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Impact of Power Sector Development on Foreign Direct Investment Growth in Nigeria: 1986-2023

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Abstract

The Nigerian government has undertaken several reforms aimed at attracting foreign direct investment to the power sector to boost the sector; these efforts may seem to have yielded modest benefits. However, the country faces challenges in attracting foreign direct investment into the power sector, including political instability, regulatory uncertainties, and security concerns. Thus, the paper investigated the impact of power sector development on foreign direct investment growth in Nigeria from 1986 to 2023. The Fully Modified Ordinary Least Squares Regression was employed as method of data analysis. Results revealed that power sector capital expenditure is significant and positively related to foreign direct investment growth in Nigeria. While, power sector recurrent expenditure is significant but negatively correlated with foreign direct investment growth. Also, the estimated impact of power sector generation on foreign direct investment growth is negative and insignificant in the long run. Furthermore, the results indicated that power distribution capacity influences foreign direct investment growth negatively and insignificantly in the long run. Therefore, the paper recommended that the Federal government should prioritize increased capital investment in the power sector, specifically in infrastructure projects like power plants, transmission lines, renewable energy sources and Research and Development; given the positive and significant relationship between power sector capital expenditures and foreign direct investment growth. Also, the Nigerian Electricity Regulatory Commission should focus on improving the reliability and consistency of power generation by upgrading existing plants, investing in diverse energy sources (e.g., renewables like solar and wind), and ensuring that power plants operate at full capacity. Further, the Nigerian Electricity Regulatory Commission should address inefficiencies in the distribution system, such as high technical and non-technical losses (e.g., electricity theft and poor metering); due to the negative and insignificant impact of power distribution on foreign direct investment growth.

Keywords: *FDI, Growth, FMOLS, Infrastructure, Power sector, Nigeria*

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Background to the Study

In today's interconnected world, the global economy relies heavily on internationalization and foreign direct investment (FDI), including traditional business sectors like mining and manufacturing. Improving Nigeria's power sector infrastructure is crucial for attracting FDI, as reliable electricity supply reduces costs, enhances efficiency, and boosts business competitiveness. However, the extent to which a country attracts FDI is a function of many factors which include: labour costs, market size, profitability expectation, human capital, FDI policy, and infrastructures such as power sector infrastructure, among others. Specifically, adequate power sector development infrastructure, such as power sector capital and recurrent expenditures, power generation, transmission, and distribution of electricity, are essential for industrialization, economic activities, and improving the quality of life. A robust power sector can significantly enhance productivity, reduce operational costs, and make a country more attractive to investors.

Nigeria's wealth of natural and human resources, including vast oil and gas reserves, arable land, and a large, youthful population, has the potential to attract significant FDI, driving economic growth. The Nigerian government has prioritized attracting FDI to stimulate economic diversification, create employment opportunities, and achieve sustainable development. However, Nigeria faces challenges in attracting FDI, including political instability, regulatory uncertainties, security concerns, and inadequate power sector infrastructure. To address these challenges, the Nigerian government has undertaken several legislative and operational reforms, such as the Electric Power Sector Reform Act of 2005, which led to the unbundling of the state-owned National Electric Power Authority and Power Holding Company of Nigeria into eighteen successor companies. These reforms aimed to encourage private sector participation, enhance efficiency, and improve service delivery in the power sector. Despite the policy efforts in the country power sector, most of the power infrastructure in Nigeria are outdated and poorly maintained. This includes generation plants, transmission lines, and distribution networks, leading to inefficiencies and frequent breakdowns. On the other hand, the traditional funding options are obviously unsustainable for economies of less developing countries like Nigeria, hence the need for private capital such as Foreign Direct Investment (FDI). The lack of modern infrastructure, fragility of the national grid and lack of spinning reserves; discourages potential investors who require a reliable power supply for their operations. Hence, the paper was motivated to examine the impact of power sector development on foreign direct investment growth in Nigeria from 1986 to 2023.

Literature Review

Conceptual Review

Foreign Private Investment is made up of both Foreign Direct Investment (FDI) and Foreign Portfolio Investment (FPI). In the Nigerian context, FDI forms the largest part of foreign inflow of capital and in many quarters, it is regarded as foreign private capital. This is primarily because of the place of Multinational Corporations in the economic and political development of the country. Generally, FDI takes place when an investor

establishes foreign business operations or acquires foreign business assets, including establishing ownership or controlling interest in a foreign company (Chitadze, 2022). Foreign Direct Investment (FDI) is defined by the World Bank (2010) as investment to acquire a lasting management interest (10 per cent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of private equity capital, reinvestment of earnings, other long-term capital and short-term capital as shown in the balance of payments.

