Cogent Economics & Finance

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/oaef20

# Services trade and infrastructure development: Evidence from African countries

Kabiru Hannafi Ibrahim, Rossanto Dwi Handoyo, Wasiaturrahma Wasiaturrahma & Tamat Sarmidi

**To cite this article:** Kabiru Hannafi Ibrahim, Rossanto Dwi Handoyo, Wasiaturrahma Wasiaturrahma & Tamat Sarmidi (2022) Services trade and infrastructure development: Evidence from African countries, Cogent Economics & Finance, 10:1, 2143147, DOI: 10.1080/23322039.2022.2143147

**To link to this article:** https://doi.org/10.1080/23322039.2022.2143147



Published online: 18 Nov 2022.

Ibrahim et al., *Cogent Economics & Finance* (2022), 10: 2143147
**https://doi.org/10.1080/23322039.2022.2143147**

cogent economics & finance

DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

# Services trade and infrastructure development: Evidence from African countries

Kabiru Hannafi Ibrahim[1,2], Rossanto Dwi Handoyo[2*], Wasiaturrahma Wasiaturrahma[2] and Tamat Sarmidi[3]

Received: 17 March 2022
Accepted: 31 October 2022

*Corresponding author: Rossanto Dwi Handoyo, Department of Economics, Universitas Airlangga, Airlangga Street No. 4, Surabaya 60286, Indonesia
E-mail: rossanto_dh@feb.unair.ac.id

Reviewing editor:
Yudhvir Seetharam, School of Economics and Finance, University of the Witwatersrand, Johannesburg, South Africa

Additional information is available at the end of the article

**Abstract:** Using a dynamic system GMM estimate, this study analyzed the impact of services trade on the development of infrastructure in 38 African countries over the period 2000–2020. Telecommunications, trade/transport-related, and port infrastructures were modelled as the dependent variables on services trade openness. Other sets of control variables include real GDP, financial development, gross fixed capital formation, external debt, population density, urbanization, exchange rate, and services value-added. Our empirical strategy revealed that regardless of the infrastructure indicator used in the estimate, services trade, GDP, financial development, external debt, and services value-added significantly promote the development of infrastructure in the continent. Capital formation increases trade/transport-related and reduces port infrastructure while population density increases trade/transport-related and port infrastructure. The finding further indicates that urbanization increases telecommunications and reduces trade/transport-related infrastructure. The exchange rate reduces the development of telecommunications

Rossanto Dwi Handoyo

## ABOUT THE AUTHORS

Kabiru Hannafi Ibrahim, Ph.D., is a Lecturer and Researcher at the Federal University, Birnin Kebbi Nigeria. He obtained his Ph.D. in Economics from Universitas Airlangga, Surabaya, Indonesia. He is presently the Postgraduate Program Co-Ordinator of the Economics Department, Federal University, Birnin Kebbi Nigeria. His area of research includes bilateral and multilateral trades, the environmental impact of free trade, and applied econometrics among others. Rossanto Dwi Handoyo, Ph.D., is an Associate Professor at the Department of Economics, Airlangga University, Surabaya, Indonesia. He is also a researcher and consultant at the Ministry of Trade of the Republic of Indonesia. He is presently the Head of the Economics Department at the Faculty of Economics and Business, Airlangga University. His research interest is in the field of international economics as well as development studies.

## PUBLIC INTEREST STATEMENT

This study analyzed the impact of services trade on the development of infrastructure in 38 African countries over the period 2000–2020. Telecommunications, trade/transport-related, and port infrastructures were modelled as the dependent variables on services trade openness. Other sets of control variables include real GDP, financial development, gross fixed capital formation, external debt, population density, urbanization, exchange rate, and services value-added. Our empirical strategy revealed that regardless of the infrastructure indicator used in the estimate, services trade, GDP, financial development, external debt, and services value-added significantly promote the development of infrastructure in the continent. Capital formation increases trade/transport-related and reduces port infrastructure, while population density increases trade/transport-related and port infrastructure. The finding further indicates that urbanization increases telecommunications and reduces trade/transport-related infrastructure. The exchange rate reduces the development of telecommunications and port infrastructure. The findings are therefore vital to present policies related to services trade and infrastructure development in African countries.

and port infrastructure. The findings are therefore vital to present policies related to services trade and infrastructure development in African countries.

**Subjects: Development Studies; Economics and Development; Economics; Finance**

**Keywords: Services trade; infrastructure development; dynamic system GMM; African countries**

**JEL Classification: F10; H54; L18; N77; O18**

## 1. Introduction

Various studies have affirmed the importance of services in the country's development. Services play a fundamental key role in terms of building infrastructure, trade facilitation, competitiveness, and countries' integration into the global economies. More importantly, services are the strength of countries' digital infrastructure (World Trade Organization, 2017). Services also play the role of integrating world economies into the modern trading system as well as providing infrastructure to aid trade in both goods and services. Services openness enhances economic and trade integration by enabling the interconnectedness of various countries around the world. Services trade liberalization has increased the participation of African countries in services trade and has positively integrated the continent into the global services economy. Services openness has in many ways promote the growth of infrastructure, facilitate trade in goods, and other economic activities in the continent.

