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Infrastructure-Growth Link and the Threshold Effects of Sub-Indices of Institutions

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Abstract

Purpose: This study extends previous empirical work on the threshold effects of institutions on the relationship between infrastructure and economic growth. It does so by using three sub-indices of institutions as the threshold variable in place of aggregate index. This is with a view to determining the roles of the sub-indices in the nexus between infrastructure and economic growth. **Research design, data and methodology:** The analysis is based on a dynamic panel threshold regression model using a panel data set comprising 41 countries in Sub-Saharan Africa over the sample period of 1996-2015. Data are obtained from Ogbaro (2019). **Results:** The study finds that infrastructure exerts significant positive effects on economic growth below and above the threshold values of the three sub-indices, with higher effects above the threshold values. Results also show that on average, the Sub-Saharan African countries are not able to satisfy any of the threshold conditions, which accounts for their poor growth experience. **Conclusion:** The study concludes that countries with weak institutions do not benefit maximally from infrastructure development policies. The paper, therefore, recommends that countries in Sub-Saharan Africa need to focus on improving their institutional patterns if they are to reap the optimum benefits from their infrastructure development efforts.

Keywords : Infrastructure, Institutions and Growth, Threshold Model, Sub-Saharan Africa

JEL Classification Code: C24, H54, O43

1. Introduction

The role of infrastructure in the growth and development of any economy cannot be over-emphasized. Many of the countries that have been able to rise above the developing country status and have transformed to developed high-income countries have done so as a result of strategies which included massive investment in infrastructure. The experience of countries in East Asia readily comes to mind. These countries, according to Noland and Pack (2003), have been able to achieve sustained growth on the basis of infrastructure development, among other factors. For example, the growth performance of the region between 1960 and 2002 surpassed that of the other world regions by a wide margin (Fischer, 2004). The case of China in particular is worthy of note as the country's economy has enjoyed about three decades of double-digit growth (Amadeo, 2016). The Chinese economy has experienced tremendous growth to the extent that it has become the world's second largest according to Mullen (2017). As noted by Chatterjee (2005), as well as Straub, Vellutini and Warlters (2008), much of China's sustained high economic growth and increased competitiveness has been attributed to massive development of infrastructure.

While supporting the claim, Organization for Economic Cooperation and Development (OECD, 2012) reports that massive investments in that country's infrastructure established the backbone for other economic activities such as manufacturing, which in turn spurred economic growth. Hence, this justifies China's heavy spending on

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infrastructure since the early nineties. Against this backdrop, scholars and development institutions have suggested that for developing countries to achieve sustainable economic growth, it is necessary for policy makers to concentrate on improving infrastructure, among other strategies. For instance, the International Monetary Fund (IMF, 2014) has suggested that it is the right time to raise infrastructure investments in countries where there are infrastructure bottlenecks. In view of this, the attention of policymakers in developing countries has shifted to infrastructure as a reliable tool for achieving the much-desired sustainable growth.

The importance of adequate provision of infrastructure in the process of growth has also been recognized in the empirical literature. As a matter of fact, the empirical studies on the growth effects of infrastructure are quite enormous. This enormous body of knowledge can be divided into four strands, with the first strand of the literature focusing on the impact of infrastructure on growth. Although majority of the studies in this category find positive effects, evidence of negative, insignificant, or ambiguous effects have continued to emerge as well. The inconclusive evidence obtained by these studies has been attributed to their failure to account for the intervening influence of the quality of institutions in the relationship. The need to address this gap in the literature has led to the emergence of the second strand of the literature, which has concentrated on assessing how the infrastructure-growth relationship is shaped by institutions (or some form of proxy). A major limitation of these studies is their use of linear interaction models, which has been criticized to be overly restrictive (see, for example, Law, Azman-Saini & Ibrahim, 2013).