Power generation capacity, referring to the maximum amount of electricity that can be produced by power plants within a country, is a fundamental aspect of the power sector. This capacity is crucial for meeting the diverse electricity demands of residential, commercial, and industrial users, impacting the overall economic stability and growth of a nation (IEA, 2019). Installed capacity is a critical component of a country's power sector. It directly influences the ability to meet growing electricity demands, support economic activities, enhance the quality of life, attract foreign investment, and ensure overall energy security. For countries like Nigeria, increasing installed capacity is essential for achieving sustainable economic growth and development. Furthermore, capital expenditure in the power sector is essential for building, maintaining, and expanding the infrastructure required to generate, transmit, and distribute electricity. This framework provides an in-depth look at the types of investments, planning and forecasting processes, and key considerations involved. Capital expenditure in the power sector includes investments in several key areas. One crucial area is generation facilities. This involves building new power plants, including those powered by fossil fuels, nuclear reactors, and renewable energy sources such as solar farms and wind turbines. These investments are vital for meeting growing electricity demand and facilitating the transition to cleaner energy sources (International Energy Agency, 2020). While, recurrent expenditure in the power sector involves the ongoing costs required to maintain and operate the infrastructure necessary for generating, transmitting, and distributing electricity. Effective management of these expenditures is crucial for ensuring reliable electricity supply and overall system efficiency. Recurrent expenditures in the power sector include operational costs, which encompass the day-to-day expenses of running power plants, transmission lines, and distribution networks. These operational costs cover fuel for power generation, salaries and wages for employees, and expenses for routine maintenance and repairs (International Energy Agency, 2020). Also, the distribution framework in the power sector involves the systems and processes used to deliver electricity from transmission networks to end-users, including households, businesses, and industries. Here, substations play a critical role in maintaining voltage stability and managing the flow of electricity to various parts of the distribution network (U.S. Department of Energy, 2020). Distribution networks also include various control and safety devices. These devices, such as circuit breakers, switches, and protective relays, are essential for managing the flow of electricity and protecting the network from faults and overloads. They help ensure the safety and reliability of the electricity supply (Electric Power Research Institute, 2019).

Empirical Review

Depending on quarterly secondary data from the National Statistics of China, World Bank, UNCTAD, National Institute of Statistics of Rwanda, and the National Bank of Rwanda; Abadata and Ze (2024) explored predictors of the foreign investment from China coming into Rwanda from 2007 to 2020. From literature and based on the availability of data, market size, trade openness, infrastructure, and human capital were measured as predictors of Chinese FDI. The data were analyzed using Linear Regression. The finding of the study showed that variables have a positive effect on FDI from China, and it found that though FDI had an effect on overall economy of Rwanda, the effect was not statistically significant. The study suggested that Rwanda's policy on foreign investment should aim to attract and encourage Chinese investment to increase the economy of Rwanda. To encourage more FDI, the Rwandan government can offer Chinese investors greater ownership, locational, and internalization benefits. It also should continue to strengthen economic policy transparency since it lowers transaction costs and hence improves incentives for foreign investment.

Tsaurai. (2023), investigated the dynamics of foreign direct investment (FDI) inflows into Central and Eastern European countries (CEECs) using panel data (1994–2020) analysis methods such as fixed effects, fully modified ordinary least squares (FMOLS) and random effects. Specifically, the study examined what factors could account for the mixed pattern of FDI inflows into CEECs. The mixed results from the existing empirical literature on FDI inflow dynamics triggered the undertaking of this study to contributed to the ongoing debate on the subject. The study noted that infrastructural development, economic growth and domestic investment had a significant positive influence on FDI across all three panel data analysis methods. Other variables that were found to have had a significant positive effect on FDI include (1) complementarity between in-frastructural and financial development (fixed effects, random effects), (2) trade openness (fixed effects) and (3) savings (random effects, FMOLS). A significant negative impact of the exchange rate on FDI was observed under the FMOLS. CEECs are therefore urged to implement policies to increase infrastructural development, financial development, trade openness and savings to enhance the inflow of FDI. Future studies should investigate the minimum threshold levels of the explanatory variables of FDI.

Chowdhury and Anuradha (2023) analysed the determinants of net inward FDI for four Asian countries, China, Japan, India, and Korea by considering the generic FDI theory models like Flying Geese Model and Eclectic theory. It considers GDP growth rate, Inflation (proxy for economic stability), Nominal exchange rate and Real interest rate (proxy for cost of capital) as the independent variables. The paper found the existence of a long run cointegration between FDI inflow, GDP growth rate, Inflation and exchange rate using ARDL model with significant Error Correction Terms for all four countries. However, the analysis found out that no specific set of common variables help to determine FDI for all the countries. The study concluded that a country specific FDI model may be better fit than a generic FDI theory-based model.

Adopting the data of Chinese listed enterprises from 2011-2020, Yu *et al*. (2023) investigated the impact of the Belt and Road Initiative (BRI) on corporate overseas investment (COI) and its mechanisms via exploiting the difference-in-differences model (DID). Results showed that the BRI has significantly facilitated the COI along the routes. Further, mechanism analysis verified that tax incentives and credit environment improvement are the main channels by which BRI enhances COI. Heterogeneity results revealed that this initiative is more prominent for small and medium-sized enterprises and enterprises in dominant industries. The extensive analysis suggested that from a sustainable development perspective, the BRI facilitates more overseas investment of enterprises in polluting or high energy-consuming industries; the COI is more affected by BRI in regions with more stringent environmental regulations.

Relying on Ownership; Location, Internalization (OLI) and Transaction Cost Economies (TCE) Theories, Mahbub *et al* (2022) bridged existing research gap by exploring the determinants of foreign direct investment (FDI) in the renewable energy sector in Bangladesh. Based on semi-structured interviews with 13 experts, the study investigated the determinants of firms' decision-making processes in the UK, Singapore, USA, Denmark, Thailand, China, and South Korea, conducting FDI in the renewable energy sector in Bangladesh. The results showed that the institutional environment assumes the highest weight over macroeconomic and natural conditions for attracting FDI in Bangladesh's wind and solar energy projects. In the macro-economy, economic growth and access to local finance are important in attracting FDI. Contrarily, land availability assumes the highest importance for attracting FDI in the natural condition dimension.

