the major constraint affecting their performance. Besides the negative effect of outage intensity on firm's performance, it has also been reported that frequent electricity outage increases the average variable cost of firms due to the associated cost of self-generation as well as bribing electricity officials during outage periods. This is consistent with Mensah (2016), Goedhuys et *al.* (2016), Okafor (2017) and Pless and Fell (2017). However, the finding is contrary to Vial and Hanoteau (2010) which discovered that corruption has a positive effect on firm performance.

Also, the regression results in model 2 reveal that self-generation is positively insignificant to firm performance in the South East region. Contrary to our expectation, the finding of this study suggests that most firms in the sample rarely self-generate electricity, most of them often bribe electricity officials to increase their share of electricity supply from the grid which is consistent with Pless and Fell (2017). Further evidence also shows that firms bribe electricity officials in the South-East outperform firms that self-generate electricity during outage hours. This finding is consistent with Vial and Hanoteau (2010), however, it is contrary to the study conducted by Goedhuys et *al.* (2016) which found corruption to have negative impact on firm performance.

5.3.5 South-West Region

Contrary to our expectations, the regression results in model 1 for South-West region shows that bribery for electricity supply does not mitigate electricity outage. In addition, outage intensity though negative does not also affect firm performance. The insignificance effect of power outages on firm performance in South-West region, suggests the facts that firms in the sample rarely reported that poor electricity supply is a severe obstacle to them. This finding is consistent with Abotsi (2016) and Okafor (2017).

Also, for model 2, contrary to our expectations, the findings suggest that self-generation is negatively insignificant to firm performance in the South West region. The rationale for this outcome is that, firms in the South-West region rely mainly on electricity supply from the public grid, while little or nothing is devoted to bribing for electricity supply or self-generate power outage. In sum, model 1 and 2 results suggest that firms in the South-West relies on electricity supply from grid without having to self-generate or bribe electricity officials. This finding is consistent with Steinbuks and Foster (2010) and Mensah (2016).

5.3.6 South-South Region

The findings for model 1 in the South-South region, reveals that bribery for electricity supply is not significant in mitigating the effects of electricity outage on firm performance which is contrary to our expectations. The insignificance effect of bribery on electricity outage could be as results of the reliable supply of electricity to firms within the region. Further findings also revealed that outage intensity is not significant to firm performance. This points to the fact that most firms in the region barely reported that poor electricity supply was the major obstacles to their business operations. Thus, it can be said that firms in the region experienced minimal electricity outages. This finding is not consistent with Pless and Fell (2017) and Okafor (2017).

In line with our expectations, the findings in this region also reveals that self-generation is negatively insignificant to firm performance, suggesting that most firms in the sample rarely self-generate during outage. The reason is that electricity outage is said to be very low in the region and hence, firms are unwilling to expend their limited resources to self-generate. Further evidence also reveals that firms in the South-South region rely on electricity supply from the grid. This is due to the fact that the outage intensity in the region is relatively low, and thus, it is cheaper for firms to rely on grid supply than self-generate during outage periods. This is consistent with Steinbuks and Fosters (2010) and Mensah (2016).

