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Energy infrastructure and growth of domestic investment in Nigeria: An Ardl approach

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Abstract
Energy infrastructures play a crucial role in growth of domestic investment of any economy. Conventionally, most firms depend on public source of energy for production. Sequel to this, this paper examines the effect of energy infrastructure on domestic investment in Nigeria. Time series data obtained from CBN Statistical Bulletin and World Development Indicator were employed using Autoregressive Distributed Lag (ARDL) Model. Empirical findings show that energy infrastructure has a positive effect on domestic investment but non-significant. The policy .implications of this finding is that government should adopt more stringent supervision and policy to regulate execution of energy infrastructure project; and more funds needed to emancipate energy infrastructure in order to obtain desired level of domestic investment in Nigeria.

Keywords: ARDL, Domestic Investment, Energy Infrastructure Jel Classification: E58, E20, L94

Introduction

The growth and development of any economy depends largely on size of domestic investment. Essentially, developing country such as Nigeria desires sufficient and steady supply of energy infrastructure for domestic investment trepidations either small, medium or large scale businesses in order to achieve anticipated progression and improvement the nation needs (Ogunmuyiwa, Okuneye & Amaefule, 2017). Domestic investment in Nigeria has enormous advantages of stimulating economic growth and development as a result of abundant labour force simultaneously with abundant natural resources in the country. However, the epileptic power supply has not yielded the desired results for desired domestic investment that can position the economy to higher economic growth and development.

Recently, many manufacturing industries in Nigeria have been surrounded by falling efficiency rate which is triggered majorly by acute power supply, over-valued exchange rate (Afam, 2012). Consequently, the low productivity of industry in Nigerian economy is largely attributed to inadequate electricity supply, other internal and external factors (Tomola, 2012). According to

Servens (2010) opined that the level and type of connection between local investment and foreign direct investment (FDI) depends on the multinational firm's objective function

Interaction between FDI and domestic investment is of paramount importance and both can cause each other in an economy. According to Stevens (1969) opined that the level and type of connection between local or domestic investment and FDI 22depend on the multinational firm's objective function and the constrained imposed upon it by financial market and it production process (electricity availability inclusive). Therefore, one cannot conclude that FDI complement or supplement domestic investment in Nigeria. Even, if multinational firm maximizes global profits certain condition still prevails. In addition, relationships exist between the domestic investment, foreign direct investment and exchange rate as element affecting costs and capital allocation. Exchange rate may affect domestic investment positively and negatively as they influence the international trade of goods and their prices (Hooper & Kohlhagen, 1978).

Domestic investment have contributed immensely to Nigerian's gross domestic product, however, earlier studies such as Adetiloye (2011) have not categorically discussed the combined effects of energy infrastructure, exchange rate and FDI on domestic investment in Nigeria. This is a main break in literature and this study aimed to fill this lacuna. Of all modern energy types, electricity access is included most frequently as an explicit objective of national development strategies. Hence, the focus in this chapter is on electricity. Hence, the objective of this paper is to examine the combined effect of electricity infrastructure, exchange rate and FDI on domestic investment in Nigeria.

Literature Review

The Concept of Domestic Investment

Domestic investment is investment made to increase the total capital stock in the domestic economy. This is done by acquiring further capital producing assets and assets that can generate income within the domestic economy rather than abroad (Adetiloye, 2011).

Essentially, domestic investment are crucial element in computing gross domestic output of any economy and also plays dynamic roles towards global trade and foreign exchange earnings as such most countries encourage investment domestically. Given the bulbous role played by the locally made investment in country building, numerous studies have actually evaluated the performance of the sector in the light of the numerous strategies and programmes employed to encourage the progression of domestic investment (Ebi & Emmanuel, 2014).

The Concept of Energy Infrastructure

Energy Infrastructure naturally includes the traditional utilities associated with energy transport and management (coal transport trains, natural gas pipelines, electric transmission lines, etc.). However, the field also covers large-scale energy management technology such as advanced electricity metering and distribution systems, smart building technologies, and modern power plant control systems. The figure below illustrates that the energy infrastructure is effectively the interconnection between energy production and energy consumption (Chan, Forwood, Roper, & Sayers, 2009).