Employing a panel data covering 36 African countries from 2000 to 2017, Nguea and Kaguendo (2022) investigated the effects of FDI, remittances and foreign aid on access to electricity. The study used a dynamic empirical model based on system GMM to control for unobserved heterogeneity and potential endogeneity of the explanatory variables. The results showed that FDI and remittances matter for increasing access to electricity. Also, foreign aid reduces access to electricity. Further findings revealed that remittances reduce urban-rural disparities in access to electricity, while FDI and foreign aid increase disparities. The study recommended that African countries should pursue adequate reforms to create a favourable environment to international investment in the power sector by prioritizing the flows of FDI and remittances.

Using panel data and comparing two groups of fast-growing emerging countries, namely BRIC (Brazil, Russia, India, China) and CIVETS (Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa), Kechagia and Theodore (2022) investigated the role of governance in attracting FDI. Findings suggested that FDI inflows in BRICS are attracted by rule of law, regulatory quality, political stability and absence of violence, while CIVETS absorb FDI inflows due to control of corruption, political stability, absence of violence, regulatory quality and government effectiveness. The paper contributed to the existing literature since it is the first attempt to investigate the role of governance in attracting FDI in BRIC and CIVETS economies, taking into consideration other FDI

determinants. The study recommended that recipient countries abolish trade restrictions and barriers and strengthen anti-regulations, considering the positive relationship between trade openness and FDI.

Using a novel dataset, Rashed *et al*. (2022) examined the existence and nature of cointegration and causality nexuses among FDIREI, REP, and economic growth (GDP) in 32 African countries over 2003–2019. For methodological robustness purposes; GDP is added. By applying the panel vector Autoregression model based-Granger causality test and a static panel data model, which are followed by robustness tests, more informative results are reported. The paper found evidence of the growth hypothesis between REP and GDP, as a unidirectional Granger causality is seen from REP to GDP. Further, the neutrality hypothesis is confirmed among the remaining variables. The paper suggested the importance of REP in revitalizing African countries' economic growth. All facets of REP thus should be enhanced.

Murshed *et. al* (2022) evaluated the impacts of FDI inflows on enhancing renewable energy use and attaining environmental sustainability in Bangladesh between 1972 and 2015. Using the autoregressive distributed lags with structural break approach to estimate the short- and long-run elasticities, it is found that FDI inflows enhance the share of renewable electricity output in the total electricity output levels of the country. Besides, FDI inflows are also evidenced to directly hamper environmental quality by boosting the ecological footprints figures of Bangladesh. Hence, it can be said that FDI promotes renewable electricity generation in Bangladesh but transforms the nation into a pollution haven. However, although FDI inflows cannot directly reduce the ecological footprints, a joint ecological footprint mitigation impact of FDI inflows and renewable electricity generation is evidenced. Besides, the findings also verified the authenticity of the Environmental Kuznets Curve hypothesis in Bangladesh's context. Therefore, economic growth can be referred to as being both the cause and the panacea to the environmental problems faced by Bangladesh. These results, in a nutshell, calls for effective measures to be undertaken for attracting the relatively cleaner FDI in Bangladesh whereby the objectives of renewable energy transition and environmental sustainability can be achieved in tandem. In line with these findings, the study recommended several appropriate financial globalization policies.

Rehman *et al.* (2022) investigated the impact of infrastructure on spurring inward foreign direct investment (FDI) within the purview of human capital, GDP per capita, foreign aid, trade, domestic investment, population and institutional quality in Belt and Road Initiative (BRI) countries. The adopted system generalized method of movement (GMM) approach for 66 BRI countries from Europe, Asia, Africa and the Middle East. Results demonstrated that aggregate and disaggregate infrastructure indices, e.g. transport, telecommunications, financial and energy infrastructures, are the driving forces in attracting foreign direct investment (FDI) in the BRI countries. In addition, control variables (i.e. institutional quality, human capital, trade, domestic investment, foreign aid and GDP per capita) play an essential role in spurring FDI inflows. The study

suggested that policymakers should promote better institutions (like reducing corruption, favorable political stability, law and order situation, investment profile and bureaucratic quality), attracting foreign investors to employ their investments in BRI countries.

Pe˘cari´c *et al*. (2021) analyzed the system determinants and transmission mechanisms of the sectoral structure of FDI inflows on the sample of 10 CEE for the period 1995–2019. Following a critical analysis of previous research, a panel model was constructed in the empirical section. A developed credit market and the purchasing power of residents lead to greater capital inflows into the services sector, while a higher GDP growth rate and a depreciated real exchange rate led to higher inflows into the manufacturing sector. The study recommended that changing the structure of the domestic economy based on clear industrial and investment policies is the best way to attract developmentally efficient FDI.

Using a novel dataset of foreign direct investment (FDI) corporations in the renewable electricity industry (REI), coupled with a large range of employed variables, Rashed *et. al*. (2021) empirically examined FDI determinants in the REI in Africa between 2003 and 2019. The electricity insecurity issues worsen daily, aggravating all facets of African life. A range of promising and informative results were found using the FDI panel gravity fixed effects Poisson pseudo-maximum likelihood model. Further findings revealed the uselessness of fossil fuel subsidy changes in stimulating green FDI in Africa. However, a 1% growth in Africa's gross domestic product expands FDI by almost 1.5%. Similarly, one additional point in the corruption index reduces FDI by about 1.2%. Furthermore, increasing the number of educated African children and raising renewable energy awareness contributes constructively to the REI and sustainable energy development. The study recommended that to mitigate the energy issues, policymakers should elevate clean power consciousness among Africans and enhance sustainable energy support and policies.

