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Infrastructure Investment as a Panacea for Sustainable Economic Growth in Nigeria: A Granger Causality Tests Analysis

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

This paper employed Granger causality tests amid infrastructure spending, economic growth, and employment in Nigeria for the period 1960-2017 using vector autoregression (VAR) model. The result showed a strong causality between infrastructure investment and economic growth in Nigeria. Findings of the study shows a strong underlying relationship between e infrastructure investment and job creation. Economic growth seems to be the key drivers of government jobs and that the private sector jobs drives growth, however, public jobs have not been able to translates into additional jobs in the economy. The bounds test results specify the presence of long-run equilibrium relationship between infrastructure investment, economic growth, job creation and output thereby providing a theoretical underpinning for the empirical results.

Keywords: Infrastructure spending; economic growth; bounds test; public and private sector employment.

1. INTRODUCTION

The prime instrument in which the intentions of government is to achieve speedy growth in economy and augments spending in infrastructure to meet welfare requirements of its population. Every country in the world needs effective transportation, public health, electricity

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and communications systems to thrive for better living standard for its population. Unfortunately, infrastructure gap in Nigeria, may have been the reasons hindering the development and growth to global economic space. The gap in infrastructure according to [1] are the main constraint in attaining the nation's dream of becoming one of the 20 biggest economies in 2020. The small-scale business experiences power outages up five to six times daily, this tend to lower productivity as over 60 percent of the populace have no access to electricity with over $13 billion spent annually to fuel generators. There is poor connectivity between rural and urban centre which translate into deficit in agricultural productivity.

The contribution of infrastructure spending per annum to GDP is around 1.9% (approximately $4 billion) this is poor when compared with other developing countries [2]. The theoretical literature on infrastructure and growth has been noticeably influenced by the work of [3] which shows that the role of infrastructure investments may be offset by the negative impact of additional distortionary taxes to finance them. The negative effect of public spending on growth arises from the distortions to choose and the disincentive effects [4,5]. Infrastructure is broadly divided into two categories: economic and social. The former predictably includes power generation, communications, transport, sanitation facilities and water supply, while the latter includes health-care facilities and educational facilities yet some authors include recreational and cultural facilities. This classification is mostly ad hoc, as numerous forms of infrastructure may be considered as either social or economic infrastructure. Educational facilities, for example, are extensively defined as social infrastructure, nevertheless play a vital role in creating human capital, which is surely also an economic function and carries significant growth implications.

Economic theory identifies five conduits through which infrastructure can really impact on economic growth. To relate these conduits, a brief deviation into basic growth theory is essential. Development economists naturally define growth in terms of a production function for goods and services, where combined economic production is a function of assembly production inputs or factors of production. Although models differ as to which factors of production are regarded as key determinants of combined output. The determinants of aggregate output are positively related to factors of production. An increase in the stock of physical capital will lead to increases in aggregate output. Thus, economic growth arises when additional factors of production turn out to be available and are put to use. However, it is also conceivable that some factors such as political uncertainty may exercise negative impact of aggregate output.

The question is, has infrastructural spending in Nigeria translated to economic growth or what is the short and long run effect of this spending on economic growth of Nigeria? The finds of these paper will help provide policy that are infrastructural driven. The other part of the paper is ordered as follows: section two provides an overview of the related literature which followed the methodology and data analysis. Finally, paper concludes and provides recommendations for the study.

2. LITERATURE REVIEW

Infrastructure investment and economic growth is inconclusive. Some studies also found some partial positive impact of infrastructure on growth [3,6,7,8,9]. There are some other numerous studies that found little or no significantly positive relationship between infrastructure investment and economic growth [10,11,12,13]. It is proven that individual has sets of infrastructural components and it impact on social and economic development varies by way of relationship [14].

Some previous studies on the relationship public infrastructure e.g. [6] have been hurt from econometric bias and spurious correlation. In Nigeria, [15] found long term relations between infrastructure and economic growth. The connection between infrastructure and growth in African countries (Nigeria, Uganda and South Africa) has also been revealed to be positive [16].