Attempts at addressing the limitation has led to the birth of the third strand. This third body of knowledge has introduced another dimension to the modeling of the effect of infrastructure on economic growth, known as threshold regression. The threshold regression carried out by these studies is based on the use of infrastructure as both the independent variable as well as the threshold variable, while leaving out institutions completely. However, Ogbaro (2019) has argued that the omission of institutions from the threshold regression analysis creates another defect since institutional quality has been identified as an important factor that shapes the growth effects of infrastructure. This position has prompted the author to modify the threshold regression model in a study that can be regarded as constituting the fourth strand of the literature. In the study, he estimates the threshold level of institutional quality that would yield optimum growth benefits, given the level of infrastructure. His measure of institutions is based on the Worldwide Governance Indicators (WGI) of the World Bank, which comprises of six indicators. Using the method of Principal Component Analysis (PCA), the author transforms the six indicators into a composite index, which he uses in capturing institutions in the threshold regression.

As good as the use of aggregate index is in the process of empirical analysis, it, however has defects of its own. For example, Knack and Manning (2000) point out that the process may lead to the loss of conceptual precision and explicitness. While supporting this argument, Okada (2013) argues that the composite index may be excessively aggregated and therefore not yield valid results. The authors then suggest that after using the overall index (in this case, institutions), the investigation should go further by unbundling institutions in order to examine the role of each of the sub-indices in the relationship under study in order to ensure empirical precision. This paper, therefore, focuses on unbundling institutions with a view to determining the individual threshold effects of the sub-indices on the infrastructure-growth nexus. It hypothesizes that how much a country benefits from her infrastructure development efforts in terms of growth depends, to a large extent, on the quality of her institutions.

The study employs the first-differenced GMM (FD-GMM) estimator developed by Seo and Shin (2016) which is used in estimating a dynamic panel threshold regression model. The findings suggest that countries with weak institutions do not benefit maximally from infrastructure development efforts.

2. Literature Review

The first set of empirical studies, which examine the productivity of infrastructure, focuses on the link of infrastructure to economic growth. This strand of studies, which is pioneered by Aschauer (1989), can be divided into four categories on the basis of the approaches adopted. The first category employs two variants of the production function approach, namely, the Cobb-Douglas specification and the trans-log production function specification. Although majority of these studies obtain positive and significant elasticities of output with respect to infrastructure (see, for example, Albala-Bertrand, 2004; Cadot, Röller & Stephan, 2006; Kemmerling & Stephan, 2002; Munnell, 1990b; Ogbaro & Omotoso, 2017; Yamano & Ohkawara, 2000), few others, such as Canning and Pedroni (2004), Devarajan et al. (1996), Ghafoor and Yorucu (2002), and Lobo and Rantisi (1999), arrive at contradicting results.

The second category adopts the cost function framework in order to circumvent the failure of the first set of studies to account for the non-stationarity of aggregate output and infrastructure. These studies include Ezcurra, Gil, Pascual and Rapun (2005) as well as Vijverberg and Vijverberg

(2007). Evidence in this strand shows significant negative elasticities. The failure of the cost function methodology to solve problems bordering on spurious correlation and non-cointegration has led some studies to use vector autoregressive (VAR) models. Many of these studies, all of which constitute the third strand, find that infrastructure exerts positive contribution to economic growth (see, for example, Annala, Batina & Feehan, 2008; Fatai, Omolara & Taiwo, 2016; Pina & Aubyn, 2005). However, Anochiwa and Maduka (2014) find the effects to be statistically insignificant, while Apanisile and Akinlo (2013) find an inverse relationship between rail transport and economic growth. The need to address the issues of potential simultaneity and endogeneity biases as well as the problem of non-stationarity has given rise to the fourth strand of studies. These studies make use of the dynamic panel data (DPD) approach and find output elasticities that are positive and significant with respect to infrastructure (see, for example, Calderón, Moral-Benito & Servén, 2015; Ehuitché 2016; Farhadi, 2015).