TABLE 1: TWO STAGE LEAST SQUARES REGRESSION ESTIMATES

Geo-Political Zones	North-Central		North-West		North-East		South-East		South-West		South-South	
						Dependent Variable: Profit						
Independent Variable	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Outage Intensity	-0.022***		-0.023*		-0.001		-0.001***		-0.000		-0.601	
	(0.007)		(0.013)		(0.002)		(0.000)		(0.012)		(0.012)	
Instruments												
Bribery for Electricity Supply	-0.092		-0.061		-0.025*		-0.200***		-0.032		-0.003	
	(0.383)		(2.358)		(0.013)		(0.0033)		(0.026)		(0.210)	
Self-Generation	-	0.067**		-0.026		0.004		0.050		-0.491		-0.032
		(0.034)		(0.028)		(0.017)		(0.126)		(0.365)		(0.032)
Firm Level Control Variables												
Competition	-0.828**	-1.197***	-1.360*	-1.181			-0.063**	-0.498	-0.104*	-11.262*		-0.074
	(0.372)	(0.308)	(0.372)	(0.572)			(0.031)	(1.510)	(0.209)	(7.843)		(0.627)
Size	2.301***	1.226**	1.717	3.316***	0.123	0.841	0.019	0.572	0.034	2.602	4.486	
	(0.783)	(0.618)	(2.358)	(0.824)	(0.166)	(0.962)	(0.036)	(0.968)	(0.310)	(2.647)	(8.914)	
Age	4.461***	1.595*	0.458	1.210	0.336*	1.146	-	-	0.373	18.888	5.085	18.584
	(1.278)	(0.878)	(2.559)	(1.401)	(0.184)	(0.950)			(0.490)	(14.933)	(14.461)	(5.843)
Export (% of total goods sold)	0.134***	0.103***	0.005	0.015**			0.008***	0.008				
	(0.038)	(0.032)	(0.040)	(0.018)			(0.002)	(0.031)				
% of Foreign Ownership	3.112***	2.172**	1.033	0.615			1.033***	-				
	(1.337)	(1.143)	(3.549)	(0.032)			(3.549)					
Capital Intensity	0.498***	0.173	0.146	0.760***			0.042***	0.118	0.054	5.148		
	(0.165)	(0.124)	(0.524)	(0.241)			(0.015)	(1.074)	(0.166)	(4.887)		
% of Skilled Labor	2.764***	2.247**	1.315	1.335*			0.072***	-	0.091			
	(1.106)	(1.013)	(1.678)	(0.714)			(0.018)		(0.345)			
Cost of Raw Materials	-0.407***	-0.197	-1.113**	-0.635								
	(0.161)	(0.123)	(0.457)	(0.323)								
Security	-	-			-0.008	-0.088						
					(0.010)	(0.086)						
Fuel Cost	-	-				-0.199						
						(0.399)						
Sales	-	-			1.231***	1.804**		0.773	1.106***	-		
					(0.070)	(0.594)		(0.822)	(0.082)			
Constant	8.613*	2.719	-8.648	17.725	-3.690***	-9.568	0.470*	1.023	-0.765	115.267	5.085	18.584
	(4.528)	(5.390)	(12.913)	(6.677)	(1.015)	(7.955)	(0.248)	(7.891)	(2.131)	(82.190)	(14.461)	(5.843)
Wald Test	28.090***	25.670***	20.830***	45.660***	-	-	35.60***	53.78***	524.180***	3.40	0.55	0.21
F-Test	-	-	-	-	55.560***	5.31*	-	-				
Observations	21	21	21	20	68	15	10	20	12	9	55	15
Post Estimation Test												
Endogeneity Durbin (Score)	18.690***	5.796**	18.964***	0.879	-	-	4.339**	3.447*	0.452	7.225***	17.330***	0.142
Wu-Hausman	80.896***	3.812*	83.841***	0.921	-	-	0.766**	1.209**	0.117	8.141*	23.463***	0.105
Over-identification Sargan (Score)	0.060	1.834	0.006	3.590	-	-	5.153	0.051	0.607	0.393	1.050	1.032
Basmann	0.029	0.957	0.003	1.969	-	-	1.063	0.013	0.160	0.091	0.993	0.739
Ramsey RESET					1.03	35.95	-	-	-	-		

Note: The values reported in parenthesis are standard errors while ***, **, and * indicate the rejection of the null hypothesis at 1%, 5% and 10%, level of significance respectively.

Source: Authors' Computation from World Bank Enterprise Survey, 2014

5.0 Conclusion and Recommendations

This paper provides evidences on the role of corruption in moderating the relationship between electricity outage and firm performance across the six geo-political zones in Nigeria. In addition, this study also assessed effect of self-generation on firm performance across the six geo-political zones and comparison were made as to whether it is more profitable for firms to self-generate electricity during outage periods or bribe electricity officials to avert or mitigate power outage. The findings from this study reveal that, electricity outage is negatively significant to firm performance across the six geo-political zones in Nigeria. However, the impact is less severe and insignificant in the North-East, South-West and South-South regions. Further, evidence from this study also shows that electricity self-generation does not have any significant impact on firm performance across the six geo-political regions with the exception of the North-Central region. The study discovered that reliance on self-generation during electricity outage might reduce firm performance in the long run. This is due to the high marginal cost associated with self-generation.

