



Infrastructural development and trade performance in Sub-Saharan African countries

Forget Mingiri Kapingura¹

Kazeem Abimbola Sanusi^{2*}

^{1,2}University of Fort Hare, South Africa.

¹Email: fkapingura@ufh.ac.za

²Email: sanusikazeemabimbola@yahoo.com

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(* Corresponding Author)

Abstract

This study investigates the impacts of infrastructural development on trade performance in 30 sub-Saharan African economies using panel data from 2000 to 2020. The study employs the Generalized Method of Moments (GMM) dynamic pooling estimator and Dumitrescu–Hurlin (DH) panel causality tests. The empirical evidence suggests that both transport and ICT infrastructure have significant and positive effects on trade performance in sub-Saharan African countries. It has been found that trade performance is not significantly impacted by the relationship between economic growth and infrastructure development. This underscores the slow pace of economic growth in the region. The Dumitrescu–Hurlin (DH) panel causality tests establish evidence of unidirectional causality from each proxy of infrastructural development to trade performance and not vice versa. The study concludes that the sub-Saharan African government must purposefully invest in infrastructural development as a means to improve trade activity in the region. It is imperative to actively seek effective policies and a favourable macro environment to promote the necessary economic growth in order to fully realise the advantages and incentives of infrastructure investments.

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1. Introduction

International trade performance is an important factor in the development process and globalization attainment. Countries around the world could exchange goods and services with one another through international trade assisting in the meeting of needs for both production and consumption. The process of growth and the standard of living are accelerated by other factors. Infrastructure development, the quantity of tariffs and other trade obstacles are two factors that have an impact on trade performance. It is important that developing infrastructure has a significant impact on the nation's exports and imports and has a variety of other economic benefits including improved trade performance (Baita, 2021). Infrastructure development is crucial for international trade because it increases mobility and accessibility and enables more efficient use of resources (World Bank, 2019; World Trade Organization, 2018). The effectiveness of trade performance is increased by infrastructure improvements both in terms of time and financial savings. Long- and short-term predictions indicate that increased infrastructure will boost commerce (Kim, 2006). Furthermore, the relationship between increased trade and economic development, job creation and profit is clear (Donaldson, 2018).

The significance of infrastructural development has been documented in the theoretical and empirical development literature. For instance, the comparative advantages of manufacturing are changed by infrastructural expansion which also increases trade competitiveness. Infrastructure development has a

positive effect on a country's cost and ease of conducting business which improves international trade performance (Baita, 2021). The African Development Bank has recently estimated that the continent's yearly infrastructure needs range from \$130 to \$170 billion with a funding deficit of \$68 to \$108 billion. These numbers are significantly higher than the \$93 billion in yearly requirements and \$31 billion in annual finance shortfalls that were previously estimated by the World Bank. Both the potential benefits of a solution and the economic costs of Africa's poor infrastructure and limited stock are significant for the continent. Finances shouldn't be a barrier to funding infrastructure in Africa and around the world. Institutional investors comprising insurance firms, retirement savings plans, and sovereign wealth funds, manage assets valued at around \$100 trillion in addition to the limitless resources provided by the public sector and central banks in developed countries. The development of solid and modern infrastructure is central to the attainment of developmental objectives such as industrialization, improved trade or exports, urbanization and economic development (Kim, 2006). Infrastructure has been generally categorized into economic and social categories.

Social infrastructure includes education, health and culture. On the other hand, communication, energy and transportation are known examples of economic infrastructure. Infrastructural growth has been extremely beneficial for global trade. Infrastructure development can speed up transaction completion times and alter the nature of international trade transactions (Baita, 2021). A country's ability to facilitate trade, increase its trade income and expand cross-border trade can all benefit from infrastructure investment particularly in developing countries where a lack of domestic infrastructure is frequently cited as a major barrier to responding to globalization (Donaubauer, Meyer, & Nunnenkamp, 2018). The growth and development of developing and least developed countries are nevertheless hampered by a lack of infrastructure (Chakraborty & Nandi, 2011). The deteriorating and depleting infrastructure of developing countries, particularly those in sub-Saharan Africa is making things worse for the governments in these areas. (Orbital Insight, 2019). Global trade has benefited greatly from infrastructure growth. Infrastructure development has the potential to change the nature of international trade transactions and speed up transaction completion times (Baita, 2021).