The development of the services economy and services trade has resulted in the development of infrastructure around the world. The telecommunications, trade/transport-related and port infrastructures were not an exception in this regard. Therefore, the inseparable nature of the services sector and services trade and their development is consistently linked to the development of infrastructure. Services trade openness is one of the channels through which low-cost and high-quality infrastructural services can be efficiently provided (WTO, 2004). Services trade openness has resulted in an increased telecommunications infrastructure and competition in African countries. It has resulted in an increased per capita main telephone lines, connection capacity, and lower call rates. According to WTO (2004) in sub-Saharan Africa (SSA) before the liberalization of the 1980s and 1990s, the growth of telecommunication infrastructure was extremely low and the services providers mostly had very low equity. The liberalization of transport services (especially air and water transport) is key to the development of port infrastructure, improving the quality of ports, and enhancing transport networks (WTO, 2004). Air and sea transport services are some of the most traded services among countries around the world. The development of air and sea transport services has necessitated the growth and development of port infrastructures in all countries around the world. The increase in the number of international air transport passengers and vessels conveying goods has increased in recent times and this has resulted in the growth and development of port infrastructure. In African countries, FDI as one of the modes of service plays a pivotal role in the development of telecommunications, trade/transport-related, and port infrastructure. This is because a large portion of FDI is directed toward these infrastructural sectors. Despite the role of services liberalization in building countries' infrastructure, in most African countries basic infrastructures are under state monopolies. This has negatively affected the development of infrastructure and access to infrastructural services in the continent. Infrastructural development can be achieved not only through public participation but through a combination of public engagement, domestic private participation, and international collaborations (Collier, 2014; Tei & Ferrari, 2018). To exploit countries' economic potential and develop infrastructure, Makovsek et al. (2015) have suggested the use of public-private partnership investment in the development of infrastructure and liberalization for more foreign direct investment (FDI) inflow. It has been found that because of the dominant role of government in building infrastructure Africa's infrastructural requirements outweigh the ability of the continent to finance it, as such, there is a need for foreign participation in various infrastructural development projects which can be achieved through liberalized services economy in the continent (Collier, 2014).

Infrastructure like telecommunications, airports, seaports, roads, railways, power plants, schools, hospitals, etc., are fundamental in structural transformation and are the major inputs required in the production process through the services it provides like internet services, information and communication technology (ICT) services, transport services, electricity services, energy services, education services, health services, etc. Infrastructure plays a vital role in enabling the trade of goods and services through the removal of intangible barriers to trade and the adoption of efficient communication and transport networks. Economic activities and trade relied on the basic infrastructure provided by the services sector. Services provide intermediate inputs to almost all economic activities through infrastructural services. It is, therefore, important to note that limits on the cross-border supply of services (e.g., quota), and restrictions of foreign ownership which are measures to restrict services trade will affect the development of both hard and soft infrastructure. Essential infrastructure permitting goods and services to be provided are also provided by various services. Services trade openness will render economies into a world of competition by bringing more investment in various infrastructural services and failure to open up the service sector may reduce the benefits of investment in infrastructure (Borchert et al., 2017).

Over the last few decades, there has been an enormous increase in services trade openness in African countries which was aimed at creating a favourable business environment that could lead to the growth and development of infrastructural services, more access to services, increased economic integration, and encourage the inflow of FDI. This has resulted in an enormous increase in infrastructure and access to services and more importantly increased the level of Africa's engagement in the global economies. Despite such an increase in infrastructure and access to various infrastructural services in African countries, there has been a dearth of the empirical literature on the focus on measuring the degree to which services trade openness impacted infrastructural services in the continent.

With this in mind, therefore, the objective of this study is to investigate the impact of services trade openness on infrastructure development in African countries. The focus of this study would be on three infrastructural sectors, which are telecommunications, trade/transport-related, and port infrastructures which may include both hard/tangible and soft/intangible infrastructures. The hard component includes any physical part that accommodates telecommunications networks, postal services, and transport networks, while the soft component refers to the services provided by these networks. Infrastructure in totality is difficult to measure and is associated with many measurement issues when it comes to quantifying the actual level of a country's infrastructure. As a result, researchers often resort to using soft infrastructure as a proxy for a country's level of infrastructure. For instance, the use of the internet, cost of the internet, speed of the internet, telephone line per 1,000 people, or telephone penetration are used to reflect telecommunications infrastructure; access to quality road, postal services, and railway services are used to reflect trade/transport-related infrastructure; port efficiency and efficiency of customs procedures are used to reflect ports infrastructure. The more advanced are, the country's telecommunications, trade/transport-related, and ports infrastructure, the higher will be the telecommunications network, transport network, and postal services within the reach of the populace.

The choice of telecommunications, trade/transport-related, and port in this study is important because these infrastructural sectors are major constraints to the digital world economy, countries' integration, and economic and social development. Furthermore, the focus on African countries is important because the continent especially SSA is lagging in terms of basic infrastructures like telecommunications, information and communications technology (ICT), trade/transported related, and ports infrastructure. It is against this background upon this study will measure the effect of services trade on the development of infrastructure in the African continent. This study is a novel empirical work on the impact of services trade on infrastructural development. The study followed the literature and applied a new trade openness index proposed by (Squalli & Wilson, 2011). Additionally, we followed Ibrahim (2021), Ibrahim et al. (2021a), Ibrahim et al. (2021b), and Ibrahim et al. (2022) and constructed our services trade openness index based on the General Agreement on Trade in Services (GATS)

definition of services trade. In this vein, therefore, by using a new openness index, the study further adds to the existing literature by providing the first evidence of the services trade openness impact on infrastructure development in African countries. The use of this new measure constitutes a significant improvement over earlier work that predominantly used the traditional measures of trade openness despite their weakness. As expected, our finding confirmed the positive impact of services trade on infrastructure development. Additionally, gross domestic product (GDP), financial development, external debt, and service value-added were found to significantly add to the development of the three infrastructural indicators. Therefore, these findings are important for trade and infrastructure development policies in African countries.

The remaining parts of this study are arranged as follows: part 1 elucidates the theoretical and the empirical reviews, part 3 presents the methodological approach, part 4 presents the empirical finding and part 5 concludes the paper and offers policy recommendations.

## 2. Literature review

### *2.1. Theoretical review*

#### *2.1.1. The dynamic theory of diffusion and contagion*

One of the theories that explained the relationship between a country's domestic and international developments is the dynamic-comparative theory. The theory is based on the effects of diffusion and contagion on a country's national policy-making in the international environment. The theory saw a country's development as not an independent but interconnected, interaction, intertwining, and co-evolution of different types (Gourevitch, 1978; Peter et al., 1994; Schneider, 2001). In this regard inter-country and country contagions are possible. This theory is used in this study because a country's infrastructure development depends not only on its domestic key players but on foreign infrastructure providers. The theory is also applicable to African countries as infrastructure development in these countries cannot be made in isolation but with more openness to trade and FDI in infrastructure. Therefore, the development in other countries can result in a contagion effect on a country's development by way of openness to trade and investment hence improving the level of its infrastructure.