The lessons that could be drawn from the foregoing is that the authorities should ensure adequate provision of electricity infrastructures across the six geo-political zones especially in regions where electricity outage is high. Also, there is the need to create a task that will monitor the DISCOs and their employees with the aim of curbing bribery activities within the Nigerian electricity sector. Additionally, the DISCOs and the authorities in the electricity market can mitigate output and revenue loss created by uncertainties in power outages. This can be done by ensuring full disclosure of information on outage schedules, so as to assist firms to efficiently organize, manage and plan their production activities. Firms can also explore other alternative sources of electricity such as solar which is cheaper and cleaner as against the use of generators.
Finally, the decision by firms to self-generate during outage periods should be cautiously examined to ensure that the associated marginal cost does not exceed the benefits. In a situation where the cost of self-generation outweighs the benefits, it will be profitable and beneficial for firms to completely rely on electricity supply from the grid than self-generate electricity during power holidays.

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Appendix

A: Summary Statistics for the Six Geo-Political Zones

Table A1-Summary Statistics of Key Variables for North Central Zone

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US)	259	3,062,867	49,300,000	-48,700,000	792,000,000
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	259	34.314	90.570	0	1000
Self-Generation (% of electricity consume)	259	56.286	22.838	0	100
Fuel Cost ($US)	259	9,734.662	127,196.5	0	2,030,457
Instrumental Variables					
Bribery for Electricity (% of Sales)	259	14.777	2.168	0	25.773
Sales Revenue ($US)	259	5,457,673	51,345,000	5,060,000	1,094,000,000
Firm Level Control Variables					
Competition	259	1.587	1.289	0	4
Size	259	1.367	0.716	0	3
Age (years)	259	15.038	7.921	0	46
Export (% of firm share of Export)	259	4.332	10.452	0	50
Foreign Ownership (=1 if % of foreign ownership ≥ 10%)	259	0.119	0.325	0	1
Capital Intensity ($US)	96	3,212.567	1,201.221	0	30,567.345
Skilled Labor Workers	94	120.345	280.542	23	532
Cost of Raw Materials	86	14,083.768	4,532	1,856	23,256

Competition (scale of 0-4 with 0 meaning no competition, and 4 meaning very intense competition); Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

Table A2-Summary Statistics of Key Variables for North West Zone

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US)	406	9,067,364	153,000,000	-5,087,158	3,050,000,000
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	406	34.042	56.498	0	630
Self-Generation (% of electricity consume)	406	41.936	33.735	0	100
Fuel Cost ($US)	406	268.443	970.172	0	10,152.28
Instrumental Variables					
Bribery for Electricity (% of sales)	406	22.141	14.543	0	23.456
Sales Revenue ($ US)	405	15,680,123	163,432,000	680	6,789,345,000
Firm Level Control Variables					
Competition	405	1.407	1.002	0	4
Size	406	1.229	0.753	0	3
Age (Years)	406	15.222	10.368	1	105
Export (% of firm share of Export	406	11.884	22.391	0	100
Foreign Ownership (=1 if % of foreign ownership ≥ 10%)	406	0.185	0.389	0	1
Capital Intensity ($US)	100	13,876.234	3,241.576	2,785.216	19,853.183
Skilled Labor Workers	142	151.123	220.423	4	586
Cost of Raw Materials ($US)	123	11,456.412	1,823.312	9,778.454	19,222.765

Competition (scale of 0-4 with 0 meaning no competition, and 4 meaning very intense competition); Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

Table A3-Summary Statistics of Key Variables for North East Zone

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US)	85	12,781	38,947.52	-76,142.13	251,116.80
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	85	30.753	38.827	0	200
Self-Generation (% of electricity consumed)	85	32.271	29.443	0	100
Fuel Cost ($US)	85	137.175	582.157	0	5,076.142
Instrumental Variables					
Bribery for Electricity (% of sales)	84	5.571	6.738	0	60
Sales Revenue ($US)	85	30,345.254	52,317.980	721.675	403,567.132
Firm Level Control Variables					
Security(% of Sales)	85	4.341	8.801	0	60
Size	85	1.235	0.591	0	3
Age (Years)	85	15.882	9.078	2	44

Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

Table A4-Summary Statistics of Key Variables for South East Zone

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US)	158	302,909.80	2,565,850	-601,421.30	31,600,000
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	158	122.025	289.202	0	2000
Self-Generation (% of electricity consumed)	158	36.278	31.861	0	100
Fuel Cost ($US)	158	395.046	1,685.165	0	15,228.43
Instrumental Variables					
Bribery for Electricity (% of sales)	158	24.062	12.459	0	80
Sales Revenue ($ US)	158	700,670.343	1,090,067	10,234.433	52,552.,000.568
Firm Level Control Variables					
Competition	158	1.848	1.130	0	4
Size	158	0.968	0.633	0	3
Age (Years)	158	17.108	9.607	2	62
Export (% of firm share of export)	158	6.019	15.002	0	95
Capital Intensity ($US)	50	13,896.543	2,234.222	8,658.356	19,318.560
Skilled Labor Workers	64	432.222	520.341	21	823

Competition (scale of 0-4 with 0 meaning no competition, and 4 meaning very intense competition); Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

Table A5-Summary Statistics of Key Variables for South West Zone

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US '000)	232	30,500	393,000	-1,730,000	5,080,000
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	232	30.047	43.950	0	372
Self-Generation (% of electricity consumed)	232	61.364	33.534	0	100
Fuel Cost ($US)	232	103,328.60	1,059,097	0	15,200,000
Instrumental Variables					
Bribery for Electricity(% of sales)	232	8.326	5.345	0	25
Sales Revenue ($US'000)	232	53,455	657,234	11,727	10,631,555
Generator Ownership (=1 if yes)	232	0.844	0.368	0	1
Firm Level Control Variables					
Competition	232	1.708	2.651	0	4
Size	232	1.691	0.825	0	3
Age (years)	232	21.408	18.570	0	168
Capital Intensity ($US)	45	75,390.345	64,325.450	3,245.867	224,006.899
Skilled Labor	80	464.111	567.340	93	912

Competition (scale of 0-4 with 0 meaning no competition, and 4 meaning very intense competition); Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

Table A6-Summary Statistics of Key Variables for South South Region

Variables	Observations	Mean	Standard Dev.	Minimum	Maximum
Performance Measure					
Profit ($US)	71	19,900,000	162,000,000	-641,035.60	1,370,000,000
Electricity Reliability Measure					
Outage Intensity (monthly average incidents)	71	25.845	30.994	0	100
Self-Generation (% of electricity consumed)	71	70.873	31.685	0	100
Instrumental Variables					
Bribery for Electricity (% of sales)	71	1.845	1.294	0	4
Sales Revenue ($US)	71	30,500,000	132,500,000	1300	1,500,400,000
Firm Level Control Variables					
Competition	71	1.000	1.014	0	4
Size	71	1.042	0.642	0	3
Age (Years)	71	14.296	11.455	2	51

Competition (scale of 0-4 with 0 meaning no competition, and 4 meaning very intense competition); Size (scale of 0-3 with 0 meaning micro firm with less than 5 employees and 3 meaning large firm with employees' not less than 100).