Several empirical studies have investigated how infrastructure development impacts trade (Ismail & Mahyideen, 2015; Raychaudhuri & De, 2016; Rehman, Ding, Noman, & Khan, 2020; Shepherd, 2016). Substantive empirical efforts on the relationship between infrastructural development and trade performance on the African continent have been documented in the literature. The majority of these studies came to the conclusion that infrastructure growth enhances trade performance. Some research revealed a one-way and two-way relationship between these two crucial variables. For instance, Baita (2021) concludes that infrastructural development promotes trade in ECOWAS countries. This is consistent with empirical findings from East Africa as Ochieng, Abala, and Mbithi (2020) argue that infrastructural development is crucial to trade performance in the region. Similarly, Rehman et al. (2020) conclude that the development of infrastructure will accelerate trade in Latin America. This empirical study was conducted because there have been significant empirical studies on the relationship between infrastructure development and economic growth. There has been relatively little research on the relationship between infrastructure development and trade performance, particularly in sub-Saharan African countries. In addition, our study investigates whether infrastructural development has an effect on trade performance using the Generalized Method of Moments (GMM) dynamic pooling estimator put forward by Arellano and Bond (1991). This approach is better than traditional approaches like Ordinary Least Square (OLS), fixed impact and random effects because it manages the endogeneity issue that these other approaches cannot handle. The following sections of the study are structured as follows: Section 2 reviews the literature on infrastructural development, trade performance and economic growth. In section 3, the study's methodology is detailed. Section 4 contains the empirical findings and discussions while the study is concluded in section 5.

2. Literature Review: Theory and Practice

2.1. Theoretical Framework: Infrastructure-Led Development Theory

Agénor's (2010) theory on infrastructure-led development is one of the most popular theories on the role of infrastructure in economic growth. According to Agénor (2010), insufficient infrastructure development will result in countries' economies experiencing slow economic growth. Infrastructure is often viewed as the engine of a country's or economy's growth. The theory claims that infrastructure has an impact on the creation of goods improving trade over time. The level of infrastructure efficiency is thought to be non-linear due to network effects. However, if governance is adequate enough to ensure a sufficient level of public investment efficiency, an increase in the percentage of infrastructure spending may aid in the transition from low growth equilibrium which is characterized by low productivity and low savings through trade to high growth equilibrium. Infrastructure plays a crucial role in the process of growth and development. The theory demonstrated that reallocation increases steady-state health production which lowers time preference and increases savings. In a steady state, these greater savings result in higher private capital and consumption. Indeed, in the theory, households are motivated to save more money by improvements in the utilization of health services whose supply depends on public investment in infrastructure as well as rises in the rate of return on physical capital. The model's prediction that low growth often correlates with low productivity is consistent with other research claiming that improvements to the health infrastructure typically have a

significant impact on growth even though it does not specifically account for demographic concerns. For instance, Fogel (1994) suggested that an increase in effective labor contributions as a result of increased health infrastructure along with other infrastructure in the economy was the primary cause of Britain's economic growth (approximately 0.33 percent per year) between 1780 and 1980. Consequently, better export results should result from higher worker productivity. Hence, this study adopts the Agénor (2010) infrastructure-development theory. According to the proposition, the economy's production technology may exhibit considerable convexity due to network effects brought on by public infrastructure which would have significant implications for the relationship between public investment and economic growth. The degree of public infrastructure efficiency and the stock of public capital (in contrast to the stock of private capital) are related nonlinearly as a result of these impacts. It was shown that this non-linearity could result in a number of distortions in the market.