#### *2.1.2. The structuralist view of Neo-liberals*

An inevitable force of structural changes resulting from technological development and international economic integration has been the cause of state withdrawal from infrastructure provision and development according to structuralist theories. Neoliberal economists like Sachs et al. (1995)held the view that countries are exposed to unavoidable convergence pressure to eliminate inefficiency and increase the growth of infrastructure through the process of globalization and economic integration. Because of the recent wave of globalization and technological development countries are progressively forced to position themselves toward increasing efficiency in infrastructure by assimilating their economy with other countries through openness. With an increase in globalization and openness, foreign factors of production are becoming more important when compared to domestic factors of production. In this situation, the provision and development of infrastructure cannot be financed by the state but by the foreign services suppliers through FDI and a more open economy. The theory asserts that to increase competition and reduce inefficiencies in infrastructural services and development, sooner or later a country must embark on privatization and liberalization. Schulze and Ursprung (1999) noted that mobile factors of production, privatization, and liberalization of infrastructure should not be neglected because of their critical role in bringing more FDI. During the 1980s neo-liberal theory remained a guideline of economic policy which was closely related to liberalization and privatization for the development of infrastructure (Müller, 1994).

*2.1.3. Neo-Keynesian and Neo-Marxist*

A contrary view from Economists of Neo-Keynesian and Neo-Marxist backgrounds like Van Der Pijl (2005), Scherrer (2004), and Gill (2008) have argued that state withdrawal in the provision and development of infrastructure jeopardizes stability, security, and solidarity and consequences to that would be social, country and global disintegration with indicators like criminality, poverty, and unemployment.

*2.1.4. Historical model of infrastructure development*

One of the infrastructural models which have been repeatedly confirmed in several cases from the 19$^{th}$ century to the present time is the historical model of infrastructure. The historical model of infrastructure was drawn from the Networks of Power of Thomas (1983), though the model has been in existence much longer than many research projects in infrastructure development. This model of infrastructure has led to three major conclusions. First, the model claimed that true infrastructure is initially created locally, controlled centrally, and systematically coordinated. Secondly, the transformation of the built infrastructure starts with the transfer of technology from one country to another by way of openness, country integration, and FDI. The stage of the transformation of infrastructure brings technical changes as well as cultural, legal, social, organizational, and financial adjustments within the system of infrastructure. Thirdly, the infrastructures are integrated into ways that allow for connecting different countries' systems of infrastructure. Path dependence is created when countries' infrastructure grows, and the countries' infrastructure when initially formed is difficult to change as most infrastructure only required an upgrade. The growth of the historical model of infrastructure marked a turning point from the government's homogeneous centrally controlled provision of infrastructure to a widely distributed system where the government may only partly involve in the provision and development of infrastructure and replaced by individual and foreign services providers.

***2.2. Empirical review***

The few available works on the infrastructural development impact of trade openness include; Roy (2017) who observed that services provide necessary infrastructure supporting trade, and that openness to trade and investment improves infrastructure and increases connectivity in low, middle, and high-income countries. Studies by Roy (2019) and Hildegunn K. Nordås and Rouzet (2016) show a negative nexus between services trade and infrastructural services across countries. World Bank, World Development Report (2016), revealed a negative link between entry barriers to the services industry and investment in ICT and digital technology infrastructure. A monitoring exercise by OECD & WTO (2017) established a link between the services sector and trade/transport-related infrastructure. Moreover, in the case of China, Xu et al. (2020) report that electricity infrastructure for inter-regional trade has been economically viable and barriers to electricity services trade have negatively affected the benefits of electricity infrastructural investment. A study by Jiya et al. (2020) revealed a long-run decreasing effect of trade on the link between infrastructure and manufacturing output in 14 Common Market for Eastern and Southern Africa (COMESA) member states. Felbermayr and Tarasov (2022) have noted that the spread of transport infrastructure has been the result of government efforts to improve welfare from economic openness. Lorz (2020) observed that in exporting countries the gains from reduced transport costs in foreign trade have resulted in more investment in infrastructure than in importing countries. While analysing the trade effects of infrastructure, Wessel (2019) observed that the quality of road infrastructure is less important than road density in determining this effect. In a sample of 189 countries including 44 SSA, Shepherd (2017) reports a significant link between the performance of trade facilitation and infrastructural development indicators. However, Firdausy (2018) revealed the inevitable role of private participation in the development of urban infrastructure in Indonesia. Pradhan et al. (2014)observed a long-term causal link between the telecommunications infrastructure, trade, urbanization rates, capital formation, and GDP growth in G20 economies.

In a study of Latin America and the Caribbean (LAC), Tei and Ferrari (2018) have found a positive significant link between transport infrastructure investment and other variables related to

international trade in the regions. Edame et al. (2014)revealed that short-run changes in trade openness, population density, and urbanization affect the growth of infrastructure in Nigeria. Similarly, Edame and Fonta (2014) report about 99.38% feedback on the previous year's disequilibrium from the long-run elasticity of trade openness, urbanization, and population density, as the determinants of infrastructure spending. Hocman et al. (2013) developed a theoretical model and validate the influence of trade on infrastructure investment. Jansen and Nordås (2004), have found a significant association between trade flows and telecommunication, financial, and road infrastructure. In a sample of 54 countries, Harmes-Liedtke and Di Matteo (2011) revealed a positive significant association between infrastructure development, export, GDP per capita, and global competitiveness index.