Source: Author's Computation from World Bank Enterprise Survey, 2014

B: Summary of Empirical Literatures

Table B1-SUMMARY OF LITERATURES

S/N	AUTHOR(S)	THEORIES/HYPOTHESIS USED	COUNTRY & PERIOD COVERED	METHODOLOGY		FINDINGS
				VARIABLES	ESTIMATION TECHNIQUES	
1	Doe & Emmanuel (2014)	NOT STATED	Ghana 2014	-Frequency of power outage; -Returns on Asset;	Correlation Analysis	-That Poor electricity supply results to a massive decline in production, quality, sales and firm's profitability.
2	Abotsi(2016)	Efficiency Hypothesis	Sub-sahara Africa 2014	-Number of power outage -Informal payment -Age of Business -Export orientation -Labor - Energy - Capital -Competition -Total annual sales	Tobit model and Stochastic Production Frontier	-That Power failure has a negative impact on the production efficiency of firms in Africa
3	Abeberese(2016)	NOT STATED	India 2001-2008	-Electricity price, -Coal price; -Firms' level of output -Employment -Material inputs -Capital Type of Industry	OLS and Second Stage OLS	-That electricity price has a negative effect on firm's output, labour Productivity and machine intensity -The price of electricity also affects firm's choice of industry to operate'
4	Cissokho & Seck (2013)	NOT STATED	Senegal 2013	-Efficiency of firm -Electricity issues -Size -Age	Cross Sectional analysis	-That power outage has a positive significant effect on cost and technical efficiencies of SMEs than large firms. -On the other hand, power failure has a negative effects on output of firms.

				-Export Orientation		
5	Mensah(2016)	NOT STATED	Sub-Sahara Africa 2015	-Power outage -Cost of self-generation -Firms revenue -Productivity	OLS and Second Stage OLS	That power outage has a negative effects on revenue and production
6	Arlet (2017)	NOT STATED	Global 2015	-Power outages -Electricity Tariffs & the Connection process -Gross National Income (GNI)	OLS	-Power outages negatively impact firm productivity -Electricity tariffs affects firms negatively but impact is severe on SMEs
7	Okafor (2017)	NOT STATED	Nigeria 2010	-Profit per worker -Sales per worker -Age -Capital intensity -Competition -Bribes -Total investment -Access to finance -Poor electricity delivery -Telecommunication	OLS and Probit regression	-That skilled labour force, export, foreign ownership and capital investment influence firm's performance positively
8	Wu (2008)	NOT STATED	Asian Countries 1998-2000	-Firm's Size -Corporate governance -Market environment -Quality of government service -Taxation	Probit, ordered and Interval Regression	-That firm size, growth rate, and corporate governance are the main determinant of bribery activities at the firm level -That Asian firms are more likely to bribe when faced with fierce market competition, corrupted court system and inefficient government services
9	Allcott et al (2014)	NOT STATED	India 2005	-Revenue -Capital Stock -Total Person Engaged -Material Purchased -Fuel Purchased -Electricity purchased -Electricity Consumed	OLS and IV Regression	-That Electricity black out reduces output of firms by five percent -That Power outages affects mostly SMEs and firms without alternative power supply

				-Self-generated -Electricity intensity -Self-generation share -Energy revenue share		
10	Alam (2013)	NOT STATED	India 2006	-Capital -Material -Profit -Output -Electricity bought -Total electricity supply -Own generator	Optimisation	-That power outage result to a decline in annual sales, output and profit across industries. -That Frequent power outage lowers the output and profits of firms that depend largely on electricity
11	Alby et al (2012)	NOT STATED	Indonesia, Lithuania, Brazil, Poland, and Thailand	-Firm level control, -Number of power outages -Return on Investment (ROI) -Generator (Generator is a binary variable that is if Firms own generator or not)	OLS and Probit Regression	-That power outage negatively affects returns on investment for firms that relied heavily on electricity for operation.
12	Eifert et al (2008)	NOT STATED	17 Developing Countries in Africa, Asia, and latin America	-Sales revenue -Raw materials -Capital -Labor	Descriptive Analysis	-That indirect cost relating to infrastructure and services account for a relatively high sh-are of firm's cost in Africa
13	Fisman & Svensson (2005)	NOT STATED	Uganda 1995-1997	-Growth rate -Bribe -Tax -Sales -Age -Foreign aid	OLS and IV regression	-That taxation and bribery negatively affect firm's performance in Uganda
14	De Rosa et al (2010)	NOT STATED	EU and Non-EU Countries	-Total Firm productivity -Bribe tax, -Time tax,	OLS and IV regression	-That bribe tax has a negative effect on firms for full sample period. - For split samples time tax, tends to have a negative effects on firms operating in the EU countries while bribe tax affects non-EU countries negatively