2.2. Empirical Literature

One of the main developmental obstacles facing all countries particularly those in Africa is insufficient infrastructure. Therefore, it is necessary to look at how infrastructure development affects the process of growth. For instance, Bhattacharya, Oppenheim, and Stern (2015) argued that there is inadequate infrastructure in the world to address the global infrastructure shortage. The situation is especially worrisome for the African continent which has a huge infrastructural deficit (Gutman, Sy, & Chattopadhyay, 2015). Foster and Briceño-Garmendia (2010) and Calderón and Servén (2010) argued that developing countries would require more significant infrastructure investment in order to accelerate the process of economic growth and the potential benefits of infrastructure development. Donaldson (2018) argued that infrastructural development impacts trade and economic growth positively. This is consistent with the findings by Rehman et al. (2020) and Yang (2018). Researchers have paid some attention to the mechanism defining the relationship between improved infrastructure and trade performance. It was first suggested by Bakos (1997) that improved infrastructure such as the internet would lower the costs of transportation and communication in international trade. Chen and Dahlman (2005) examined the relationship between infrastructure development and international service trade using the trade gravity model. According to their results, information technology will encourage the growth of international trade in services by bringing down the cost of business communications. According to Bojnec and Fertő (2009), infrastructure improvements can dramatically reduce trade costs, eliminate information asymmetry and boost the efficiency of information transmission between market participants. Furthermore, various empirical conclusions have shown that infrastructure significantly affects the expansion of international trade in services. Rehman et al. (2020) used regression analysis to examine the effect of infrastructure development on commerce and their findings indicated that the internet and ICT infrastructure have a large beneficial impact on global trade. Yang (2018) constructed grouped data for developed and developing countries and experimentally examined the effects of infrastructure development on international trade using panel data from 152 countries from 2005 to 2015. The findings demonstrated that the development of infrastructure in both developed and developing countries made a substantial contribution to supporting international trade and advancing development.

Nath and Liu (2017) conducted an experimental study on the effects of infrastructure development such as ICT development on global trade using panel data from 49 countries between 2000 and 2013. The findings show that the growth of international trade has been significantly aided by the development of ICT. Alagidede, Ibrahim, and Sare (2020) looked at the effects of financial and trade integration on structural transformation in 28 SSA nations between 1985 and 2015 using the GMM system. They find evidence of how complementary trade and financial integration affect structural transformation in the selected countries. The production of goods and services is positively and considerably impacted by trade and financial integration. Kanwal, Khan, and Rauf (2020) investigate the contribution of infrastructure to South Asia's economic development. The outcomes of the pooled mean group estimator point to an advantageous effect of infrastructure on economic expansion. Our review of the literature reveals that although there are numerous studies on the relationship between infrastructure and growth and trade. There is very little research on the relationship between infrastructure and commerce particularly in sub-Saharan African countries.

3. Empirical Approach

3.1. Data Sources

The study investigates the impact of infrastructural development on trade performance in 30 selected sub-Saharan African countries. The selected sub-Saharan African countries are Angola, Botswana, Kenya, Lesotho, Mozambique, Namibia, South Africa, Mauritius, Tanzania, Zambia, Rwanda, Gambia, Malawi, Cameroon, Cape Verde, Ghana, Guinea, Nigeria, Zimbabwe, Sierra Leone, Cote d'Ivoire, Eritrea, Gabon, Togo, Uganda, Liberia, Ethiopia, Burkina Faso, the Seychelles and Mali. Our study follows Azolibe and Okonkwo (2020) on the measure of infrastructure development. However, our study only adopts two measures of infrastructure development. The measures employed are the Transport Infrastructure Index (TRI) and the Information Communication Technology Infrastructure Index (ICTI). Accordingly, the transport index was used for the transport index and the ICT index for telecommunication infrastructure. Data on the transport index and the

ICT index were gotten from the Africa Development Bank database. Economic growth was measured by the log of Gross Domestic Product (GDP). Trade performance is measured by export volume and net exports. GDP and the inflation rate (denoted as INF) are used as the control variables. The data on the selected variables is sourced from the World Development Indicator (WDI). Our study covers the period from 2000 to 2020.

3.2. Econometric Strategy

Our econometric strategy involves the Generalized Method of Moments (GMM) dynamic pooling estimator. The technique was advanced by Arellano and Bond (1991). This method has an advantage over traditional approaches like OLS, fixed effects and random effects because it handles the endogeneity issue.

Our model specifications are stated as follows:

$$TP_{it} = f(IF_{it}, CV_{it}, \varepsilon_{it}) \tag{1}$$

where TP_{it} is the measure of trade performance, IF_{it} is the proxies of infrastructural development CV_{it} , are the control variables (gross domestic and inflation), ε_{it} is the error term while subscripts i and t are country and time indices respectively.

$$TP_{it} = \alpha_0 TP_{it-1} + \alpha_1 IF_{it-1} + \alpha_2 CV_{it-1} + \varepsilon_{it} \tag{2}$$

$$\varepsilon_{it} = \gamma_I + \mu_t + \varepsilon_{it}$$

As a result, we use α_0 to examine if the selected sub-Saharan Africa's level of trade meets at a common steady-state; γ_I is the country-specific fixed effects; μ_t is the time effects and ε_{it} is the error term which is believed to be independently and identically distributed $iid N(0, \sigma^2)$.