Available studies that examined the effect of infrastructure on openness to trade include: Rahman et al. (2021) who observed that in China and 21 Asian economies, ICT and transport infrastructure promotes trade flow. In a similar study, Bankole et al. (2015) show that telecommunication infrastructure positively affects the efficiency of intra-African trade. A study by Bottasso et al. (2018) revealed that a rise in port infrastructure is closely linked to a rise in Brazilian exports. Similarly, Mlambo (2021) has found a positive effect of port infrastructure on Africa's trade while Munim and Schramm (2018) show that, in developing countries, a rise in the quality of port infrastructure is associated with a surge in seaborne trade. In another study, Bensassi et al. (2015) revealed that logistics infrastructure positively affects bilateral exports of Spanish regions to destination countries. However, Celbis et al. (2014) observed that a rise in telecommunication and transport infrastructure is associated with an increase in trade flow. In a study by Coşar and Demir (2016), improved transport infrastructure has been found to allow countries access to the global supply chain and increase trade competitiveness. As observed by Donaldson (2018), in the case of India, railroad infrastructure significantly affects international and interregional trade. Empirical findings from Liang and Liu's (2020) study reports that port infrastructure improves economic growth and negatively affects seaborne trade. Rehman et al. (2020) has found that infrastructure increases export and reduces trade deficits in South Asian countries.

Portugal-Perez and Wilson (2012) indicate that the infrastructure development's effect on exports decreases per capita GDP in a sample of 101 countries. In a sample of 75 economies, Wilson et al. (2005) showed that infrastructural services positively and significantly affected trade flows. Francois and Manchin's (2013) finding suggests that exports depend on infrastructure related to transport and communication, while Abeliansky and Hilbert (2017) have found the quality of infrastructure affects export in developing economies while in advanced economies it is the quantity of infrastructure that affects export. While examining the influence of infrastructure on intra-regional trade, Akpan (2014) reports that an improvement in the quality of road infrastructure increases trade between the Economic Community of West Africa States (ECOWAS). A similar finding by Hildegunn Kyvik Nordås and Piermartini (2004) indicates that infrastructural quality affects trade flows among 138 countries. Edmonds and Fujimura (2006), have found a positive and significant effect of infrastructure on open trade in the region of Greater Mekong.

Studies on the determinants of infrastructural development include, Joseph (2018) who observed that public debt and government revenue significantly affect infrastructure development in Uganda. A study by Ojo (2020) has found that per capita GDP and unemployment drive the development of infrastructure in Nigeria. While Chotia and Rao (2018) observed that in India, government debt and deficit financing were significant determinants of PPPs in infrastructure. Randolph et al.'s (1996) finding showed that infrastructure development is influenced by economic development, urbanization, and labour force participation rate in 27 low- and middle-income countries. In LAC countries, Cerra et al. (2017) revealed that government expenditure and private sector spending were the determinant factors for improving the stock of infrastructure. Oladipupo and Ibadin (2016), have found an increasing nexus between infrastructure, oil and non-oil revenue in Nigeria. Empirical analysis by Maria and Bagado (2015) shows that legal framework and public sector efficiency, and market condition were significant

factors determining infrastructure investment in LAC. Dao (2008), reports that private spending on telecommunication significantly affects the number of fixed and mobile telephone lines in developing countries. In a panel of 48 Muslim developing countries, Kasri and Wibowo (2015) revealed that country risk, institutional quality, and market conditions significantly affect private participation in financing infrastructure. Calderón and Chong (2004) have found a negative association between both the quality and quantity of infrastructure with income inequality.

Studies based on the infrastructure and macroeconomic variables include: Worlu and Nkoro (2012) who observed that tax affects the development of infrastructure in Nigeria. Cigu et al.'s (2018) finding revealed that in 28 European Union (EU) countries transport infrastructure, economic growth, and public sector performance are significantly correlated. A study by (Holtz-Eakin & Schwartz, 1995) has found no evidence of increased productivity from improved infrastructure in the United States. Babatunde (2018) reports that expenditure on health, transportation, education, and telecommunication infrastructure has a positive impact on the GDP growth in Nigeria. Fedderke et al.'s (2006) findings show that investment in roads, transport, and housing affects GDP growth in South Africa. In the context of 45, sub-Saharan Africa Kodongo and Ojah (2016) have found that economic growth significantly influences the quality of infrastructure, infrastructural services access, and spending on infrastructure. Another study by Shinyekwa and Ntale (2017) observed that infrastructure significantly affects manufacturing exports for East African countries. In a panel of 88 countries, Calderón et al. (2015) have found infrastructure, physical capital, and human capital to significantly affect GDP.

Based on the previous literature, the role of services trade in promoting infrastructure development at the time of writing this study has not been investigated by any empirical study. The current study observed that previous studies have only focussed on determining the effect of infrastructure on trade flows ignoring the role of trade openness in influencing the development of infrastructure. It is a general belief that in African countries the quality and development of infrastructure may also be derived from trade and the extent to which economies are opened rather than trade is influenced by infrastructure. The liberalization embarked on by African countries in the 1980s and 1990s has increased the participation of foreign services suppliers in the various telecommunication, trade, transport, and port infrastructure. As economies become more integrated through increased bilateral and multilateral trade relations this might have a positive effect on infrastructure development. Despite this firm belief, this study has not been able to find studies on the infrastructural impact of services openness. This represents a knowledge gap that this study will attempt to fill.

## 3. Data and method

The study utilized an unbalanced panel for 38 countries in Africa, which include Algeria, Angola, Benin, Burkina Faso, Burundi, Central African Republic, Cote d'Ivoire, Cameroon, Congo Democratic Republic, Congo Republic, Egypt, Gabon, Ghana, Guinea, Gambia, Guinea-Bissau, Kenya, Liberia, Morocco, Madagascar, Mali, Mozambique, Mauritania, Malawi, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Chad, Togo, Tunisia, Tanzania, Uganda, South Africa, Zambia, and Zimbabwe. The study covered the period of twenty-one years from 2000 to 2020. The use of this period is limited and driven by sample countries and data availability. The data are obtained from the World Bank World Development Indicators (WDI) and the World Economic Forum (WEF). The data definition, description, and sources are presented in Table 2.