Applying Co-integration and Granger causality test for the period 1981 to 2006, [17] examine the impact of investment in public infrastructures on poverty alleviation and thus economic development. They found public infrastructure Granger cause GDP, but fiscal deficit does not Granger cause GDP. [18] examine the impact of infrastructure investments in South Africa. Their result also shows that infrastructure investment has a positive effect on economic growth and development. It is necessity to determine the impact of infrastructure investment on the economic growth. However, this under-scored by the fact that infrastructure, apart from serving as a direct input, can also be an intermediate input in the production process. Thus, activities of the real sector of the economy are influenced by infrastructural investment and consequently their contributions to economic growth [19,20]. Theoretically, disregarding the sectoral multiplier effects could lead to biased and unproductive results. In the controversy in the theoretical literature as to the implication and undeniably direction of causality, this paper seeks to investigate the impact of infrastructure investment on economic growth in Nigeria. The next section focuses on the methodology of the study.

3. METHODOLOGY

The paper employs VAR model and the equations can be specified:

$$(\mathrm{GDPg})_t = \mathrm{a} + \sum_{n=1}^{m} \beta_i (\mathrm{GDPg})_{t-\mathrm{i}} + \sum_{j=1}^{n} \Upsilon_j (\mathrm{EINFIg})_{t-\mathrm{j}} + u_t \qquad (1)$$

and

$$(\mathrm{EINFIg})_t = \theta + \sum_{j=1}^{n} \phi_i (\mathrm{EINFIg})_{t-\mathrm{i}} + \sum_{j=1}^{n} \psi_j (\mathrm{GDPg})_{t-\mathrm{j}} + \eta_t \qquad (2)$$

where,

u_t and η_t are error terms for the two equations respectively.

The Nigerian time series date exhibit a major structural break due to a democratic transition from the military system. Thus equations (1) and (2) are re-specified to include a dummy variable with values of 0 for the military period and 1 for the post military period as follows:

$$(\mathrm{GDPg})_t = \mathrm{a} + \sum_{n=1}^{m} \beta_i (\mathrm{GDPg})_{t-\mathrm{i}} + \sum_{j=1}^{n} \Upsilon_j (\mathrm{EINFIg})_{t-\mathrm{j}} + \delta DUM + u_t \qquad (3)$$

and

$$(\mathrm{EINFIg})_t = \theta + \sum_{j=1}^{p} \phi_i (\mathrm{EINFIg})_{t-\mathrm{i}} + \sum_{j=1}^{q} \psi_j (\mathrm{GDPg})_{t-\mathrm{j}} + \lambda DUM + \eta_t \qquad (4)$$

Where DUM = a dummy variable with the value of 0 for military period and 1 for post- military period as explained earlier. In order to validate the results obtained using VAR model in the preceding section; we employed autoregressive distributed lag (ARDL) model, proposed by [21]. This method permits us to test both short- and long-run relationship between the dependent and the independent variables. To examine the short- and long- run relationships between economic growth and infrastructure investment, following [21], the study employed vector autoregression (VAR), as infrastructure investment-led growth function:

$$\alpha_t = \mu + \sum_{n=1}^{m} \beta_i \mathrm{x}_{t-1} + e_t \qquad (5)$$

Where α_t is the vector of both explanatory variables x_t and dependent variable α_t defined as real GDP. The vector matrix representing a set of explanatory variables is defined as; x_t = [$EINFI_t$, LAB_t, EX_t, IMP_t], where EINFI = investment in economic infrastructure; LAB = labour (total formal sector employment); EX = exports of goods and services; and IMP= imports of goods and services. The public sector and private sector employment are combined into one series: i.e., total formal sector employment in order to eliminate possible multicolinearity among the time series. The trade variables EX and IMP are included because international trade is inextricably linked with financing for development, and remains an engine of economic growth. For instance, export growth accounts for about 40% of the increase in gross domestic product (GDP) of both developing and developed countries, except the United States while the faster growth on average in output and trade in developing and transition economies, compared with the developed world, is matched by their increasing share of world trade, from 35% in 2000 to over 40% in 2007 (UN DPI, 2008). The exclusion of the trade variables could therefore result in misspecification of the ARDL growth model; u_t = [u_y u_x], t is time or trend variable, while is the matrix of VAR parameters for lag *i*. In this model, the study considers the actual values of the variables in its place of their growth rates to enable us examine both the short-term and long-term causal relationships between the dependent and the explanatory variables. From equation (5) the study further specifies a Vector Error Correction Model (VECM) as follows:

$$\Delta\alpha_t = \mu + \alpha t + \delta\pi_t + \sum_{i=1}^{p-1} \psi_i \Delta y_{t-i} + \sum_{i=1}^{p-1} \psi_i \Delta x_{t-i} + e_t \qquad (6)$$