Infrastructural development affects trade performance through its interaction with economic growth. It is believed that there would be a multiplicative interacting term between infrastructural development and economic growth as a result of economic development in sub-Saharan Africa consequently, we have the following equation:

$$TP_{it} = \omega_0 TP_{it-1} + \omega_1 IF_{it-1} + \omega_2 CV_{it-1} + \theta(IF_{it} \times EG_{it}) + \varepsilon_{it} \tag{3}$$

Where economic growth is denoted with EG_{it} for country and i time t .

θ is a measure of the impact of infrastructural development on the trade performance conditioned upon the economic growth of the countries. The endogeneity issue arises as the error term may correlate since we include lagged dependent.

Consequently, we use the system generalized method of moments (GMM) dynamic pooling estimator in our estimation process. A general system GMM framework is given from Equation 2 as follows:

$$TP_{it} = \sum_{k=1}^p \gamma_k TP_{it-k} + \alpha_1 IF_{it} + x_{it} \mathfrak{X} + \varepsilon_{it} \tag{4}$$

\mathfrak{X} is the regressor and p is the maximum lag in the model.

The error term should be uncorrelated with the regressors to estimate Equation 2 in the presence of endogeneity. This drawback requires the adoption of instrumental variables that affect regressors to have an impact on trade performance.

Our study also employs Dumitrescu–Hurlin (DH) panel causality tests to determine the causality between each measure of trade performance and infrastructural development proxies. If the null hypothesis is accepted, it confirms no causal relationship between the variables. If the results reject the null hypothesis; this means there is a causal relationship among the variables.

4. Empirical Findings

Table 1 highlights the descriptive characteristics of the variables. Table 1's data shows that countries in sub-Saharan Africa import more than they export considering the greater mean value of imports as a percentage of GDP. When compared to export values (15.64), import values have a standard deviation of 19.87 indicating that they are more dispersed.

Table 1. Summary statistics of the variables.

| Statistics | EXP | IMP | TRI | ICTI | EG | INF |
|--------------|-------|-------|-------|-------|-------|--------|
| Mean | 28.1 | 33.6 | 18.5 | 11.6 | 3.05 | 31.6 |
| Median | 29.81 | 32.23 | 17.02 | 9.5 | 10.03 | 29.67 |
| Maximum | 41.2 | 63.09 | 59.0 | 76.0 | 14.53 | 24.5 |
| Minimum | 18.2 | 26.34 | 0.01 | 0.84 | 7.43 | 1.9 |
| Std. dev. | 15.64 | 19.87 | 0.026 | 0.15 | 0.36 | 1779.4 |
| Skewness | 0.91 | 1.01 | 0.13 | 0.39 | 0.25 | 31.26 |
| Kurtosis | 1.71 | 1.71 | 2.74 | 3.46 | 1.64 | 11.89 |
| Jarque-Bera | 19.81 | 19.81 | 32.9 | 20.94 | 21.6 | 25.90 |
| Probability | 0.97 | 0.97 | 0.54 | 0.260 | 0.23 | 0.98 |
| Observations | 630 | 630 | 630 | 630 | 630 | 630 |

On the measures of infrastructure, transport infrastructure index had an average of 18.5% and the ICT infrastructure index had an average of 11.6% showing that transport infrastructure is better than ICT infrastructure in sub-Saharan African countries. The table also shows that the average value of Gross Domestic Product in these countries is 3.05% which represents the real gross domestic products of countries within the sub-Saharan region. It depicts their growth and development during the study period. The average inflation rate is around 31.6. This affirms the fact that inflation remains a major macroeconomic challenge in sub-Saharan Africa.