Although the four categories of studies which constitute the first strand of the literature has provided some insight into the productivity of infrastructure, they have been criticized for not considering the role of institutions in the relationship. Scholars have argued that, based on their quality, institutional factors will either limit or boost the efficient use of infrastructure. For example, Hall, Sobel, and Crowley (2010) maintain that countries, which have good institutions, show positive growth rates whenever the stock of capital increases, while setting aside resources for the purpose of developing infrastructure may lead to zero growth rate, or worse still, negative growth rates, in countries with poor institutions due to corruption, rent-seeking actions, and other unproductive activities. Agénor and Montiel (2015) also posit that devoting resources to infrastructure is not sufficient to stimulate economic growth and that there is a need for strong institutions that will act as catalyst and improve the efficiency of capital.

Furthermore, Wu, Tang, and Lin (2010) attribute the efficacy of government spending on growth to the institutional quality of the country in question. They argue that in low-income countries, which are usually characterised by poor institutions, government expenditures have the tendency to retard growth or become ineffective. While also supporting this line of thought, Dabla-Norris, Brumby, Kyobe, Mills, and Papageorgiou (2012) contend that embarking on considerable infrastructure development in an environment characterized by weak institutions has the tendency of potentially undermining its growth benefits. What this suggests is that "better infrastructure (that is, infrastructure development embedded within a sound institutional framework), more growth" is a more accurate proposition than "more infrastructure, more growth". Hence, investigating the nexus between infrastructure and growth without paying adequate attention to how institutional factors contribute to this relationship as a complementary factor may lead to seriously misleading inferences. The importance of such consideration in the case of SSA in particular, where many countries are plagued by poor maintenance of existing facilities, coupled with wanton vandalization and destruction of infrastructure facilities as a result of high rates of corruption and terrorism, cannot be overemphasized.

This gap in the literature has led some scholars to investigate the mediating role of institutions in the relationship between infrastructure and economic growth using linear models. On the whole, they find that the payoff to infrastructure is significantly high in countries or places with high institutional quality (e.g., Crescenzi, Cataldo & Rodríguez-Pose, 2016; Escobal & Ponce, 2011; Seethepalli, Bramati & Veredas, 2008) and that the effect is low, insignificant, or negative in countries with low institutional quality (see, for example, Badalyan, Herzfeld & Rajcaniova, 2015; Kodongo & Ojah, 2016; Okoh & Ebi, 2013). However, the use of linear models by the empirical literature on the relationship among infrastructure, institutions, and growth has been faulted for being overly restrictive. In view of this, the need to introduce non-linearity in the modeling of the growth effects of infrastructure has been canvassed. This has led to the emergence of another set of studies, which captures non-linearity using threshold regression models. On the whole, these studies, which include Candelon, Colletaz, and Hurlin (2013) as well as Deng, Shao, Yang, and Zhang (2014), obtain results that reject the hypothesis of the existence of linearity in support of strong threshold effects in the productivity of infrastructure.

One notable limitation of the studies on the threshold modeling of the growth effects of infrastructure is their omission of institutions from the analysis. This gap has been pointed out and addressed in a study by Ogbaro (2019) in which the threshold value of aggregate institutional quality that must be attained for infrastructure to yield optimum growth benefits in Sub-Saharan Africa (SSA) is computed. His results show that the threshold value is 0.410 and that on average, SSA countries fall short of this level since the mean value of their index of institutional quality is 0.387. The author concludes that one of the factors responsible for the slow growth experienced by countries in the region is their low institutional quality.

This present study seeks to improve on Ogbaro's (2019) work by replacing the aggregate institutional quality with three sub-indices. The advantage of such sub-indices over the aggregate measure is that the latter may be overly aggregated to reveal the true and reliable influence of infrastructure on economic growth (Okada, 2013).

3. Research Methods and Materials

3.1. Theoretical Framework and Model

Following Ogbaro (2019), this study adopts the dynamic panel threshold regression model based on the New Institutional Economics theory (see Ogbaro (2019) for more on this theory). The theory was developed by Matthews (1986), North (1990), North and Thomas (1973), and Williamson (1985). The model is specified as follows:

$$y_{it} = \left(\rho_1 y_{it-1} + \delta_{11} k_{it} + \delta_{21} x_{it} + \delta_{31} q_{it}\right) I\{q_{it} \le \lambda\} + \left(\rho_2 y_{it-1} + \delta_{12} k_{it} + \delta_{22} x_{it} + \delta_{32} q_{it}\right) I\{q_{it} > \lambda\} + \varepsilon_{it} \quad (1)$$