Conceptually, infrastructure may affect domestic investment in two major ways: (i) directly, considering the sector contribution to GDP formation and as an additional input in the production process of other sectors3; and (ii) indirectly, raising total factor productivity by reducing transaction and other costs thus allowing a more efficient use of conventional productive inputs. Hence electricity infrastructure can be considered as a complementary factor for domestic investment (Stewart, 2010).

Energy infrastructure investment is complementary to other investment in the sense that insufficient infrastructure investment constrains other investment, while excessive infrastructure investment has no added value. To the extent that suboptimal infrastructure investment constrains other investment, it constrains growth (Newbery, 2012).

Empirical Review

Quantitative evidence of the impact of electricity on economic development (especially in comparison to other publicly provided services) hardly exists. Stronger evidence is needed for better-informed policy decisions, such as the priorities of public investment options (World Bank 2010). Of all modern energy forms, electricity access is comprised most regularly as an explicit aim of national expansion strategies. Empirical evidence which can be used to corroborate the arguments above is surprisingly scarce. In particular, little direct evidence has been published to underpin energy infrastructure and domestic investment in Nigeria. Medlock and Soligo (2001), Ho and Siu (2006); and Morisset (2000) claim that electrification can reduce poverty through enabling 'productive uses' of electricity. Ozun, and Cifter (2007) showed that one of the reasons why there is little understanding of the links between electricity supply and poverty reduction through income generation is because the relationship consists of several steps and many factors influence each of these steps. The first step towards a business benefiting from electricity supply is the physical provision of electricity and the entrepreneur's decision to make use of it. However, it is the steps that follow, namely the actual use of electricity and the subsequent changes that electricity use brings in the enterprise (e.g. increased productivity), which can ultimately lead to impacts at enterprise level, such as increased income. The theory regarding the causal chain from energy supply infrastructure to development outcomes.

Sekkat and Varoudakis 2004; Asiedu, 2000; Morisset, 2000; Zachariadis, 2007; Loree and Guisinger, 1995; and Wheeler & Moody, 1992 pointed out that energy infrastructure improvement in developing nations have not been given proper attention by previous and current government in Africa and Nigerian government inclusive. The earlier researchers maintained that adequate infrastructural improvement is an indispensable condition for foreign investor to function efficiently because adequate infrastructure reduce cost of production and increase profit.

Asiedu (2002) and Wei (2000) stated that business locality with adequate electricity infrastructure is more attractive than the others, it is established that with adequate infrastructural improvement the nations are rewarded with more investments. Edun (2011) states that it is vital for Nigeria to invest more on infrastructural amenities and reduction in the ever-increasing price of power and cement, with motivations for investors to enter the building material market; it is this infrastructural expansion that will act as the basis for FDI attraction into the most populous nation in Africa. For a country like Nigeria with many neighbouring developing countries, electricity infrastructural development could be a comparative advantage to attract investment.

Borensztein, 1998; De-mello, 1997; & Obwona, 2001 all maintained the fact that FDI is a core mechanism for the repositioning of modern technology, stimulating more to growing than domestic investment. Employing endogenous growth model, in which the level of scientific advancement is the core element of the long-term growth rate of income. It is arguably that for long term capital flows, to benefiting any countries, certain conditions are required such as adequate human capital, sufficient infrastructure, economic stability and liberalized markets (Bengoa & Sanchez-Robles, 2003). Buckley et al (2002) opined that the magnitude to which FDI adds to growth is a function of the social conditions and economic in the recipient economy, nations by means of large savings, trade openness policy and high levels of modern technological give more benefit from augmented FDI to their countries.

Markussen and Vernables (1998) argued that FDI is presumed to complement domestic capital thereby stimulating the productivity of the domestic investments, Borenzstein (1998), and Driffield (2001). Romer (1990) examined a panel models on industrial development, in Chenery (1986) opinion, the quality and quantity of production factors, as well as the conversion of the production processes are elements in developing a competitive advantage.