Table 2. Correlation matrix.

| Statistics | EXP | IMP | TRI | ICTI | EG | INF |
|-------------------|------------|------------|------------|-------------|-----------|------------|
| EXP | 1 | 0.98 | 0.86 | 0.51 | 0.75 | -0.21 |
| IMP | 0.49 | 1 | 0.12 | 0.06 | 0.11 | 0.33 |
| TRI | 0.86 | 0.12 | 1 | 0.36 | 0.13 | 0.56 |
| ICTI | 0.51 | 0.06 | 0.36 | 1 | 0.25 | 0.53 |
| EG | 0.75 | 0.11 | 0.13 | 0.25 | 1 | -0.62 |
| INF | -0.21 | 0.33 | 0.56 | 0.53 | -0.62 | 1 |

Table 2 displays the static correlation coefficients, sometimes referred to as pairwise correlation coefficients. The findings from Table 2 show that there are proxies for infrastructure development. The correlations between export and transport infrastructure and ICT infrastructure are found to be positive and strong. This suggests that trade and infrastructural development in sub-Saharan Africa move in the same direction. This indicates that the improvement or development of infrastructure in sub-Saharan Africa is a conduit for trade performance because developed infrastructure enhances productivity and makes exportation convenient. Import also established a positive association with transport infrastructure and ICT infrastructure but the relationship is observed to be weak with a value of 0.12 and 0.06 respectively. This suggests that countries in sub-Saharan Africa could possibly develop their infrastructure with more imports though the relationship is quite weak. Importation of products that cannot be domestically produced will enhance economic activity.

We make use of export and import as two dependent variables as measures of trade performance in order to attain the objective of understanding how the development of infrastructure affects trade performance in the sub-Saharan African economy. Tables 3 and 4 illustrate how trade performance is measured, i.e., how exports and imports are impacted by sub-Saharan Africa's infrastructure development respectively. Table 3 shows the empirical findings on the effect of infrastructural development on exports as a measure of trade performance. Hence, we estimate 4 different models in the table using different proxies of infrastructural development. The first model uses the transport infrastructure index as a proxy for infrastructural development.

The second model uses the ICT infrastructural index as a proxy for infrastructural development. Models 4 and 5 use multiplicative interactions of GDP with transport infrastructure and multiplicative interaction of GDP with ICT infrastructure. In the first model, the level of export is found to have a significant impact on export. In other words, the previous value of export has a significant impact on export. Our findings also show that there is a positive relationship between exports and economic growth. This is consistent with findings in the literature. The economic growth relationship with import is positive but weak with regards to import. The relationship between export and inflation is negative as well as the import relationship with inflation. Our findings also show that transport infrastructure has a significant impact on trade performance. The implication here is that sub-Saharan African countries with massive investment in transport infrastructure can boost the trade performance of their economies. Though the effect of inflation on trade performance is negative, the impact is not statistically significant on trade performance.

The previous value of export has a significant impact on the current export for model 2. ICT infrastructure has been found to have a positive and significant impact on trade performance. By implication, ICT infrastructure has a significant impact on trade performance. This suggests that heavy investment in ICT infrastructure would strengthen the performance of trade in sub-Saharan African countries. This finding is consistent with Kim (2006); Donaubauer et al. (2018) and Baita (2021) as they all confirm the positive impact of infrastructural development on trade.

The impact of interacting transport infrastructure with economic growth on trade performance is seen as having insignificant impact. Inferentially, there is no apparent effect on trade performance when transport infrastructure and economic growth interact. Finally, on export, model 4 shows that interacting ICT infrastructure with economic growth has a negative impact on trade performance in sub-Saharan African countries. The probable reason for the observations in model 3 and Model 4 is the poor growth of the economy in most of the sub-Saharan African economies. Some of these countries frequently experience stunted or negative growth.

Table 3. Regression analysis when export as a dependent variable.

| Variables | 1 | 2 | 3 | 4 |
|-----------------------|----------------------|-----------------------|----------------------|----------------------|
| Constant | -2.561** (0.001) | -3.623** (0.002) | -4.653*** (0.254) | -2.023*** (0.424) |
| Lag-export | 0.567*** (0.000) | 0.248*** (0.000) | 0.7561*** (0.000) | 0.697*** (0.000) |
| TRI | 0.0317 *** (0.00) | | | |
| ICTI | | 0.00126*** (0.002) | - | |
| INF | -0.026 (0.032) | 0.0065 (0.478) | 0.168 (0.025) | 0.628 (0.025) |
| Transmission channel | | | | |
| TRI X GDP | | | 0.05632 (0.432) | - |
| ICTI X GDP | | | - | -0.165 (0.542) |
| Diagnostic test | | | | |
| Wald chi ² | 251.2*** (0.00) | 410.2*** (0.00) | 301.2*** (0.00) | 641.2*** (0.00) |
| Sagan test | 17.542 (1.000) | 16.567 (1.000) | 19.167 (1.000) | 20.171 (1.000) |
| AR (1) | -2.624* (0.062) | 2.563* (0.075) | 2.873* (0.081) | 2.563* (0.095) |
| Number of countries | 30 | 30 | 30 | 30 |
| Observations | 630 | 630 | 630 | 630 |