where y_{it} denotes economic growth; y_{it-1} denotes one-period lag of economic growth; k_{it} denotes physical capital; x_{it} denotes composite infrastructure index; q_{it} denotes the sub-index of the quality of institutions (threshold variable); $I\{.\}$ is an indicator function; λ is the threshold value $\rho_1, \delta_{11}, \delta_{21}, \delta_{31}$ and $\rho_2, \delta_{12}, \delta_{22}, \delta_{32}$ represent the slope coefficients pertaining to the lower and upper regimes, respectively, while ε_{it} denotes the error term. Physical capital is added to the model as a control variable, while the lag of economic growth is introduced for the purpose of capturing "conditional transitional convergence," which is an important phenomenon for developing countries like those in SSA.

3.2. Estimation Method

This study uses the same method employed by Ogbaro (2019), i.e., the first-differenced GMM (FD-GMM) estimator developed by Seo and Shin (2016). The reliability of the results obtained from the estimator is based on two tests, namely, test of linearity and the J-test. The former, which is based on the null of the existence of linearity, determines the correctness of using a non-linear (threshold) model. If the results of the test yield a probability value that is less than the conventional 5% level of significance, the null is rejected, thus confirming the existence of non-linearity (threshold effects) in the relationship under study. The latter tests the validity of the lagged values of the explanatory and threshold variables, which are used as instruments on the basis of a null of valid instruments. The need to instrument the explanatory and threshold variables with their lagged values is informed by the fact that these variables are allowed to be endogenous by the estimator. Hence, the instruments are adjudged valid if the test yields a probability value of 5%.

3.3. Data

Following Ogbaro (2019), this study uses a panel of 41 countries in SSA over the sample period of 1996-2015. All the data are from Ogbaro (2019), which gives the measurement of economic growth as the natural logarithm of per capita Gross Domestic Product (GDP). The measurement of physical capital is given as the natural logarithm of per capita gross capital formation. These two variables are measured in constant 2010 US dollars. The author includes the following five measures of physical infrastructure: fixed telephone subscriptions, mobile cellular subscriptions, electric power consumption, improved water source, and improved sanitation facilities. He uses six indicators of institutional quality, which are obtained from the Worldwide Governance Indicators (WGI).

In line with Ogbaro (2019), the five measures of infrastructure are expressed in their natural logarithms and transformed into a single index using PCA. As for the quality of institutions, this study differs from the approach adopted by Ogbaro (2019) by not transforming the six indicators into a single index. Instead, this paper employs three sub-indices of institutions also obtained using PCA. Economic institution sub-index (ECI), which is constructed from the combination of government effectiveness and regulatory quality, provides information on the extent to which sound policies are able to enhance private sector development. Legal institution sub-index (LGI), which is constructed from the combination of rule of law and control of corruption, is a reflection of the effectiveness of the rule of law and the extent of its enforcement by the authorities. Political institution sub-index (PLI), which is constructed from the combination of voice and accountability as well as political stability and absence of violence, provides an indication of the level of political stability and its consequence with regards to society. This categorization of institutional sub-indices follows the works of Asongu, Nwachukwu and Orim (2018) as well as Demir (2015).

4. Results and Discussion

For the purpose of providing a basis for the quantitative analysis undertaken in the study, the descriptive statistics of the data used are examined first. The results of the statistics are presented in Table 1.

The table shows that the results on average GDP per capita, average initial GDP per capita, physical capital, and index of infrastructure are in line with the ones obtained by Ogbaro (2019). With regard to the results on institutional quality, the table shows that the mean value of legal institutions is approximately equal to the one obtained for the aggregate index of institutional quality by Ogbaro (2019), while economic and political institutions are approximately 0.01 and 0.02 greater, respectively.