Kang *et. al.* (2021) investigated the relationship between urban population (UP), carbon dioxide (CO2), trade openness (TO), gross domestic product (GDP), foreign direct investment (FDI), and renewable energy (RE). Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) models for estimation were used in the study, which covered yearly data from 1990 to 2019. Results suggest that there is a significant and negative nexus between FDI and renewable energy in South Asian nations. The study's findings revealed a strong and favorable relationship between GDP and renewable energy use. The study recommended that policymakers in South Asian economies should view GDP and FDI as fundamental policy instruments for environmental sustainability. To reduce reliance on hazardous energy sources, the government should also reassure financial sectors to participate in renewable energy.

Inglesi-Lotz and Ajmi (2021) examined the impact that electricity prices and supply, as representatives of the energy conditions of South Africa (SA) as a host country, had to the

attractiveness of FDI to SA. To do so, this study used the Autoregressive Distributed Lag (ARDL) cointegration approach for the period 1985 to 2018. The findings of the study indicated that indeed the initial hypotheses have been confirmed: (1) electricity supply is a positive contributor to inward FDI, ceteris paribus, and (2) electricity prices are a negative contributor to inward FDI, ceteris paribus. The study recommended that policy makers should promote other technological avenues for accessing energy to investors, alternative to their purchasing electricity from the national grid.

Natasya (2021) examined the factors that influence FDI in East Kalimantan Province. The dependent variable is FDI and the independent variables are GRDP per capita, Human Development Index (HDI), Electricity Infrastructure, Communication Infrastructure, Road Infrastructure Length, and Government Expenditure, which fulfilled the criteria for this research data from 2015-2019. This study model is a regression of panel data that is a mixture of cross-section data and time series data and is analyzed using multiple linear regression models of fixed effect analysis as the chosen model. The research findings showed that the GRDP per capita, HDI, communication infrastructure, and length of road infrastructure variables have a positive and significant impact on FDI in East Kalimantan. Meanwhile, the electricity infrastructure and government expenditure variables do not have a significant effect on FDI in East Kalimantan. The study recommended that the East Kalimantan Government should prioritize variables that have a substantial impact on FDI in East Kalimantan thus that they might optimize FDI growth without ignoring other variables.

Mbiankeu (2020) investigated the effects of communication, energy and transport infrastructures development on Foreign Direct Investment (FDI) in Cameroon. The study employed Autoregressive Distributed Lag (ARDL) approach to cointegration and an Error Correction Model using time series data for the period 1984-2014. The results revealed that communication infrastructure has a positive and significant impact on FDI in both the long run and the short run. Findings also revealed a negative impact of energy infrastructure in attracting FDI in the long run and in the short run while an insignificant impact of transport infrastructure on FDI is registered in both the long run and the short run. The results suggested that the improvement of business climate trough better infrastructures play a major role in attracting FDI in Cameroon.

During the years 1981–2014, Ogunjimi and Amune (2019) investigated the contributions infrastructure made to FDI in Nigeria. It also investigated the type of infrastructure that has more impact on FDI attraction. The study used Autoregressive Distribution Lag (ARDL) framework to determine the long-run relationship among the variables and the result shows that there is a long-run relationship between infrastructure and FDI in Nigeria. The result of the estimation of the selected ARDL Error Correction Model showed that none of the infrastructure variables (tractor, telephone lines and electricity) employed in this study is significant to attract FDI into Nigeria in the short-run although electricity production (power supply) was found to influence FDI in the long-run. The study thus recommended that the power sector be revitalized and should be given

priority as it will attract FDI, increase national output and move Nigeria closer to actualizing her dream of becoming one of the twenty leading economies in the world by the year 2020.

Manyuchi (2016) examined the relationship between foreign direct investment (FDI) and the transfer of technology in Angola's energy sector. The analysis is based on qualitative case study methodology research conducted in Angola in 2014 and revealed that energy production and distribution-technology infrastructure, including machinery and human skills, have been developed largely through FDI inflows. There is, however, no evidence that this FDI has enlarged Angola's endogenous scientific and technological research capabilities in the energy sector; therefore, policies that promote these capabilities, especially manufacturing capabilities, should be introduced.

Theoretical Framework

The theoretical underpinning of this paper is the Ownership-Location-Internalization (OLI) Eclectic Theory, proposed by Dunning (1988) has been adopted as a theoretical framework for this study. The theory focuses on three forms of international growth: licensing, exports, and FDI. This model supports managers in choosing appropriate strategies for expansion, emphasizing the importance of proper understanding. Before entering foreign markets, managers must make decisions such as screening the market, deciding whether to export, screen the product, enter a joint venture, or take control in a brown-field investment.

The OLI framework is an extension of the internalization theory, which originated from the transaction theory. The model was developed to understand FDI worldwide and helps firms select markets that offer prospects for growth and fit strategically with their company. The International Market Selection (IMS) process has three stages: market screening, market identification, and market selection. The theory is deemed appropriate as a theoretical framework owing to its suitability in capturing contemporary trends in international trade. The theory relaxes some of the restrictive assumptions of the classical models (absolute advantage and comparative advantage) of international trade and captured the essential role of factor endowments in determining a country's comparative advantage and international trade position.