Note: ***, ** and * being 1%, 5% and 10% significant levels as well as () denoting the p-values.

Table 4 presents the results of the effect of infrastructure development on trade performance with imports as a measure of trade performance. We estimate 4 different models with each of the proxy of infrastructure development. In our model, the previous value of the import is found to have a significant impact on the import level as a measure of trade performance. Transport infrastructure is observed to have a significant positive infrastructure impact on imports. This implies that heavy investment in infrastructure will ease access to important and essential commodities that must be imported as nations around the world are encouraged to import commodities in which they have the least comparative advantage. Inflation is also found to have a positive but insignificant impact. The positive impact follows simple economic reasoning as foreign made goods could be more attractive in the presence of high domestic inflation. However, the impact is not significant. In model 2, ICT infrastructure is also found to have a significant positive impact on import as a measure of trade performance. Inflation is also observed to show a similar impact as noted under model 1. In model 3, transport infrastructure is interacted with economic growth and its impact is found to be insignificant on import as a measure of trade performance. This empirical finding corroborates some empirical submission in the literature such as [Bojnec and Fertö \(2009\)](#); [Nath and Liu \(2017\)](#) and [Ochieng et al. \(2020\)](#) among others. Similarly, interacting ICT infrastructure with economic growth has insignificant and negative impact on import levels in model 4. This underscores the earlier position that the level of economic growth is generally low and there is a need for sub-Saharan African countries to adopt growth stimulating policies that would ensure full maximization of infrastructural development gains on trade performance. The diagnostic tests such as Wald Chi², Sagan p-values and Autoregressive (AR(1)) reveal that our models are robust. For instance, Wald Chi² results are significant hence we reject the null hypothesis that the measures of trade performance and infrastructural development proxy are not significant to the model. Hence, we conclude that measures of trade performance and infrastructural development proxy are significant to model fit. Sagan p-values are greater than 0.05 and 0.1 which affirms that our model is robust.

4.1. Dumitrescu–Hurlin (DH) Panel Causality Tests

We estimate the Dumitrescu–Hurlin (DH) panel causality tests to wrap up our estimation method and empirical findings are contained in [Table 5](#). Our findings show the existence of a unidirectional causal relationship between transport infrastructure and exports as a measure of trade performance. In other words, transport infrastructure is found to drive trade not vice versa. This is the case with imports as a measure of trade performance. This means transport infrastructure drives import not the reverse. This is similar with ICT infrastructure as evidence of unidirectional causality is found from ICT infrastructure to export and also from ICT infrastructure to import.

Table 4. Regression analysis when import as a dependent variable.

| Variables | 1 | 2 | 3 | 4 |
|-----------------------|----------------------|-----------------------|----------------------|----------------------|
| Constant | -4.125** (0.001) | -7.231** (0.018) | -2.573*** (0.140) | -4.361*** (0.624) |
| Lag-import | 0.623*** (0.000) | 0.861*** (0.000) | 0.308*** (0.000) | 0.486*** (0.000) |
| TRI | 0.0317 *** (0.00) | | | |
| ICTI | | 0.00126*** (0.002) | - | |
| INF | 0.032 (0.251) | 0.001 (0.478) | 0.017 (0.520) | 0.003 (0.425) |
| Transmission channel | | | | |
| TRI X GDP | | | 0.02741 (0.751) | - |
| ICTI X GDP | | | - | -0.078 (0.542) |
| Diagnostic test | | | | |
| Wald chi ² | 652.4*** (0.0000) | 526.10*** (0.0000) | 872.4*** (0.0000) | 922.4*** (0.0000) |
| Sagan test | 13.42 (1.000) | 24.17 (1.000) | 20.167 (1.000) | 21.11 (1.000) |
| AR (1) | -1.04* (0.092) | -1.130* (0.049) | -1.603* (0.052) | -1.963* (0.095) |
| Number of countries | 30 | 30 | 30 | 30 |
| Observations | 630 | 630 | 630 | 630 |

Note: ***, ** and * being 1%, 5% and 10% significant levels as well as () denoting the p-values.