To explore the effect of services trade openness on infrastructure empirical models on the determinants of infrastructure were reviewed and the controlled variables used in the model estimating this relationship are selected. Service trade openness is added to the selected determinants of infrastructural development to examine its impact on the development of infrastructure. We choose three different indicators of infrastructure development that are related to the quantity and quality of infrastructure which are telecommunications, trade/transport-related, and port infrastructure.

For the empirical analysis, the study used the dynamic System Generalized Method of Moment (SGMM) estimator for the dynamic panel. The use of a dynamic model is important because most economic variables are dynamic. Infrastructure and its determinants which vary across country and time are specified as:

$$\begin{aligned} lnINFdev_{it} = {} & \beta_0 + \beta_1 lnINFdev_{it-1} + \beta_2 lnSTO_{it} + \beta_3 lnRGDP_{it} + \beta_4 lnFD_{it} + \beta_5 lnGFCF_{it} \\ & + \beta_6 lnEXTDEBT_{it} + \beta_7 lnPOPDENS_{it} + \beta_8 lnURB_{it} + \beta_9 lnEXCRT_{it} \\ & + \beta_{10} lnSER_{it} + \lambda_i + \gamma_t + \varepsilon_{it} \end{aligned} \tag{1}$$

where; $i$ is the individual dimension or countries in the cross-section (In this case African countries; $i$ = 1, 2, 3 …… 38), $t$ is the time dimension; ($t$ = 2000, 2001 …… 2020). $INFdev_{it}$ is the infrastructure development indicator which can be any of the telecommunications, trade/transport-related, and port infrastructures, $INFdev_{it-1}$ is the lag dependent introduced to capture the dynamic properties of the model, $STO_{it}$ is the services trade openness and is our main variable of interest. $RGDP_{it}$ is the real GDP per capita, $FD_{it}$ is the financial development, $GFCF_{it}$ is the gross fixed capital formation, $EXTDEBT_{it}$ is the external debt. Incorporating external debt into the model is motivated by the fact that many developing, low- and middle-income countries have extensively used external debt to finance infrastructural investment (Daniel et al., 2019). $POPDENS_{it}$ is the population density, and $URB_{it}$ is urbanization. Population density and urbanization are included in the model because demographic factors also influence the demand for infrastructure. $EXCRT_{it}$ is the exchange rate, $SER_{it}$ is the share of the services sector, $\lambda_i$ is the country fixed effects; $\gamma_t$ is the year dummy; and $\varepsilon_{it}$ is the idiosyncratic error component. All the variables were converted to log form.

The degree to which services trade openness can affect infrastructural development is measured and summarized by $\beta_2$. Services trade openness in our data is a composite share of trade, comprising the use of trade share relative to a country's trade level to total world trade. We expect services trade openness to positively impact infrastructure development. Other explanatory variables include real GDP per capita and we expect its sign to be positive (+), financial development (+), gross fixed capital formation (GFCF) (+), external debt (+), population density (+), urbanization (+), exchange rate (-), and services sector value-added (+).

In a panel data analysis, the most common estimation techniques are the static pooled ordinary least square (POLS) estimate, random effect (RE), and fixed effect (FE) model that controls for the country and time-specific effect. Estimating the parameters of a dynamic model using POLS, fixed, and random estimators may result in a biassed estimate of model parameters. This is because in our formulated model some explanatory variables may likely be endogenous and the model parameters cannot be estimated with a certain degree of accuracy using POLS, FE, and RE coefficients. Arellano and Bond (1991) have put forward the GMM for a dynamic panel that includes the lag of the dependent variable as an additional regressor to deal with the problems associated with POLS, FE, and RE estimators in the dynamic panel. To remove the fixed country effect in panel data, Arellano and Bond's estimation procedures required taking the first difference of equation (1) as follows:

$$\begin{aligned} ln\Delta INFdev_{it} = {} & \beta_1 ln\Delta INFdev_{it-1} + \beta_2 ln\Delta STO_{it} + \beta_3 ln\Delta RGDP_{it} + \beta_4 ln\Delta FD_{it} \\ & + \beta_5 ln\Delta GFCF_{it} + \beta_6 ln\Delta EXTDEBT_{it} + \beta_7 ln\Delta POPDENS_{it} + \beta_8 ln\Delta URB_{it} \\ & + \beta_9 ln\Delta EXCRT_{it} + \beta_{10} ln\Delta SER_{it} + \Delta\gamma_t + \Delta\varepsilon_{it} \end{aligned} \tag{2}$$

From Equation (2) the within estimator is also biassed because of the differences in random disturbance term $\Delta\varepsilon_{it}$ are also correlated with the differences in lagged dependent variable $\Delta INFdev_{it-1}$. Blundell and Bond (1998) pointed out that with a small period and persistent time series the GMM estimator for the first difference as specified in Equation (2) is likely to be biassed because of the weak instruments provided by the lagged levels. Another shortcoming of applying

a difference estimator is that while differencing to remove country-specific effects may result in eliminating vital information in panel cross-country variation at levels.

To remove these problems and control for potential endogeneity and reverse causality in our analysis, the study adopts the approach of Bond et al. (2001), Blundell and Bond (1998), and Arellano and Bover (1995) i.e. system GMM, which was also advanced by Roodman (2009). The system GMM estimator is known to pool the moment conditions for both the models at levels and differences (Arellano & Bover, 1995; Blundell & Bond, 1998). When the series is persistent, the SGMM estimator performs better with more precision and less bias and has more benefits as it does not need the use of external instruments to control for endogeneity. It does this by instrumenting the differences and the lagged values between two periods of time of the endogenous dependent variables.

Two diagnostic tests must be passed for the system GMM estimator to be consistent. First, additional moment conditions must be valid and not related to the residual. The Hansen and Sargan tests were used to verify and test this hypothesis. Secondly, the test for correlation of disturbances which ought to reject the hypothesis of the absence of first-order (AR1) correlation and ought not to reject the hypothesis that second-order (AR2) correlation is absent. This has been verified by applying Arellano-Bond AR1 and AR2 tests. According to Blundell and Bond (1998), Arellano and Bover (1995), and Arellano and Bond (1991) the procedure of SGMM is supported if we fail to reject the null hypotheses of Sargan, Hansen, and AR2 tests. The results of these tests (p-values) are shown in Table 3 under the three estimates.