Methodology

The paper adopted a time series expo facto research design. Time series expo factor research design is a method of research that can truly test hypotheses concerning cause-and-effect relationships, as well as combines the theoretical consideration with empirical observation. The design of this paper is quantitative as it is meant to collect and analyse given data on the relationships between foreign capital flows and economic growth in Nigeria.

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Model Specification

The model for the paper based on the theoretical framework and modified model of Ogunjimi and Amune (2019) that examined the impact of infrastructure on foreign direct investment in Nigeria. The model applied in the paper is of the form;

$$InFDI_t = \beta_{it} + \beta_1 InELPD_t + \beta_2 InFTS_t + \beta_3 InTRCT_t + \varepsilon_t$$

Where, In: Natural logarithm; FDI = Foreign Direct Investment; ELPD = Electricity Production (KwH); FTS =Fixed Telephone subscriptions (per 100 people); TRCT = Tractors per 100 sq. km of arable land;

However, the above model was modified by decomposing power sector development into power sector capital expenditures, power sector recurrent expenditures, power sector generation and power sector distribution. Thus, equation (1) can be functionally rewritten in semi-logarithm equation as:

$$FDI_t = \beta_{it} + \beta_1 InPSCEX_t + \beta_2 InPSREX_t + \beta_3 InPSGN_t + \beta_4 PSDT + \varepsilon_t \qquad (2)$$

Where, In = Natural logarithm; FDI = FDI net inflow as percentage of GDP.,PSCEX = Power sector capital expenditures., PSREX = Power sector recurrent expenditures., PSGN = Power sector generation proxy by megawatts of electricity generation from natural gas., PSDT = Power sector distribution measured by access to electricity (% of population). β_0 = The intercept or autonomous parameter estimate, $\beta_1 to \beta_4$ = Parameter estimate representing the coefficient of PSCEX, PSREX, PSGN and PSDT respectively, and ε_t - other variables not explicitly included in the model.

Furthermore, the a priori expectations of the parameters to be estimated are as expressed below:
$\beta_1 > 0$; The coefficient of power sector capital expenditures is expected to be positive and have a positive impact on foreign direct investment.

$\beta_2 > 0$; The coefficient of power sector recurrent expenditures is expected to be positive and have a positive impact on foreign direct investment.

$\beta_3 > 0$; The coefficient of power sector generation is expected to be positive and have a positive impact on foreign direct investment.

$\beta_4 > 0$; The coefficient of power sector distribution is expected to be positive and have a positive impact on foreign direct investment.

Power sector infrastructures such as capital expenditures, recurrent expenditures, power sector generation and power sector distribution acts as a support network for the new technology brought in by foreign direct investors (Craigwell, 2012). Similarly, the conducive environment brought by a developed infrastructure attracts foreign direct investors (Denisia, 2010). The paper used the Fully Modified Ordinary Least Squares to examine the impact of power sector development on foreign direct investment growth in Nigeria from 1986 to 2023.Thus, the mathematical formulation of equation (2) starts with the cointegrating regression as follows:

$$FDI_t = \beta_0 + \sum_{t=1}^{T} \beta_1 InPSCEX_t^* + \sum_{t=1}^{T} \beta_2 InPSREX_t^* + \sum_{t=1}^{T} \beta_3 InPSGN_t^* + \sum_{t=1}^{T} \beta_4 PSDT_t^* + \varepsilon_t \quad (3)$$

Where $PSCEX_t^*$, $PSREX_t^*$, $PSGN_t^*$ and $PSDT_t^*$ are the transformed variables adjusted for serial correlation and endogeneity. A key strength of the FMOLS lies in its ability to account for potential endogeneity in the independent variables and serial correlation in the error terms. The FMOLS applies adjustments to mitigate potential biases and serial correlation issues that often arise in OLS estimations when dealing with non-stationary data, that is common in time series analyses of economic variables.

Additionally, the FMOLS offers flexibility in terms of the integration order of the variables under study. By implication, whether the variables are integrated or order zero, one, mixed or even fractionally integrated, the FMOLS can be effectively applied. This versatility allows for a rigorous analysis without imposing strict assumptions about the integration properties of time series data.

Data Analysis and Results

Variables Description and Measurements

Table 1 gives specific summary of variables description, measurements and source of data.

Table 1: Variables Description and Measurements

Variable	Acronym	Description	Measurement	Source
Foreign direct investment	FDI	An investment made by a firm or individual in one country into business interests located in another country.	Annual (Percentages)	World Development Indicators (World Bank, 2024)
Power sector capital expenditures	PSCEX	These are spending of government for the generation, transmission and distribution of electricity in a given economy	Annual (₦' B)	Central Bank of Nigeria (CBN, 2024)
Power sector recurrent expenditures	PSREX	These are costs required to maintain and operate the infrastructure necessary for generating, transmitting, and distributing electricity	Annual (₦' B)	Central Bank of Nigeria (CBN, 2024)
Power sector generation	PSGN	Megawatts of electricity generation from natural gas	Annual (GWh)	International Energy Agency (IEA, 2024)
Power sector distribution	PSDT	This is measured by access to electricity (% of population).	Annual (Percentages)	World Development Indicators (World Bank, 2024)

Source: Researchers' Compilation, 2024

Results

Descriptive Statistics

Table 2 presents the descriptive statistics for the paper.