Table 5. Dumitrescu–Hurlin (DH) panel causality test results.

| Variables | Dumitrescu–Hurlin causality pattern |
|------------|-------------------------------------|
| TRI → EXP | Unidirectional causality |
| TRI → IMP | Unidirectional causality |
| ICTI → EXP | Unidirectional causality |
| ICTI → IMP | Unidirectional causality |

5. Conclusion

This empirical attempt investigates the impacts of infrastructural development on trade performance in sub-Saharan African countries. We make use of annual data from 2000 to 2020 for 30 sub-Saharan African countries. We make use of exports and imports as percentages of GDP to measure trade performance. We also employ two measures of infrastructure development which are transport infrastructure and ICT infrastructure. As a result of the inclusion of the lagged dependent variable in the model, we make use of the Generalized Method of Moments (GMM) dynamic pooling estimator to overcome the challenge of endogeneity. We believed that economic growth had an interactive effect on the role of infrastructural development on export performance due to the dismal growth of the economy in this region. Hence, we interact economic growth with each measure of infrastructure development to see the interactive effect of growth with infrastructural development on export performance. Finally, we adopt Dumitrescu–Hurlin (DH) panel causality tests between each measure of trade performance and infrastructural development proxies.

Our findings confirm that both transport and ICT infrastructure have a significant and positive impact on each measure of trade performance. The interactive economic growth with transport infrastructure has no significant effect on exports as a measure of trade performance in sub-Saharan African countries. Interactive effect of economic growth on ICT infrastructure has an insignificant and negative impact on exports. The poor growth of the economy in sub-Saharan African countries has been presented as a possible reason for this.

Our findings also show that both transport infrastructure and ICT infrastructure have a significant and positive impact on imports as a measure of trade performance. The interactive effect of transport infrastructure on economic growth has no significant impact on import performance. The interaction of ICT infrastructure with economic growth has no significant effect on import as a measure of trade performance. Dumitrescu-Hurlin (DH) panel causality tests show there is unidirectional causality running from each proxy of infrastructure to each measure of trade performance and not vice versa. Our study concludes that the sub-Saharan African government must deliberately invest in infrastructural development which in turn will improve trade activity in the region. It is imperative to actively seek effective and effective policies that would stimulate the necessary economic growth in order to fully realise the advantages and incentives of infrastructure expenditures.