### *3.1. Measuring services trade openness*

In this study, we measure the services trade openness (*STO*) variable based on Squalli and Wilson's (2011) new procedure for measuring trade openness. Squalli and Wilson (2011) opined that an open economy is one with high total trade to overall GDP and accounts for a sizeable share of world total trade relative to other countries. In this regard, their proposed trade openness index constitutes a composite index obtained by combining the country's traditional trade openness index and its share in total world trade (i.e. trade/GDP ratio and world trade share). Squalli and Wilson (2011) proposed the following composite trade openness index;

$$TO_i = \frac{(X+M)_i}{\frac{1}{n}\sum_{j=1}^{n}(X+M)_j} \times \frac{(X+M)_i}{GDP_i} \tag{3}$$

where the $TO_i$ is the trade openness for $i$ $^{th}$ country, the $i$ subscript represents the country dimension, $n$ represents the number of countries, $(X+M)_i$ is the sum of exports and imports for $i$ $^{th}$ country, $(X+M)_j$ is the total world trade, and $GDP_i$ is the $i$ $^{th}$ country's GDP.

According to Squalli and Wilson (2011), this new measure has an advantage over the conventional measure of trade openness, i.e. $(X+M)/GDP$. In a panel and cross-country studies, Squalli and Wilson (2011) maintained that a high trade/GDP ratio is not the true measure of countries' openness because smaller countries may have high trade/GDP ratios due to their small economic sizes. While bigger economies would tend to have a low trade/GDP ratio because their foreign trade only constitutes a small fraction relative to their economic sizes even though they are major contributors to global trade. This will result in placing smaller economies as more open than bigger economies when the trade/GDP ratio is used as a measure of trade openness. Therefore, their measure provides an adjusted trade openness index that better reflects the actual degree of countries' openness. Based on Equation 3, country $i$ $^{th}$ will tend to have an upward rise in its trade openness higher than $(X+M)/GDP$ ratio provided that its actual world trade share, i.e., $(X+M)_i/(X+M)_j$ exceeds the world average $(\frac{1}{n})$. For details see, Squalli and Wilson (2011).

Additionally, in measuring service trade openness, we adopt the definition of services trade as given by the GATS. The GATS has recognised four modes through which services are supplied and traded across national boundaries. These modes include; (1) cross-border trade in services, e.g.,, banking and architectural services transmitted through telecommunications or email, (2) consumption abroad, e.g.,, movement of patients and tourists to another country to acquire services, (3) commercial presence, e.g.,, existence of services provider in the country where the services are consumed, these services are mostly supplied via FDI, (4) temporary movement or the presence of a physical person in the territory of another country to provide services, e.g.,, foreign teachers, doctors, and accountants. This is the framework adopted in this study to construct services openness. Services trade openness may be narrowed down and miscalculated when studies only consider the Balance of Payment (BoP) gross term cross-border services supply which does not account for modes 3 and 4 and some services value addition hidden in good trade (Roy, 2019). Therefore, cross-border services trade does not replicate the actual services trade flow. Determined to fill this gap in the literature, in this study we used modes 3 and 4 in addition to modes 1 and 2 which are included in services export and import data. This represents a significant improvement over previous works of literature that only used services export and import to measure openness. We used remittances received and paid by countries as a proxy for services provided through the movement of professional workers. Our constructed services trade openness is a broad measure that includes all the modes of services supply as identified by GATS. Moreover, our procedure of measuring services trade openness has helped in solving some methodological issues associated with measuring trade in services.

## 4. Empirical findings

Table 1 displays the link among the model variables. The variables are weakly and moderately correlated at a highly statistically significant level (statistical significance not reported). This implies that there is no possibility of a multicollinearity problem. Additionally, we used the variance inflation factor (VIF) test and re-checked for multicollinearity. The VIF values for the three models are 1.68, 1.91, and 1.82 which all fall below the generally acceptable standard value of 6. This further indicates that the estimated models did not suffer from multicollinearity problems. This is one of the advantages of using panel data (i.e. less multicollinearity). As expected, the three infrastructural indicators are positively and significantly correlated with service openness as our main independent variable. The correlations between the indicators of infrastructure and the control variables are highly statistically significant at a less than 1% level except for trade/transport-related infrastructure and GFCF, port infrastructure, and urbanization, which were significant at less than 5% and 10% levels. In Table 2, in terms of variability, as measured by the standard deviations, which are quite low, there are no high variations among the sample countries. This implies that the countries in the panel operate almost similar macroeconomic policies. This will help in reducing cross-country heterogeneity in our empirical analysis.

### *4.1. Dynamic GMM estimate*

For the GMM estimates to be consistent Hansen test, the Sargan test, and the serial correlation test of the second-order, i.e. AR(2) must be passed. If we fail to reject the hypothesis of instrument validity in considering the analogue moment condition in the sample countries, this will give support to the use of the GMM approach. The correlation test of the disturbance is based on the hypothesis that there is no serial correlation of the second-order of the differenced random disturbance term. AR(1) is always expected unless the error term at a level (original error term) follows a random walk. AR(2) requires that the original error term follows the moving average for at least first-order in which case we will say that there exists no correlation in the original residual and apply the analogous instruments or moment condition in our estimate. Findings reported in Table 3 revealed that all the specification tests are passed in all three estimates. The Sargan and Hansen tests have failed to reject the hypothesis of valid instruments and also there is no second-order serial correlation of random disturbance terms. Therefore, in all estimates of Table 3, the instruments used are valid, and as such our models are correctly specified.