Krol (2001) summarized the existing literature, which suggests that reduction in congestion and adequate maintenance contribute to greater benefits from public infrastructure. By making use of the Greek data, Rovolis and Spence (2002) have shown that public infrastructure and private capital are complementary. Similarly, Reinikka and Svensson (2002) have shown that poor public capital significantly reduces the complementary private investment, while Boarnet (1998) argues that due to

negative spillover effects, public infrastructure investment can lead to growth in one sector at the expense of the other.

From the previous empirical studies have not sufficiently treated energy infrastructure and economic growth, the basic rationale of this study is to understand how energy infrastructural development improves economic progression and emancipation in host economies. Most of the literatures reviewed, none has been able to show out that frequently that growth in the economy does not translate into emancipation of the economy. Nigeria, regardless of her economic growth over the years has not manifested this into economic emancipation. Hence, this paper attempts to fill this gap in the literatures.

Methodology

Sources of Data

The data used in the paper were obtained from the Central Bank of Nigeria (CBN) and World Development Indicator (WDI). The paper make used of ARDL techniques on time series data that span over 36 years from 1980 to 2016.

Model Specification

The theoretical framework for this study is based on Neo-classical Growth Model which is expressed by :

$Y = Af(K, L)$

Where Y is the Gross Domestic Product (GDP), K is the stock of capital, L is the amount of unskilled labour and A is exogenously determined level of technology (energy). A change in the exogenous variable (A: Energy) will cause a shift in the production function. No doubt, the effect of electricity (energy) is shown through the size of domestic investment and translated to the economy.

The fluctuation in the size of domestic investment is due to inadequate power supply to the industrial activities. Arising from the above, this study posits a functional and behavioural relationship between energy infrastructure and domestic investment as shown below. The functional relationship is stated thus:

$DOI = f(EINFRA, EXCH, FDI)$ (i)

Where:

DOI = Domestic Investment

EINFRA = Energy Infrastructure measured by electricity consumption level by industries

EXCH = Exchange rate

FDI = Foreign Direct Investment

$DOI = \alpha + \beta_1 FDI + \beta_2 EXCH + \beta_3 ENINFRA + u_t$ (ii)

The ARDL model specification is;

$DOI\ \alpha + \sum_{i=1}^{\eta} \beta_i DOI_{t-i} + \sum_{i=0}^{b_1} \theta_i FDI_{t-1} + \sum_{i=0}^{b2} \mu_i EXCH_{t-1} + \sum_{i=0}^{b_3} \Omega_i\ ENIFRA_{t-1} + u_t$ (iii)

$DOI = \alpha + \sum_{i=1}^{\eta} \beta_i DOI_{t-i} + \sum_{i=0}^{b_1} \theta_i FDI_{t-1} + \sum_{i=0}^{b2} \mu_i EXCH_{t-1} + \sum_{i=0}^{b_3} \Omega_i\ ENINFRA_{t-1} + u_t$ (iv)

$DOI = \sum_{i=1}^{\eta} \beta_i\ \Delta DOI_{t-1} + \sum_{i=0}^{b_1} \theta_i\ \Delta FDI_{t-1} + \sum_{i=0}^{b2} \mu_i \Delta EXCH_{t-1} + \sum_{i=0}^{b_3} \Omega_i \Delta ENINFRA_{t-1} + u_t$ (v)

Obtain the error term as

$W_t = DOI_t - (\beta_1 FDI_{t-1} + \beta_2 EXCH_{t-1} + \beta_3 ENINFRA_{t-1})$ (vi)

Rename the error term W_t as ECM and restricts it to lag 1, and inserting it into the short run dynamic equation to get;

$DOI_t = \beta_0 DOI_{t-1} + \beta_1 FDI_{t-1} + \beta_2 EXCH_{t-1} + \beta_3 ENIFRA_{t-1} + ecm_{t-1}$ (vii)

The study now conducts the bound test to obtain the F-stat and x^2 and compares them with the Pesaran statistics both at lower bond I(0) and upper bond I(1). If the computed F-stat and x^2 – stat fall below I(0), there is no co-integration. If they fall in between I(0) and I(1), test is inconclusive but if they fall above I(1), then there is co-integration.