Table 1: Descriptive Statistics

Variable	Mean	Minimum	Maximum
GDP	2229.692	186.661	20333.940
Initial GDP	2175.885	170.582	20333.940
Physical Capital	797.955	3.124	17012.380
Index of Infrastructure	-0.324	-5.768	2.831
Economic Institutions	0.401	0.160	0.727
Legal Institutions	0.386	0.175	0.692
Political Institutions	0.405	0.064	0.697

The analysis under the test of threshold effects involves using the three sub-indices of institutional quality one after the other as the threshold variable. This is with a view to assessing the roles of the sub-indices as well as understanding the one that matters the most and how it affects the nexus between infrastructure and economic growth. The results of the three threshold regressions are presented in Tables 2 to 4.

The results obtained from using the economic sub-index as the threshold variable are shown in Table 2. The results reveal that the estimated threshold value of economic institutions is 0.438. This implies that the SSA countries must attain a threshold level of 0.438 (on a 0-1 scale) in terms of economic institutions if they are to reap optimum growth benefits from infrastructure development. This threshold value is greater than 0.401 which is the mean value reported for the region for the sub-index from the descriptive statistics. This implies that, on average, the countries in the region are not able to attain the threshold level. To be specific, results show that about 57% and 43% of observations fall within the lower and higher regimes, respectively. With regard to the signs on the regressors, initial GDP per capita, physical capital, and infrastructure record positive values below and above the threshold level, respectively, while the sub-index of institutions records negative and positive values, respectively.

In terms of magnitudes, the coefficients of physical capital in both the lower and higher regimes are 0.246 and 0.525, respectively. The implication of this is that every 1% rise in physical capital will result in about 0.25% and 0.53% increases in per capita GDP in the lower and higher regimes respectively. Institutional quality records coefficients of -0.024 and 0.037 in the lower and higher regimes, respectively. The implication is that on average, every 1% rise in institutional quality will reduce (increase) per capita GDP by about 0.02% (0.04%) in lower-quality (higher-quality) institution countries.

Table 2: Threshold Results Using Economic Sub-Index

Regressor	Threshold Variable: Economic Institutions
	Lower regime
Initial GDP	0.117 (0.021)
Physical capital	0.246 (0.219)
Infrastructure	0.158 (0.592)
Institutions	-0.024 (0.266)
	Upper regime
Initial GDP	0.215 (0.046)
Physical capital	0.525 (0.228
Infrastructure	0.352 (0.859)
Institutions	0.037 (0.994)
	Difference
Initial GDP	0.098 (0.001)
Physical capital	0.279 (0.080)
Infrastructure	0.194 (0.089)
Institutions	0.061 (0.728)
Threshold	0.438 (0.021)
Upper regime (%)	42.6
Linearity (p-value)	0.00
J-test (p-value)	5.13 (0.072)
No of instrumental variables	33

Notes: All the variables are expressed in logs. Dependent variable is log GDP per capita. Robust standard errors are reported in parenthesis. The null hypothesis of the linearity test is that there is no threshold effect, while the null hypothesis of the J-test is that the instruments are valid.

Infrastructure records a coefficient of 0.158 for countries below the threshold level, which indicates that for every 1% increase in infrastructure in those countries, real GDP per capita will increase by about 0.16%. On the other hand, the magnitude is 0.352 for countries within the higher regime, indicating that every 1% increase in infrastructure will increase real GDP per capita by about 0.35% in high-quality institution countries. The inference is that SSA countries, which are able to attain the threshold level of economic institutions, gain about 0.19% more in terms of real GDP per capita than those that are not able to do so for every 1% increase in infrastructure stock.

For the validity of the findings above, the linearity test and J-test results are also presented in Table 2. The linearity test yields a probability value of 0.00, which provides strong evidence for the rejection of the null of linearity in favor of threshold effects. The J-test yields a probability value of about 0.07, which implies that the null of valid instruments cannot be rejected.

The results obtained from using the legal sub-index as the threshold variable are presented in Table 3. The results show that the estimated threshold value is 0.435. This implies that the SSA countries must attain a threshold level of 0.435 (on a 0-1 scale) in terms of legal institutions if they are to reap optimum growth benefits from infrastructure development. This threshold value is greater than 0.386, which is the mean value reported for the region for the sub-index from the descriptive statistics. To be specific, results show that about 74% and 26% of observations fall within the lower and higher regimes, respectively. The signs on the regressors are consistent with the ones obtained using economic institutions sub-index. In terms of magnitudes, however, the coefficients of the regressors are generally smaller.