**Table 1. Correlation analysis**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | lntelcom. | | | | | | | | | | | |
| 2 | lnt&t. | 0.11 | | | | | | | | | | |
| 3 | lnport | 0.47 | −0.16 | | | | | | | | | |
| 4 | lnsto | 0.21 | 0.31 | 0.11 | | | | | | | | |
| 5 | lngdp | 0.49 | 0.22 | 0.28 | 0.43 | | | | | | | |
| 6 | lnfd | 0.51 | 0.50 | 0.48 | 0.56 | 0.48 | | | | | | |
| 7 | lngfcf | 0.21 | 0.04 | −0.27 | 0.34 | 0.33 | 0.20 | | | | | |
| 8 | lnextdebt | −0.18 | −0.11 | 0.10 | −0.21 | −0.28 | −0.32 | −0.25 | | | | |
| 9 | lnpopdens | 0.03 | 0.09 | 0.10 | 0.13 | −0.25 | 0.04 | −0.11 | 0.01 | | | |
| 10 | lnurb | 0.30 | −0.29 | 0.06 | 0.36 | −0.26 | −0.27 | −0.22 | 0.43 | −0.05 | | |
| 11 | lnexcrt | −0.40 | 0.15 | −0.31 | −0.08 | −0.41 | −0.25 | −0.15 | 0.02 | 0.05 | 0.37 | |
| 12 | lnser | 0.40 | 0.28 | 0.45 | 0.62 | 0.43 | 0.48 | 0.03 | −0.14 | 0.40 | −0.29 | −0.30 |

Source: Author's computation

**Table 2. Variables descriptive analysis, sources, and definition**

| Variables | Definition | Sources | Mean | Std. dev. | Min. | Max. |
|---|---|---|---|---|---|---|
| lntelcom | Telecommunications infrastructure (measured as fixed telephone subscriptions (per 100 people) | WDI | 0.10 | 0.69 | 1.13 | 2.26 |
| lnt&t | Trade/transport-related infrastructure (measured as the quality of trade and transport-related infrastructure) which is based on the logistics performance assessment by the WDI | WDI | 0.82 | 0.29 | 0.23 | 2.12 |
| lnport | Ports infrastructure (measured as the quality of port infrastructure) which is based on the logistics performance assessment by the WEF | WEF | 1.15 | 0.40 | 0.31 | 2.03 |
| lnsto | Services trade openness is constructed based on the GATS definition of services and Squalli and Wilson's (2011) approach | Author's construct | 4.40 | 2.44 | 0.85 | 10.72 |
| lnrgdppc | GDP per capita in real term (at 2010 constant US$) | WDI | 6.89 | 0.89 | 5.36 | 9.22 |
| lnfd | Financial development (measured by domestic credit to the private sector as % of GDP) | WDI | 4.00 | 0.29 | 4.06 | 5.26 |

(*Continued*)

**Table 2. (*Continued*)**

| Variables | Definition | Sources | Mean | Std. dev. | Min. | Max. |
|---|---|---|---|---|---|---|
| lngfcf | Gross fixed capital formation (measured as % of GDP) | WDI | 3.09 | 0.51 | 1.11 | 4.39 |
| lnextdebt | External debt stocks (% of GNI) | | 3.73 | 0.81 | 0.93 | 7.23 |
| lnpopdens | Population density (measured as people per sq. km) | WDI | 3.75 | 1.09 | 1.08 | 6.44 |
| lnurb | Urbanization (measured by population in the largest cities as % of the total population) | WDI | 3.51 | 0.45 | 1.43 | 4.49 |
| lnexcrt | Exchange rate (measured as the official rate per US$) | WDI | 4.51 | 2.50 | 0.35 | 11.02 |
| lnser | Services sector (measured by the services value addition to GDP) | WDI | 3.20 | 0.28 | 1.65 | 4.42 |

Source: Author's computation

Note: WDI = World Development Indicators, WEF = World Economic Forum



cogent economics & finance

We use a two-step estimate instead of a one-step estimate, this is because the two-step estimate uses the right corresponding moment conditions that are more robust and more efficient. In all the estimates, to ensure that our empirical findings are not affected by extreme values we used Cook's (1977) distance outlier test and remove all the extreme values.

Table 3 presents the results of the system GMM estimate with three different indicators of infrastructure used as regressands. In our whole estimate, the empirical results show that the constructed models are dynamic as all the coefficients of the lag-dependent variables are positive and significant at a high level of less than 1%. This result suggests that the current infrastructure is also affected by not only the services trade and set of control variables but also by its past level in African countries. This also implies that there exists long-term nexus between the independent and the dependent variables with a speed of adjustment of 55% for telecommunications infrastructure, 25% for trade/transport-related infrastructure, and 13% for port infrastructure. This finding necessitates the need to use the GMM approach for the dynamic panel.

Our empirical findings in Table 3 show that the development of telecommunications, trade/transport-related, and port infrastructures in Africa are determined by services trade and other explanatory variables. Service trade significantly and positively affects infrastructure development in African countries. Column (1) of Table 3 suggests that on average at less than a 1% level of significance, a 1% increase in openness to trade is closely linked to a 0.0205% increase in a telecommunications infrastructure while column (2) finding revealed that a 1% increase in trade openness increases trade/transport-related infrastructure by 0.00516%, significant at a less than 5% level. The effect of trade on port infrastructure is highly significant at less than 5% level indicating that a 1% increase in trade openness is connected with a 0.00210% rise in port infrastructure. Our result also revealed that the elasticity of services trade impact on telecommunications infrastructure is higher than that of trade/transport-related and port infrastructures. This result is in line with the findings of Pradhan et al. (2014) in a sample of G20 countries, Tei and Ferrari (2018) in the case of LAC countries, Edame et al. (2014), and Edame and Fonta (2014) in the case of Nigeria, Cerra et al. (2017) in the case of 110 countries' panel, Harmes-Liedtke and Di Matteo (2011) in a sample of 54 countries.