A Priori Expectation

This has to do with the theoretical expectations of each of the variables included in the model. This expectation has to do with the signs as well as the direction of the variables. It denotes the

various ways in which we expect the explanatory variables to affect the dependent variable in the models. Specifically, at 0.05level of significance, all null hypotheses would be rejected if $p - values < 0.05$. *p*– value is a measure of how much evidence exists against the null hypothesis (H_0) and the smaller the p – value, the more evidence exists against the null hypothesis. Furthermore, the null hypothesis would be rejected if adjusted R-square is lower than 0.60 and the calculated F-test (statistical table) is found to be greater than the critical F-test value at the level of significance.

Independent Variable	Full Name	Expected Sign
EXCH	Exchange Rate	-/+
FDI	Foreign Direct Investment	-/+
ENINFRA	Energy Infrastructure	+

Empirical Result

Augmented Dickey-Fuller (ADF) Test

In order to guide against misleading and spurious regression results, this study strictly checked the properties of the variables via the Augmented Dickey-Fuller (ADF) test. The result is presented in table 1 below.

Table 1.*Unit Root Test on Variables with Intercept (1980-2016)*

Series	ADF-Stat	5%	p-value
DOI	-1.226	-2.811	0.558
DOI(1)	-10.662	-3.591	0.000
EXCH	-0.035	1.984	0.938
EXCH(1)	-5.033	-1.932	0.000
FDI	-4.195	-5.104	0.059
FDI(1)	-8.813	-3.583	0.000
ENINFRA	-4.585	-3.445	0.000

Source: Author's Computation, (2017)

The ADF test in Table 1 reveals that EXCH, DOI, FDI were found to be I(1) series, while ENINFRA is I(0). Since the level of integration differs among the variables, the use of Johansen co-integration technique to determine their long run equilibrium becomes inappropriate. Thus, the study adopts the Autoregressive Distributive Lag (ARDL) approach to determine the relationship between the variables.

Autoregressive Distributive lag

Since the time series data are of different order, employing the use of Autoregressive Distributive Lag (ARDL) is suitable for the study. Olanrewaju (2012) explained that co-integration is used to analyse the long-run dynamics between integrated variables of the same order i.e. series made stationary at the same order of differencing. Hence, this justifies the use of ARDL as underlying techniques for this study.

Table 2 *Pre-test ARDL Bounds Test (1980-2016)*

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DOI(-1)	-0.362661	0.209573	-1.730477	0.1041
DOI(-2)	0.141101	0.204177	0.691069	0.5001
DOI(-3)	-0.182114	0.208026	-0.875440	0.3951
DOI(-4)	-0.404510	0.211899	-1.908973	0.0756
FDI	0.153480	0.260380	0.589446	0.5643
FDI(-1)	-0.105522	0.290219	-0.363594	0.7212
FDI(-2)	-0.413102	0.299375	-1.379880	0.1878

FDI(-3)	-0.610315	0.313384	-1.947501	0.0704
FDI(-4)	-0.791206	0.352556	-2.244199	0.0403
INFRA	0.067951	0.046129	1.473061	0.1614
INFRA(-1)	0.075549	0.044118	1.712426	0.1074
EXCH	0.033288	0.054230	0.613819	0.5485
EXCH(-1)	0.105944	0.068239	1.552552	0.1414
EXCH(-2)	0.071123	0.071862	0.989707	0.3380
EXCH(-3)	-0.019097	0.067990	-0.280878	0.7826
EXCH(-4)	-0.164482	0.066745	-2.464338	0.0263
C	2.618584	2.445203	1.070906	0.3011

R-squared	0.783643	Mean dependent var	8.847076
Adjusted R-squared	0.552862	S.D. dependent var	3.602869
S.E. of regression	2.409179	Akaike info criterion	4.901264
Sum squared resid	87.06219	Schwarz criterion	5.679936
Log likelihood	-61.42022	Hannan-Quinn criter.	5.159372
F-statistic	3.395615	Durbin-Watson stat	2.307515
Prob(F-statistic)	0.011287		

Source: Author's Computation, (2017)

The above table is pre-test analysis in determining bounds test among variable, since the R-squared is high and free from auto correlation thus we proceed for actual determination of Bound testing, which is shown below.