Specifically, the coefficients of physical capital in both the lower and higher regimes are 0.129 and 0.333, respectively. The implication of this is that every 1% increase in physical capital will result in about 0.13% and 0.33% increases in real GDP per capita in the lower and higher regimes, respectively. Institutional quality records coefficients of -0.012 and 0.031 in the lower and higher regimes, respectively. The implication of this is that on average, every 1% rise in institutional quality will reduce (increase) per capita GDP by about 0.01% (0.03%) in lower-quality (higher-quality) institution countries. Infrastructure records a coefficient of 0.090 for countries below the threshold level which indicates that for every 1% increase in infrastructure in those countries, real GDP per capita will increase by 0.09%. On the other hand, the magnitude is 0.278 for countries within the higher regime, indicating that every 1% increase in infrastructure will increase real GDP per capita by about 0.28% in high-quality institution countries. The inference is that SSA countries, which are able to attain the threshold level of legal institutions, gain about 0.19% more in terms of real GDP per capita than those that are not able to do so for every 1% increase in infrastructure stock.

For the validity of these findings above, the linearity test and J-test results are also presented in Table 3. The linearity test yields a probability value of 0.00, which provides strong evidence for the rejection of the null of linearity in favor of threshold effects. The J-test yields a probability value of about 0.15, which implies that the null of valid instruments cannot be rejected.

Table 3: Threshold Results Using Legal Sub-Index

Regressor	Threshold Variable: Legal Institutions
	Lower regime
Initial GDP	0.011 (0.001)
Physical capital	0.129 (0.151)
Infrastructure	0.090 (0.399)
Institutions	-0.012 (0.943)
	Upper regime
Initial GDP	0.173 (0.001)
Physical capital	0.333 (0.378)
Infrastructure	0.278 (0.326)
Institutions	0.031 (0.237)
	Difference
Initial GDP	0.162 (0.011)
Physical capital	0.204 (0.033)
Infrastructure	0.188 (0.041)
Institutions	0.043 (0.728)
Threshold	0.435 (0.014)
Upper regime (%)	26.4
Linearity (p-value)	0.00
J-test (p-value)	32.8 (0.148)
No of instrumental variables	33

Notes: All the variables are expressed in logs. Dependent variable is log GDP per capita. Robust standard errors are reported in parenthesis. The null hypothesis of the linearity test is that there is no threshold effect, while the null hypothesis of the J-test is that the instruments are valid.

The results obtained from using the political sub-index as the threshold variable are presented in Table 4. The results show that the estimated threshold value of political institutions is 0.419. This implies that the SSA countries must attain a threshold level of 0.419 (on a 0-1 scale) in terms of political institutions if they are to reap optimum growth benefits from infrastructure development. This threshold value is greater than 0.405, which is the mean value reported for the region for the sub-index from the descriptive statistics. This implies that, on average, the countries in the region are not able to attain the threshold level.

To be specific, results show that about 72% and 28% of observations fall within the lower and higher regimes, respectively. As usual, the signs on the regressors are consistent with the ones obtained so far, while their magnitudes are generally smaller than those obtained for the economic institutions sub-index but larger than when legal institutions sub-index was used. More concretely, the coefficients of physical capital in both the lower and higher regimes are 0.137 and 0.358, respectively. The implication of this is that every 1% increase in physical capital will result in about 0.14% and 0.36% increases in real GDP per capita in the lower and higher regimes respectively. Institutional quality records coefficients of -0.012 and 0.012 in the lower and higher regimes, respectively. The implication of this is that on average, every 1% rise in institutional quality will reduce (increase) per capita GDP by about 0.01% (0.01%) in lower-quality (higher-quality) institution countries.