				-Corruption perception index		
15	Lee et al (2010)	NOT STATED	Global 2006-2010	-GDP growth rate -Political rights, -Property right protection	Probit regresion	-That payment of bribes by firms depends on their exposure and vulnerability to residual right of control by government officials
16	Pless and Fell (2016)	NOT STATED	Global 2006-2012	-Propensity to bribe for an electricity connection -Generator ownership -Age of firm -Female Ownership -Foreign ownership -Population density -Working capital -Inflation -Sales -Electricity generation per capita	OLS and IV regression	-That the propensity to bribe is related to an increase in 14 power outage per month and 22% increase in annual sales lost due to power failure on average
17	Steinbuks and Foster (2010)	NOT STATED	Africa 2002-2006	-Firm Age -Firm Size, -Days of power outage -Employment	Probit and Tobit Regression	-That unreliable electricity supply is not a major driving of generator ownership in Africa. -That firm characteristics such as size, age, industrial sector, and export orientation of firms are the major factors influencing generator ownership by firms. -That generator ownership by firms will remain high around 20% even if electricity supply to firms improve or is reliable
18	Adenikinju (2005)	NOT STATED	Nigeria 1998	-Gross Output -Capital input, -Labor -Outage Cost	Revealed preference approach	That power outages affect business firms negatively, especially the small scale enterprise. -That the marginal cost of power outages to firms ranges between $0.95 to $3.13 per kwh of lost electricity
19	Vial & Hanoteau (2010)	NOT STATED	Indonesia 1975-1995	-Bribes payment -Indirect taxes -Number of employee -White collar jobs -Foreign ownership	OLS and IV regression	-That corruption has a positive and statistically significant effect on individual plant growth
20	Fisher-Vanden et	NOT STATED	China	-Capital	Panel Regression	-That firms with greater power outages resulted to increase in firm's cost by 8%

	al (2014)		1999-2004	-Wage -Materials -Electricity		
21	Johnson et al (2000)	NOT STATED	Russia, Ukraine, Poland, Slovakia and Romania 1997-1998	-Extra-legal payment for license -Extra-legal payment for services -Firms pays for protection -Taxation -Profits -Industry dummies -Country dummies -Age -Employment	Tobit and Probit Regression	-That hidden activities is larger in countries where tax rates are higher where managers are more likely to pay briberies. The study also revealed that there is no significant association between tax rates and unofficial activity in Eastern Europe
22	Rud (2011)	NOT STATED	India 1965-1984	-Agricultural Connection -Manufacturing Output per capita -Ground Water share -Rural population -Population density -Education Expenditure Per Capita -Total Credit	OLS and IV Regression	-That there is a significant positive relationship between rural electrification and manufacturing output
23	Kirubi et al (2008)	NOT STATED	Kenya 1994-2007	-Electricity supply -Agriculture -Size -Education Services	Descriptive Analysis	-Access to electricity supply allow firms (small and micro enterprise) to use electric equipment and tools which increase their productivity - Regular access electricity supply in Kenyan rural community through micro-grids, improve productivity per worker between 100 and 200 percent
24	Andersen & Dalgaard (2013)	NOT STATED	African Countries 1995-2007	-Power outages -GDP per capita -Coastal access -Precipitation	OLS and IV	-That power outages have negative impact on African countries GDP -Frequent power outages in sub-Sahara Africa impede the growth of firms by 2% annually
25	Abudu (2017)	NOT STATED	15 African Countries	-Employment growth -Sales growth	IV regression	-That corruption in the form of bribe payment have a negative effect on firms operating

			2006-2015	-Labor productivity -Employment -Sales -Labor Productivity -Bribe intensity -Age -Size -Foreign Ownership -Competition -Innovation -Experience		in Africa -That the impact of corruption is much greater on larger and older firms than smaller and younger firms.
26	Goedhuys (2016)	Corruption, Innovation and Firm's Growth: firm-level evidence	Egypt and Tunisia 2013-2014	-Innovation -Corruption -Employment growth -Firm Size -Firm Age	Conditional Recursive Mixed Process (CMP)	-Corruption affect firm performance negatively by discouraging innovations -Corruption serve as a mechanism to boycott bureaucratic obstacles relating to obtaining business permit to enhance firm performance