Where is the first difference operator capturing the short-term component of the model; the long run multiplier matrix, can be partitioned as follows:

$$\delta = \begin{bmatrix} \sigma_{yy} & \sigma_{yx} \\ \sigma_{xy} & \sigma_{xx} \end{bmatrix}$$

The diagonal elements of the matrix are unrestricted, so that the selected series can be either I(0) or I(1). The infrastructure investment-led growth function can be specified as unrestricted error correction model (UECM):

Where V_t is a disturbance term, while other variables are stated in natural logarithm. Equation (3) can also be described as an ARDL of order (p, q, l, m, n) and indicates that economic growth can be influenced and explained by its past values and past values of other variables. Since the data in Nigeria exhibit a major structural break following the 1999 democratic transition from the political system, equation (7) was modified to capture economic shock that followed the transition. The dummy variables (DUM) with the value of zero before the 1999 democratic transition and a value of 1 after the transition have been included in the equation to measure the impact of the structural change. The modified equation is expressed as

$$\Delta GDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 EINFL_{t-1} + \beta_3 LAB_{t-1} + \beta_4 EX_{t-1} + \beta_5 IMP_{t-1} + \sum_{i=1}^{P} \beta_6 \Delta GDP_{t-1} + \sum_{i=0}^{q} \beta_7 \Delta EINFL_{t-1} + \sum_{i=0}^{l} \beta_8 \Delta LAB_{t-1} + \sum_{i=0}^{M} \beta_9 \Delta EX_{t-1} + \sum_{i=0}^{M} \beta_{10} \Delta IMP_{t-1} + V_t \qquad (7)$$

$$\Delta GDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 EINFL_{t-1} + \beta_3 LAB_{t-1} + \beta_4 EX_{t-1} + \beta_5 IMP_{t-1} + \sum_{i=1}^{P} \beta_6 \Delta GDP_{t-1} + \sum_{i=0}^{q} \beta_7 \Delta EINFL_{t-1} + \sum_{i=0}^{q} \beta_8 \Delta LAB_{t-1} + \eta DUM + \sum_{i=0}^{M} \beta_9 \Delta EX_{t-1} + \sum_{i=0}^{M} \beta_{10} \Delta IMP_{t-1} + V_t \qquad (8)$$

The long run elasticities are the coefficient of one lagged explanatory variable (multiplied by negative sign) divided by the coefficient of the one lagged dependent variable. For example, in equation (6) the long run elasticity of infrastructure investment is ($\frac{\beta_2}{\beta_1}$) and etc., while the short run effects are captured by the coefficients of the first-difference variables in equation (6). A Wald test (F-statistic) is computed from the estimated equation (6) to determine the long run relationship between the variables in question and it is conducted by imposing restrictions on the estimated long run coefficients. The computed F-statistic is compared with the critical values tabulated. That is, if the computed F-statistic is greater than the upper bound value, then economic growth and its determinants are co-integrated and the study can conclude that investment in economic infrastructure and other explanatory variables granger cause economic growth. The data used in the analysis is obtained from the Central Bank of Nigeria (CBN). The process is repeated for each of the five sets of bidirectional causality hypotheses discussed at the beginning of this section.

4. DATA ANALYSIS AND DISCUSSION

The lag length is determined using the minimum of both Schwarz and Hannan-Quinn information criterion both of which selected lag length 1 while the Akaike information criterion selected lag order 2 (see Table 5). AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion.

Both Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests were conducted to determine the order of integration of the variables used in the ARDL model. This is important because in the presence of unit roots in the time series data, none of the usual test statistics for the ordinary least square regressions have standard distributions. The results obtained are reported in Table 2. Both test criteria indicate that the 5 macroeconomic variables used in the model are non-stationary at levels with or without the inclusion of a time trend. Both tests also yielded similar results when the unit tests were conducted in first differences. Except for the export variable, both ADF and Phillips-Perron unit root tests strongly rejected the null hypothesis of the presence of unit roots after first differencing with constant and time or without the time trend. The export variable has a unit root after first differencing when the time trend is included but it stationary when the trend variable is excluded under both tests. The variables in question therefore follow on I(1) process. The results of the bounds cointegration test in Table 2 show that the null hypothesis was rejected at 5% and 1% level of significance.