Table 2: Descriptive Statistics

	FDI	PSCEX	PSREX	PSGN	PSDT
Mean	1.363622	126.2733	209.0838	20774.13	52.32083
Median	1.452078	128.1100	229.8650	22099.00	52.75000
Maximum	2.900249	264.6900	611.3200	29145.00	60.70000
Minimum	-0.039520	27.97000	4.560000	9099.000	43.20000
Std. Dev.	0.826470	69.11398	178.7035	6426.882	5.291337
Skewness	0.183026	0.268797	0.489671	-0.279771	-0.110578
Kurtosis	2.020143	2.032323	2.331050	1.761253	1.972046
Jarque-Bera	1.094115	1.225407	1.406604	1.847580	1.105599
Probability	0.578650	0.541884	0.494948	0.397012	0.575337
Observations	24	24	24	24	24

Source: Author's Computation, 2024 (Eviews-12)

From table 2, Foreign direct investment (FDI)has an approximate average of 1.36%and it ranges from -0.039520(minimum) to 2.900249 (maximum), with a standard deviation of 0.82%. While, power sector capital expenditures (PSCEX) have a mean value of ₦126.2733billion, with the standard deviation of ₦69.11398billion, minimum and maximum values of 27.97000and 264.6900respectively. Similarly, power sector recurrent expenditures (PSREX)has an approximate average of ₦1209.0838billion and it ranges from 4.560000 (minimum) to 611.3200 (maximum), with a standard deviation of ₦178.7035 billion. Also, power sector generation (PSGN) has an approximate average of 20774.13Megawattsand it ranges from 9099.000(minimum) to 29145.00 (maximum), with a standard deviation of 6426. 882GWh. Further, power sector distribution (PSGN), has an approximate average of 52.32 percent and it ranges from 43.20000(minimum) to 60.70000 (maximum), with a standard deviation of5.29 percent.

Furthermore, Table 2 displayed the skewness coefficient, a measure of how far a distribution deviates from symmetry, with all the variables having skewness values greater less than one. The entire data series are not platykurtic (not having negative values), as confirmed by the kurtosis result, which measures a distribution's degree of peakedness in relation to a normal distribution. Additionally, as evidenced by the probability values of each variable's corresponding Jarque-Bera statistics, the null hypothesis is firmly supported for all five variables in their nominal form. Since the accompanying Jarque-Bera probability values of these variables have a significance level larger than 5%, it may be concluded that they have a normal distribution.

Unit Root Test

Time series data frequently display trends that can be addressed with differencing, mainly to determine the data's stationarity. To ascertain the stationarity of the series, an essential step in time series analysis is the Augmented Dickey-Fuller (ADF) unit root test, whose findings are shown in Table 3.

Table 3: Unit Root Test Result

Variable	Method	Level Stat. (Prob.)	First Diff. Stat. (Prob.)	Order of Integration
FDI	ADF	-3.898116* (0.0049)	-9.429910*(0.0000)	I(0)
PSCEX	ADF	-3.110337(0.1189)	-5.524437*(0.0049)	I(1)
PSREX	ADF	-0.254836 (0.9891)	-5.891389*(0.0001)	I(1)
PSGN	ADF	-2.452785 (0.3457)	-6.193721*(0.0003)	I(1)
PSDT	ADF	-6.747479* (0.0000)	-5.804995*(0.0003)	I(0)

*Note: * significant at 1%*

Source: Authors Computation, 2024 (Eviews-12)

Results in Table 3 revealed that FDI and PSDT variables tends to be stationary at level. However, all other variables are likely to be stationary in first difference. I (0) and I (1) are hence the integration order.

Cointegration Test

Co-integration makes sure that even non-stationary individual series can have stationary linear combinations, indicating a constant long-term association between them. To determine whether the relevant variables have a long-term relationship, the Engle and Granger (Residual Based) Cointegration Test was employed. Table 4 summarizes the findings of the Co-integration test utilizing the Engle and Granger (Residual Based) Cointegration Test.

Table 4: Result of Engle and Granger (Residual Based) Cointegration Test

Residual		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic @ (Levels)		-3.257757*	0.0023
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	

*Note: * significant at 1%*

Source: Authors Computation, 2024 (Eviews-12)

The results of Engle and Granger Residual Based Cointegration Test" is -3.257757, exceeding the critical value at the 1% significance level of-2.669359, suggesting co-integration. This indicated that the null hypothesis of no cointegrationis rejected at the 1% level, meaning that a significant long term equilibrium relationship exists amongst the variables under review. The estimation of FMOLS regression was then carried out.

Fully Modified Ordinary Least Squares (FMOLS) Regression Results

The Fully Modified Ordinary Least Squares (FMOLS) Regression findings for the model are shown in Table 5 to provide some intriguing insights into the direct impact of power sector development on foreign direct investment growth in Nigeria from 1986 to 2023.