Table 3 *ARDL Bounds Test (1980-2016)*

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	6.022184	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Source: Author's Computation, (2017)

From the Bounds testing (ARDL) in table 3 above, it is cleared that the F-Statistic is higher than the lower and upper bound limits. It is concluded that there is long-run co-integration among the variables. This means that jointly the exogenous variables are significant. Therefore, the study proceeds to short run relationship of the variables.

Table 4 *Short run Error Correction Model Result using ARDL Approach (1980-2016)*

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOI(-1))	0.445524	0.392402	1.135376	0.2740
D(DOI(-2))	0.586624	0.327362	1.791975	0.0933
D(DOI(-3))	0.404510	0.211899	1.908973	0.0756
D(FDI)	0.153480	0.260380	0.589446	0.5643
D(FDI(-1))	0.413102	0.299375	1.379880	0.1878
D(FDI(-2))	0.610315	0.313384	1.947501	0.0704
D(FDI(-3))	0.791206	0.352556	2.244199	0.0403
D(EINFRA)	0.067951	0.046129	1.473061	0.1614
D(EXCH)	0.033288	0.054230	0.613819	0.5485
D(EXCH(-1))	-0.071123	0.071862	-0.989707	0.3380
D(EXCH(-2))	0.019097	0.067990	0.280878	0.7826
D(EXCH(-3))	-0.164482	0.066745	-2.464338	0.0263
CointEq(-1)	-0.878184	0.448383	-4.032681	0.0011

Cointeq = DOI - (-0.9770*FDI + 0.0794*INFRA + 0.0148*EXCH + 1.4482)

Source: Author's Computation, (2017)

The ARDL regression result obtained using automatic lag selection method on Eview 9. The Akaike information criterion was used to hand-picked a parsimonius model of ARDL (1,4). The result of the table 4 indicates that there are direct effect of the lags of the DOI, ENINFRA and FDI on domestic investment except EXCH(-3). The Foreign Direct Investment (FDI) shows a positive effect on domestic investment which implies that a rise in FDI will lead to a corresponding increase in domestic investment in Nigeria. Energy infrastructure (ENINFRA) also indicates a positive effect on domestic investment but is non-significant at 5%. The exchange rate (EXCH) shows a negative effect on domestic investment which implies that a change in EXCH will lead to decrease in domestic investment, and is significant at 5%. From this result it is cleared that foreign direct investment, energy infrastructure and exchange rate (which is more significant) affect domestic investment in Nigeria. ENINFRA has a direct effect but non-significant, which has serious economic implication on domestic investment in Nigeria.

The Error Correction Mechanism (ECM) is used to control the short run dynamics and combined effect among the variables. The ECM coefficient must be negative, less than one and significant at 5%. Our results validate these properties because the coefficient of the ECM is -0.87, less than one and using probability value of the ECM, the study affirms that it is highly significant with p = 0.0001. The ECM result signifies that the combined effect is 0.87% which mean that any shock in the long run can be corrected by 0.87% in the short run.

Stability Check

The stability of the ECM should always be checked by graphical investigation (Pesaran, Shin & Smith, 1978). A schematic representation of the Cumulative Sum (CUSUM) and the Cumulative Sum of Square (CUSUMSQ) are also established and fall within the acceptable region with alkaike graph that underpinned our maximum lag selection criterion.