The computed F-statistic of 4.997 is greater than the upper critical bounds values of 4.01 at 5% level of significance in [21]. For unrestricted intercept, no trends as long as a strong evidence for the existence of long-run cointegrating relationship among economic growth, economic infrastructure investment, formal employment, exports and imports. Therefore, the previous pairwise Granger causality test results are underpinned by theoretical causality and henceforth go beyond capturing "temporal causality". The results show that the infrastructure investment Granger causes economic growth in Nigeria during the period under review. The bounds test result is obtainable in Table 6. The ARDL model is reported in Table 3. The goodness of fit of the model remains high with the R-squared value of 0.56. The robustness of the model has also been confirmed by several diagnostic tests. The diagnostic tests revealed that the model has the desired econometric properties, i.e. has correct functional form, its residuals are serially uncorrelated, normally distributed and homoscedastic; and hence the results reported are valid for economic inference.

Table 1. Lag order selection criteria endogenous variables: EINFI EX GDP IMP LAB exogenous variables: c sample: 1960 2017 included observations: 57

Lag	AIG	SC	HQ
0	-3.052159	-2.853394	-2.977701
1	-15.63045	-14.43786*	-15.18370*
2	-15.98480*	-13.79838	-15.16576
3	-15.61485	-12.43460	-14.42351
4	-15.41161	-11.23754	-13.84798

** indicates lag order selected by the criterion*

The long run elasticities of the variables in estimated UECM model from equation (8) are obtainable in Table 5.

The ARDL results in Table 3, shows that the short run Granger causality results are not clear. The rejection of the pairwise Granger causality test results for the relationship between infrastructure investment and employment by the estimated ARDL model could be as a result of different employment measures. Granger causality test result is shown in Table 6, the null hypothesis was rejected, indicating that economic infrastructure investment does not Granger cause GDP growth. The paper also rejects the null hypothesis that GDP growth does not Granger cause economic infrastructure investment.

Table 2. Result of the unit root test

		Panel A: Level		
Variable	**ADF**		**Phillip-Perron**	
	Constant; No Trend	**Constant; Trend**	**Constant; No Trend**	**Constant; Trend**
		Data Period:1960-2009		
GDP	-1.58108	-2.920635	-1.885513	-2.549566
EINFI	-0.944660	-1.286919		-1.136409
LAB	-2.253913	-2.300037		-1.929286
EX	-1.293143	-2.232165		-1.717712
IMP	-0.068677	-1.587005		-1.868109
		Panal B: First Difference		
Variable	**ADF**		**Phillip-Perron**	
	Constant; No Trend	**Constant; Trend**	**Constant; No Trend**	**Constant; Trend**
		Data Period:1960-2009		
GDP	-3.826569***	-3.933256**	-4.293403***	-4.283705***
EINFI	-4.293403***	-4.283705***	-3.833635**	-3.933256**
LAB	-4.420745***	-4.602148***	-4.395407***	-4.594808***
EX	-3.117706**	-2.994752	-2.922566*	-2.871092
IMP	-4.536613***	-4.351444***	-4.478528***	-4.279842***

*Key: *** Rejection of the null hypothesis of presence of unit root at 1% level; ** rejection of null hypothesis of unit root at 5% level; rejection of null hypothesis of unit root at 10% level*

Table 3. Estimated ARDL model for Nigeria's economic infrastructure investment led growth (1960-2017)

I. Coefficients and Levels of Significance				
Variable	**Coefficient**	**Standard Error**	**t-value**	**t-probability**
β_0	1.903620	0.5440	2.67**	0.012
$\mathrm{GDP_t}$	-0.39374	0.1043	-3.12***	0.004
$\mathrm{EINFL_{t-1}}$	0.024942	0.0154	2.13**	0.042
EX_{t-1}	0.150236	0.0544	2.50**	0.028
$\mathrm{EX_{t-1}}$	0.133652	0.0410	2.45**	0.013
$\mathrm{IMP_{t-1}}$	0.024253	0.0121	2.15**	0.043
$\mathrm{DUM_t}$	0.011213	0.0143	0.742	0.395
$\Delta\mathrm{GDP_{t-1}}$	0.212241	0.1644	1.42	0.111
$\Delta EINFL$	-0.00125	0.0174	-0.040	0.960
$\Delta EINFL_{t-1}$	-0.04462	0.0147	-2.36**	0.031
ΔLAB	-0.111343	0.0569	3.27***	0.002
ΔLAB_{t-1}	-0.04341	0.0652	-0.537	0.529
ΔEX	-0.05115	0.0632	-0.586	0.498
ΔEX_{t-1}	-0.04210	0.0957	-0.539	0.521
ΔIMP	0.034014	0.0427	0.512	0.488
ΔIMP_{t-1}	-0.06237	0.0474	-1.44	0.092
II Model Criteria/Goodness of fit				
R^2	0.56474		F-statistics	4.99[0.000]**
Log-likelihood	149.056		DW	2.34
Diagnostic Tests				
AR 1-2 test:	F(2,40)	3.8218	[0.0221]	
ARCH I-I test:	F(1,40)	0.2336	[0.6294]	
Normality test:	Chi^2 (2)	5.2643	[0.0921]	
Hetero test	F(28,2)	0.0872	[0.9776]	
RESET test:	F(1,41)	5.4515	[0.0372]	