Table 5: Fully Modified Ordinary Least Squares (FMOLS) Result
Dependent Variable: FDI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PSCEX)	1.380447	0.261341	5.282173	0.0001
LOG(PSREX)	-0.760262	0.162429	-4.680572	0.0002
LOG(PSGN)	-0.662006	0.860547	-0.769285	0.4517
PSDT	-0.013652	0.043006	-0.317445	0.7546
C	5.556193	6.992428	0.794601	0.4372
R-squared	0.723405			
Adjusted R-squared	0.685269			
Wald-Fstat	19.83061			
Wald-pvalue	0.0000			
Long-run variance	0.247618			

Source: Authors Computation, 2024 (Eviews-12)

From Table 5, two out of the four explanatory variables used in this paper have statistically significant influence on foreign direct investment growth in the long run during the period under review. By implications, power sector capital expenditures and power sector recurrent expenditures are important in explaining foreign direct investment growth in Nigeria. Furthermore, power sector capital expenditures variable agrees with the paper a'priori expectations. However, power sector recurrent expenditures, power sector generation and power sector distribution does not conform to the paper a'priori expectations in the long run.

Discussion of Findings

The research started with descriptive statistics of all the variables in order to determine their inter-relationships. One of the reasons for descriptive analysis is to find the mean and standard deviation of the data. The result of the descriptive statistics revealed that the means of the five variables in this paper were all positive, with power sector recurrent expenditures (PSREX) having the highest average value. Also, all the variables have skewness values greater less than one, and the entire data series are not platykurtic (not having negative values), as confirmed by the kurtosis result, which measures a distribution's degree of peakedness in relation to a normal distribution. Additionally, as evidenced by the probability values of each variable's corresponding Jarque-Bera statistics, the null hypothesis is firmly supported for all five variables in their nominal form. Since the accompanying Jarque-Bera probability values of these variables have a significance level larger than 5%, it may be concluded that they have a normal distribution.

Since the analysis is based on time series data and in order to avert the occurrence of spurious results and to determine the order of integration. Thus, the variables were investigated for their stochastic properties, using the Augmented Dickey-Fuller (ADF). From the unit root test result, FDI and PSDT variables tends to be stationary at level. However, all other variables are likely to be stationary in first difference. I (0) and I (1) are hence the integration order. Thereafter, to determine whether the relevant variables have a long-term relationship, the Engle and Granger (Residual Based) Cointegration Test was employed. The cointegration test result indicated that the null hypothesis of no cointegration is rejected at the 1% level, meaning that a significant long-term equilibrium relationship exists amongst the variables under review. The estimation of FMOLS regression was then carried out.

The estimated FMOLS regression revealed that two out of the four explanatory variables used in this paper have statistically significant influence on foreign direct investment growth in the long run. Suffices to say that, power sector capital expenditures and power sector recurrent expenditures are important in explaining foreign direct investment growth in Nigeria. Furthermore, power sector capital expenditures variable agrees with the paper a'priori expectations. However, power sector recurrent expenditures, power sector generation and power sector distribution does not conform to the paper a'priori expectations in the long run. On a basis of variable-by-variable analysis, the paper found

that power sector capital expenditure is significant and positively correlated with foreign direct investment growth in Nigeria. In other words, power sector capital expenditure stimulates FDI growth. This can be interpreted that there will be an increase of 1.38% in FDI growth in case of a 1% increase in power sector capital expenditure. This outcome is consistent with the a priori expectations of the investigation and prior studies such as Abadata and Ze (2024), Tsaurai (2023) and Rehman *et al* (2022) who all reported that infrastructure indices such as power sector capital expenditures are the driving forces in attracting foreign direct investment FDI inflows.

On the other hand, the findings indicated power sector recurrent expenditure is significant but negatively correlated with FDI growth. In other words, power sector recurrent expenditure decreases FDI growth. Controlling for other factors, for instance, a 1 percent increase in power sector recurrent expenditure will decrease FDI growth by of -0.76% in the long run. This outcome is inconsistent with the a priori expectations of the paper and Abadata and Ze (2024), Tsaurai (2023) and Rehman *et al* (2022) who all reported that infrastructure indices such as power sector recurrent expenditures are the driving forces in attracting foreign direct investment FDI inflows.

Also, the estimated impact of power sector generation on FDI growth is negative and insignificant in the long run. This implies that power sector generation does not stimulates FDI growth. By implication, one percentage change or increase in power sector generation will lead to -0.66% decrease in FDI growth in the long-run. This outcome is inconsistent with the a priori expectations of the investigation of Manyuchi (2016) who concluded that energy production and distribution-technology infrastructure, including machinery and human skills, have been developed largely through FDI inflows.

Furthermore, the results indicated that power sector distribution affects FDI growth negatively and insignificantly in the long run. This means that power sector distribution does not encourage FDI growth. In case of a 1% increase in power sector distribution, it is foreseen that there may be a decrease of -0.01% in FDI growth. This outcome does not conform to the paper a'priori expectations in the long run and study of Inglesi-Lotz and Ajmi (2021) that found power sector distribution in form of electricity supply to positively related to inward FDI, ceteris paribus. However, this finding is agreement with Nguea (2020) who observed negative impact of energy infrastructure in attracting FDI in the long run and in the short run. The R-squared value of 0.723405implies that the model is a good fit as over 72% variation in FDI growth is explained by the explanatory variables. Even after removing the impact of insignificant estimators, the adjusted R-squared value of 0.685269implies that the model is still very good. Therefore, the paper's conclusions can be relied upon for formulating policy recommendations. The Wald F-statistic of 19.83061, along with a Wald p-value of 0.0000 highlighted the overall reliability and significance of the model. By implications, the selected power sector variables have statistically significant influence on FDI growth, hence reinforcing the validity of the model. While, the long-run variance of 0.247618provided an estimate of the variability of the residuals over the long term. A relatively low long-term variance indicated that the residuals (or

errors) in the model are stable over time, suggesting that the model is reliable for predicting the long-term relationship between selected power sector variables and FDI growth.