Table 4: Threshold Results Using Political Sub-Index

Regressor	Threshold Variable: Political Institutions
	Lower regime
Initial GDP	0.113 (0.001)
Physical capital	0.137 (0.021)
Infrastructure	0.121 (0.565)
Institutions	-0.012 (0.031)
	Upper regime
Initial GDP	0.200 (0.001)
Physical capital	0.358 (0.026)
Infrastructure	0.310 (0.736)
Institutions	0.012 (0.523)
	Difference
Initial GDP	0.087 (0.041)
Physical capital	0.221 (0.065)
Infrastructure	0.189 (0.017)
Institutions	0.024 (0.205)
Threshold	0.419 (0.023)
Upper regime (%)	28.1
Linearity (p-value)	0.00
J-test (p-value)	54.9 (0.170)
No of instrumental variables	33

Notes: All the variables are expressed in logs. Dependent variable is log GDP per capita. Robust standard errors are reported in parenthesis. The null hypothesis of the linearity test is that there is no threshold effect, while the null hypothesis of the J-test is that the instruments are valid.

Infrastructure records a coefficient of 0.121 for countries below the threshold level, which indicates that for every 1% increase in infrastructure in those countries, real GDP per capita will increase by about 0.12%. On the other hand, the magnitude is 0.310 for countries within the higher regime, indicating that every 1% increase in infrastructure will increase real GDP per capita by about 0.31% in high-quality institution countries. The inference is that SSA countries, which are able to attain the threshold level of political institutions sub-index, gain about 0.19% more in terms of real GDP per capita than those that are not able to do so for every 1% increase in infrastructure stock.

For the validity of these findings above, the linearity test and J-test results are also presented in Table 4. The linearity test yields a probability value of 0.00, which provides strong evidence for the rejection of the null of linearity in favour of threshold effects. The J-test yields a probability value of about 0.17, which implies that the null of valid instruments cannot be rejected.

In summary, the results of the analyses carried out show that in all the three cases, the null of linearity, while the null of valid instruments is accepted. These confirm the validity and reliability of the findings of the study. The results also show that among the three sub-indices, economic institutions have the largest coefficients above the threshold levels, particularly in terms of the growth effects of infrastructure. This is in line with the position of Rodrik (2007) that economic institutions constitute the major source of economic growth across countries. The author argues that economic institutions influence investments in capital and technology, as well as industrial production decisively. It has also been observed that in addition to playing a critical role in economic growth, economic institutions are important for resource distribution.

The findings further suggest that if all dimensions of institutions are strengthened and improved on the basis of their individual peculiarities instead of lumping them together, their individual effects will be more pronounced. This inference is arrived at by adding the coefficients on infrastructure for the three sub-indices together below and above the threshold levels, which amount to 0.37% and 0.57%, respectively, and comparing them with the ones obtained by Ogbaro (2019) for the aggregate index (i.e., 0.18% and 0.39%). This is an indication of the existence of an inherent complementary relationship among institutional patterns. In summary, these findings presuppose that SSA can benefit optimally from infrastructure only if the three sub-indices of institutions are strengthened adequately.

In essence, the results of the study reveal that countries that are able to strengthen their institutions up to the threshold levels benefit more from infrastructure development policies in terms of economic growth.

5. Conclusion

This study investigates the roles of three sub-indices of institutions in mediating the effect of infrastructure on economic growth in the SSA region over the of period

1996-2015. Based on its empirical analyses, the study observes that countries in the SSA region are not optimizing their potentials in terms of returns to infrastructure development because the countries, on average, fall short of the critical institutional threshold levels. The study, therefore, concludes that countries with weak institutions do not benefit maximally from infrastructure development policies as weak institutions constrain the efficient use of infrastructure assets.

The findings of this study show that enjoying higher growth returns also requires fundamental and specialized institutional reforms in addition to investment in infrastructure. Hence, this study recommends that countries in SSA need to focus on improving their institutional patterns if they are to reap the optimum benefits from their infrastructure development efforts. Specifically, they need to strengthen their institutions to achieve low level of corruption, bureaucratic efficiency, government effectiveness, private sector development, promotion of rule of law, and high level of political stability.

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