Fig. 1 *Cumulative Sum of Recursive Residuals (Stability Test)*

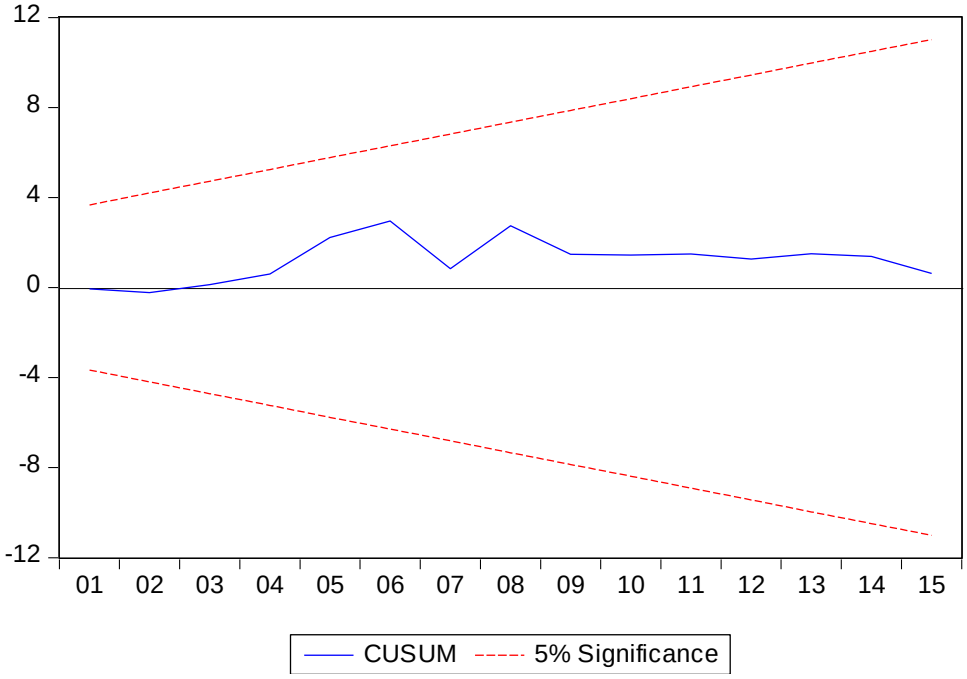


Fig. 2 *Plot of Cumulative Sum of Square of Recursive Residuals (Stability Test)*