Conclusion and Recommendations

The paper investigated the impact of power sector development on foreign direct investment growth in Nigeria from 1986 to 2023.The Fully Modified Ordinary Least Squares (FMOLS) Regression was employed as main analytical technique. Results revealed that two out of the four explanatory variables used in this paper have statistically significant influence on foreign direct investment growth in the long run during the period under review. Furthermore, power sector capital expenditures variable agrees with the paper a'priori expectations. However, power sector recurrent expenditures, power sector generation and power sector distribution does not conform to the paper a'priori expectations in the long run.

On a basis of variable-by-variable analysis, the paper found that power sector capital expenditure is significant and positively related to foreign direct investment growth in Nigeria. While, power sector recurrent expenditure is significant but negatively correlated with FDI growth. Also, the estimated impact of power sector generation on FDI growth is negative and insignificant in the long run. Furthermore, the results indicated that power sector distribution affects FDI growth negatively and insignificantly in the long run. This means that power sector distribution does not encourage FDI growth. Therefore, the following recommendations were raised from the research findings.

i. Given the positive and significant relationship between power sector capital expenditures and FDI growth, the Federal government should prioritize increased capital investment in the power sector, specifically in infrastructure projects like power plants, transmission lines, renewable energy sources as well as intentional expenditure on research and development to boost research into indigenous power installations and improved power generation and distribution processes. Also, the Federal government should expand investment in modernizing power grid systems to improve efficiency, reliability, and sustainability, as these upgrades are likely to enhance Nigeria's attractiveness for FDI.

ii. Since power sector recurrent expenditures are negatively correlated with FDI growth, the Federal government through the Ministry of Power should made efforts to reduce inefficiencies in the recurrent budget. The government should audit and streamline operational costs such as salaries, maintenance, and administrative expenses, focusing on performance-based budgeting to eliminate waste.

iii. Although power generation has a negative and insignificant impact on FDI growth, this may point to issues of unreliability rather than capacity. The government agency like the Nigerian Electricity Regulatory Commission (NERC) should focus on improving the reliability and consistency of power generation by upgrading existing plants, investing in diverse energy sources (e.g., renewables like solar and wind), and ensuring that power plants operate at full capacity.

iv. Since power distribution has a negative and insignificant impact on FDI growth, the Nigerian Electricity Regulatory Commission (NERC) should address inefficiencies in the distribution system, such as high technical and non-technical losses (e.g., electricity theft and poor metering). Further, the NERC should implement smart metering and modern grid management technologies to reduce losses in distribution and improve customer billing accuracy. A more efficient and transparent distribution network will enhance investor confidence in the power sector.

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Appendix A: Data Set Used in the Analysis

Year	FDI(%)	PSCEX (₦'B)	PSREX(₦'B)	PSGN (GWh)	PSDT (%)
1986	0.352544	0.66	0.07	N/A	N/A
1987	1.15907	0.62	0.03	N/A	N/A
1988	0.762696	1.73	0.23	N/A	N/A
1989	4.282088	1.84	0.64	N/A	N/A
1990	1.087951	1.84	0.49	N/A	27.3
1991	1.196726	1.49	0.80	N/A	35.23
1992	1.722383	2.13	0.89	N/A	36.09
1993	2.371903	3.58	1.91	N/A	36.96
1994	2.436852	4.99	0.61	N/A	37.83
1995	0.238322	9.22	0.75	N/A	38.69
1996	0.268818	8.66	2.84	N/A	39.55
1997	0.233794	6.90	3.32	N/A	40.39
1998	0.137154	23.37	3.11	N/A	41.25
1999	1.699069	17.25	11.12	N/A	44.9
2000	1.648321	27.97	11.61	9099	43.2
2001	1.618616	53.34	15.23	9553	43.9
2002	1.971584	32.47	31.03	13311	44.6
2003	1.914621	55.74	4.56	12736	52.2
2004	1.380374	30.03	23.70	16167	46.1
2005	2.836294	71.36	13.20	15771	46.8
2006	2.035753	78.68	12.90	16847	47.6
2007	2.169195	150.90	23.99	16751	50.1
2008	2.413739	152.17	70.73	15389	50.3
2009	2.900249	144.93	126.87	15248	50
2010	1.642074	151.77	281.00	19747	48
2011	2.133118	92.85	217.84	21151	55.9
2012	1.523782	97.40	243.76	23047	53
2013	1.069539	154.71	273.70	23557	55.6
2014	0.817478	111.29	235.03	26885	54.2
2015	0.621502	82.98	224.70	26697	52.5
2016	0.853396	68.80	235.45	28331	59.3
2017	0.642183	167.66	282.53	24443	54.4
2018	0.183821	203.42	321.99	25657	56.5
2019	0.485778	264.69	411.86	24633	55.4
2020	0.551894	194.41	412.37	27324	55.4
2021	0.751569	194.33	411.32	28045	59.5
2022	-0.03952	204.33	521.32	29045	60.5
2023	0.601569	244.33	611.32	29145	60.7

Sources: World Development Indicators (World Bank, 2024); Central Bank of Nigeria (CBN, 2024) and International Energy Agency (IEA, 2024)