References

- Agénor, P.-R. (2010). A theory of infrastructure-led development. *Journal of Economic Dynamics and Control*, 34(5), 932-950. <https://doi.org/10.1016/j.jedc.2010.01.009>
- Alagidede, I. P., Ibrahim, M., & Sare, Y. A. (2020). Structural transformation in the presence of trade and financial integration in Sub-Saharan Africa. *Central Bank Review*, 20(1), 21-31. <https://doi.org/10.1016/j.cbrev.2020.02.001>
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 277-297. <https://doi.org/10.2307/2297968>
- Azolibé, C. B., & Okonkwo, J. J. (2020). Infrastructure development and industrial sector productivity in Sub-Saharan Africa. *Journal of Economics and Development*, 22(1), 91-109. <https://doi.org/10.1108/jed-11-2019-0062>
- Baita, K. E. (2021). Impact of infrastructure on trade: An empirical assessment by the gravity model in ECOWAS. *Young African Leaders Journal of Development*, 3, 1-8. <https://doi.org/10.32727/24.2021.20>
- Bakos, J. Y. (1997). Reducing buyer search costs: Implications for electronic marketplaces. *Management Science*, 43(12), 1676-1692. <https://doi.org/10.1287/mnsc.43.12.1676>
- Bhattacharya, A., Oppenheim, J., & Stern, N. (2015). *Driving sustainable development through better infrastructure: Key elements of a transformation program*. Brookings Global Working Paper Series, 16570. pp: 1-48.
- Bojnec, Š., & Fertő, I. (2009). Impact of the internet on manufacturing trade. *Journal of Computer Information Systems*, 50(1), 124-132.
- Calderón, C., & Servén, L. (2010). Infrastructure and economic development in Sub-Saharan Africa. *Journal of African Economies*, 19(suppl_1), i13-i87.
- Chakraborty, C., & Nandi, B. (2011). "Mainline" telecommunications infrastructure, levels of development and economic growth: Evidence from a panel of developing countries. *Telecommunications Policy*, 35(5), 441-449.
- Chen, D. H., & Dahlman, C. J. (2005). *The knowledge economy, the KAM methodology and world bank operations*. World Bank Institute Working Paper, No. 37256.
- Donaldson, D. (2018). Railroads of the raj: Estimating the impact of transportation infrastructure. *American Economic Review*, 108(4-5), 899-934.
- Donaubauer, J., Meyer, B. E., & Nunnenkamp, P. (2018). A new global index of infrastructure: Construction, rankings and applications. *World Economy*, 39(2), 236-259. <https://doi.org/10.1111/twec.12290>
- Fogel, R. (1994). *Economic growth, population theory, and physiology: The bearing of long-term processes on the making of economic policy*. National Bureau of Economic Research, Inc No. 4638.
- Foster, V., & Briceño-Garmendia, C. (2010). Africa's infrastructure: A time for transformation. *World Bank*, 52102, 1-413.
- Gutman, J., Sy, A., & Chattopadhyay, S. (2015). Financing African infrastructure: Can the world deliver? *National Academies*, 01560963, 1-20.
- Ismail, W. N., & Mahyideen, M. J. (2015). *"The impact of infrastructure on trade and economic growth in selected economies in Asia"*. ADBI Working Paper No. 553. Asian Development Bank Institute Kasumigaseki Building 8F 3-2-5 Kasumigaseki, Chiyoda-ku Tokyo 100- 6008.
- Kanwal, S., Khan, B., & Rauf, M. Q. (2020). Infrastructure of sustainable energy development in Pakistan: A review. *Journal of Modern Power Systems and Clean Energy*, 8(2), 206-218. <https://doi.org/10.35833/mpce.2019.000252>
- Kim, E. (2006). An application of an integrated transport network multi regional cgemodel to the calibration of synergy effects of highway investments. *Economic Systems Research*, 21, 377-397.
- Nath, H. K., & Liu, L. (2017). Information and communications technology (ICT) and services trade. *Information Economics and Policy*, 41, 81-87. <https://doi.org/10.1016/j.infoecopol.2017.06.003>
- Ochieng, J., Abala, D., & Mbithi, M. (2020). Infrastructure development, institutions, and intra-regional trade: The case of East Africa. *The European Journal of Applied Economics*, 17(2), 104-118. <https://doi.org/10.5937/ejae17-26791>
- Orbital Insight. (2019). *New infrastructure's impact on retail and commerce*. Retrieved from <https://orbitalinsight.com/blog/newinfrastructures-impact-retail-commerce>
- Raychaudhuri, A., & De, P. (2016). Trade, infrastructure and income inequality in selected asian countries: An empirical analysis in: Roy, M. and Sinha Roy, S., Eds International Trade and International Finance. In (pp. 257-278). New Delhi: Springer. https://doi.org/10.1007/978-81-322-2797-7_12
- Rehman, F. U., Ding, Y., Noman, A. A., & Khan, M. A. (2020). The nexus between infrastructure and export: An empirical evidence from Pakistan. *Global Journal of Emerging Market Economies*, 12(2), 141-157.
- Shepherd, B. (2016). Infrastructure, trade facilitation, and network connectivity in Sub-Saharan Africa. *Journal of African Trade*, 3(1-2), 1-22. <https://doi.org/10.1016/j.joat.2017.05.001>
- World Bank. (2019). *World development report 2020: Trading for development in the age of global value chains*. The World Bank. Retrieved from <https://elibrary.worldbank.org/doi/pdf/10.1596/978-1-4648-1457-0>
- World Trade Organization. (2018). *World trade report*. Retrieved from https://www.wto.org/english/res_e/publications_e/world_trade_report18_e.pdf
- Yang, Q. (2018). The effects of internet penetration on service trade-empirical analysis of 152 countries. *Journal of Capital University of Economics and Business*, 20(2), 62- 71.