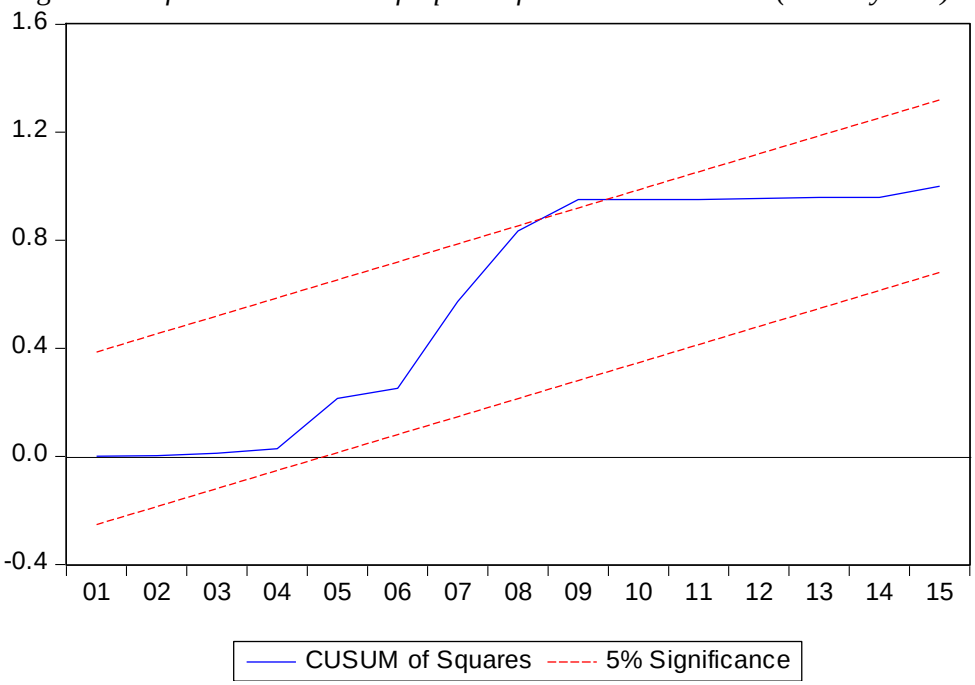
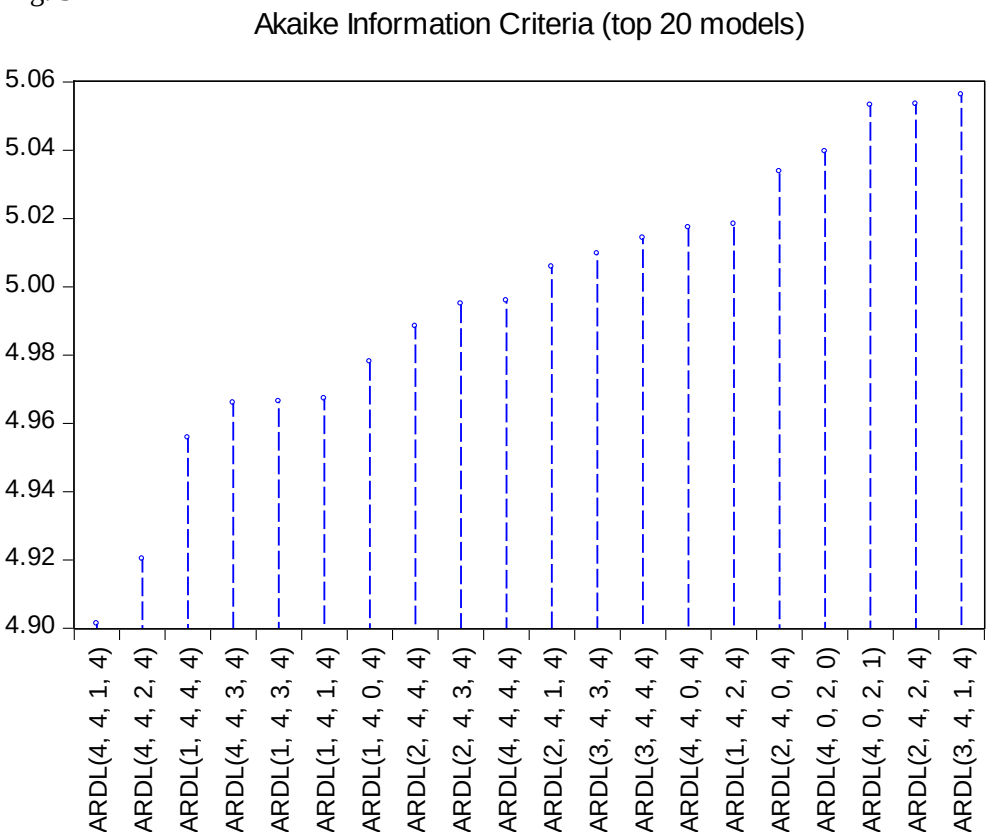


Fig. 3



Discussion of Findings and Concluding Remarks

This paper addressed energy infrastructure and domestic investment in Nigeria. Using electricity consumption rate to measure energy infrastructure in relation to domestic investment in Nigeria. The ARDL results obtained show that there is positive relationship between DOI and FDI in the short run and this result is in line with apriori expectation. It technically means that an increase in FDI will lead to increase in DOI all things being equal. This result corroborates with Levine (2002) findings. The energy infrastructure has expected sign but it is non-significant which indicate most of the government spending on energy infrastructure is not professionally executed as a result of diversion of fund to private pulse in the country. The exchange rate affect domestic investment negatively, this is as a result of high exchange rate in the country translate to high production cost which is transfer to final consumer and hence, lead to reduction of a firm customer based as a result of high in price of a particular commodity.

In sum, the study established that energy infrastructures need more adequate attention and supervision by government since Nigeria has propensity to grow it DOI. The major implication of the positive effect between DOI and ENINFRA is that, there is improvement in energy infrastructure in Nigeria, however, the government needs more stringent supervision, policy and more funds needed to emancipate energy infrastructure in order to obtain desired level of domestic investment in Nigeria.

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