****, **, * indicate level of significance at 1%, 5% and 10% respectively*

Table 4. Bounds test for cointegration analysis based on equation (8)

Critical value	Lower bound value	Upper bound value
1%	3.74	5.06
5%	2.86	4.01
10%	2.45	3.52

Computed F-Statistic: 4.997(significant at 5% level)

Table 5. The long-run elasticities of the explanatory variables

Variable	Elasticity
EINFI	0.100
LAB	0.406
EX	0.332
IMP	0.070

Both hypotheses are rejected at 1% level of significance indicating that there are strong two-way causal relationships between economic infrastructure investments and economic growth in Nigeria for the period. This implies that an increase in GDP, governments will be able to spend more on infrastructure. This will in turn increase the marginal productivity of capital and labour in the private sector inspiring huge investment. Conversely, more investments could drive productive capacity, create opportunities for jobs and trigger higher wages resulting in increased income thereby boosting aggregate demand and economic growth. Deficit infrastructure has remained the major obstacle to economic growth in Nigeria. Increased public investment on economic infrastructure has therefore been contributory factor in enhancing the private sector competitiveness. Furthermore, the study did not find any causal relationship between public or private sector employment and economic growth. This could imply growth without employment and that is what the Nigerian economy is been criticized.

Table 6. Pairwise granger causality tests between economic growth, infrastructure investment and employment

Null Hypothesis	F-Stat	Critical F Value at 1%	Critical F Value at 5%	Critical F Value at 10%	Decision
EINFIg Does not Granger cause GDPg	4.94***	2.62(25,22)	1.96(25,22)	1.68(25,22)	Rejected at 1%
GDPg Does not Granger cause EINFIg	6.35***	3.57(9, 39)	2.82(9, 39)	2.22(9,39)	Rejected at 1%
EINFIg Does not Granger cause PUBEMPg	1.54	2.62(25,23)	2.62(25,23)	1.68(25,23)	Not rejected
PUBEMPg Does not Granger cause EINFIg	2.26*	3.57(9, 39)	2.27(9, 39)	2.21(9,39)	Rejected at 10%
EINFIg Does not Granger cause PVTEMPG	6.57***	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Rejected at 1%
PVTEMPg Does not Granger cause EINFIg	2.08	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Not rejected
GDPg Does not Granger cause PUBEMPg	2.03	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Not rejected
PUBEMPg Does not Granger cause GDP	0.70	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Not rejected
GDP Does not Granger cause PVTEMPg	0.41	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Not rejected
PVTEMPg Does not Granger cause GDP	0.48	3.57(9, 39)	2.27(9, 39)	2.21(9, 39)	Not rejected

Source: Authors'Computation

*The symbols *** and * indicate the rejection of the null hypothesis that one series does not Granger cause another at 1% and 10% level of significance respectively. Values in brackets are lower and upper degrees of freedom (df) respectively. For all Models, DW statistic ranged between 1.81 and 2.24*

5. CONCLUSION AND POLICY RECOMMENDATION

The study concludes that economic growth is the core drivers of public sector jobs in Nigeria. However, the private sector was supposed to be the major player in providing jobs which seems not to be the case for Nigeria as it has failed to have translated into more jobs in the economy. The study recommends that government should play a role of enabler and controller of services provided by private sector. The private sector's involvement in growth and running of infrastructure and the provision of public services is indeed the only way to meet the growing infrastructure needs in Nigeria. The purpose behind this strategy is to activity involve private participation, as this would improve efficiency and adequate provision of services. Private participation in infrastructure could augment investments in infrastructure unconstrained governments from heavy administrative and financial burdens. Given budget constraints, alternative policies are required to create enabling environment that is conductive and sustainable in public- private partnership professional (4 Ps) engagement in their infrastructural sectors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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