Findings also revealed that a rise in per capita GDP asserts a significant positive effect on all three indicators of infrastructure development in African countries. The result indicates that a 1% rise in GDP per capita is connected with a 0.747% rise in telecommunications infrastructure. At less than a 5% significance level, a 1% rise in per capita GDP increases trade/transport-related infrastructure by 0.0163%, respectively. Port infrastructure also increases by 0.04770% resulting from a 1% increase in GDP as suggested by the estimate. Our finding is supported by Hildegunn K. Nordås and Rouzet (2016) in a cross-country study, Kasri and Wibowo (2015) in 48 Muslim developing countries, Harmes-Liedtke and Di Matteo (2011) in a sample of 54 countries, and Randolph et al. (1996) in a sample of low- and middle-income countries.

As expected, financial development is positively related to all the indicators of infrastructure development. This suggests the need for African countries to adopt broad-based financial development strategies in the continent. For instance, from the estimates, a 1% rise in financial development is associated with a 0.106% increase in telecommunications infrastructure, a 0.0892% increase in trade/transport-related infrastructure, and a 0.0416% increase in port infrastructure. This finding is supported by Cerra et al. (2017) in the case of 110 countries panel.

Gross fixed capital formation increases trade/transport-related infrastructure and reduces port infrastructure. While there is no established evidence that gross fixed capital formation significantly affects telecommunications infrastructure because the estimated elasticity is insignificant. The empirical result also indicates that a 1% rise in gross fixed capital formation is generally associated with a 0.134% increase in trade/transport-related infrastructure and reduces port infrastructure by 0.128%. This finding is supported by Pradhan et al. (2014).

**Table 3. System GMM estimate of the services trade effect on infrastructure development**

| Variables | (1) Telecommunications infrastructure | (2) Trade/transport-related infrastructure | (3) Port infrastructure |
|---|---|---|---|
| Constant | 2.338 | −5.065*** | 12.45* |
| | (1.476) | (0.821) | (6.523) |
| L.Infrast. | 0.449*** | 0.754*** | 0.872*** |
| | (0.151) | (0.107) | (0.0939) |
| lnSTO | 0.0205*** | 0.00516** | 0.00210** |
| | (0.00724) | (0.00245) | (0.00103) |
| lnRGDP | 0.747* | 0.0163** | 0.0477* |
| | (0.398) | (0.00767) | (0.0268) |
| lnFD | 0.106* | 0.0892* | 0.0416* |
| | (0.0525) | (0.0479) | (0.0228) |
| lnGFCF | 0.121 | 0.134* | −0.128*** |
| | (0.124) | (0.0711) | (0.0437) |
| lnEXTDEBT | 0.000604* | 0.0770*** | 0.192** |
| | (0.000349) | (0.0244) | (0.0939) |
| lnPOPDENS | 0.0403 | 0.0281** | 0.0313* |
| | (0.0314) | (0.0141) | (0.0169) |
| lnURB | 0.0596** | −0.00758* | 0.000970 |
| | (0.0290) | (0.00399) | (0.000612) |
| lnEXCRT | −0.385*** | 0.0166 | −0.926* |
| | (0.143) | (0.0885) | (0.560) |
| lnSER | 0.550** | 0.688*** | 0.0304* |
| | (0.279) | (0.203) | (0.0172) |
| Sargan_test | (0.309) | (0.366) | (0.111) |
| Hansen_test | (0.094) | (0.568) | (0.324) |
| AR(2) | (0.592) | (0.459) | (0.164) |
| Observations | 527 | 662 | 604 |
| No. of code | 38 | 38 | 38 |
| Instruments | 35 | 30 | 33 |
| Year effect | Included | Included | Included |

Source: Author's computation

Note: The statistical significance of the estimates at < 1%, < 5%, and < 10% are denoted by ***, **, and * respectively. Values in parentheses are standard errors, except for the Hansen, Sargan, and AR(2) tests which are probability values.

Our empirical strategy suggests that external debt stocks increase all three indicators of infrastructure development. This finding is supported by Kasri and Wibowo (2015) and contradicts (Cerra et al., 2017). Findings indicate that a 1% increase in external debt increases telecommunication infrastructure by 0.000604%, trade/transport-related infrastructure by 0.0770%, and port infrastructure by 0.192%. This is consistent with Runde et al. (2019) who revealed that many developing, low- and middle-income countries have extensively used external debt to finance infrastructural investment.

Our specifications revealed that population density promotes the development of trade/transport-related and port infrastructure in African countries. The result indicates that a 1% rise in population density is closely linked to a 0.0281%, and a 0.0313% increase in trade/transport-related and port infrastructures. This result supported our theoretical a priori and is also supported by Edame et al. (2014) and Randolph et al.'s (1996) empirical findings.

The finding further revealed a positive and significant nexus between urbanization and telecommunications and also a negative relationship with trade/transport-related infrastructure. From the estimate, a 1% rise in urbanization is connected with a 0.0596% rise in telecommunications infrastructure and also a 0.00758% decrease in trade/transport-related infrastructure. The decrease in trade/transport-related infrastructure resulting from increased urbanization is not in line with our a priori expectation as urbanization is the result of industrialization and is expected to assert an increasing impact on the development of trade/transport-related infrastructure. This is also consistent with Randolph et al.'s (1996) finding. The impact of urbanization on port infrastructure is positive but not statistically significant.

The exchange rate coefficient is significant and negative for telecommunications infrastructure and port infrastructure and positive but not statistically significant for trade/transport-related infrastructure. The finding indicates that a 1% increase in the exchange rate reduces telecommunications infrastructure by 0.385%. Furthermore, results indicate that a 1% rise in exchange rate reduces port infrastructure by 0.926%.

There is no doubt about the highly positive and significant role of services value-added in promoting all indicators of infrastructure development. A plausible reason for this is that most infrastructures were in form of services which called for a significant association between infrastructure and services value-added. Our findings show that a 1% rise in service sector value-addition is connected with a 0.550% increase in telecommunications infrastructure, a 0.688% increase in trade/transport-related infrastructure, and a 0.0304% increase in port infrastructure respectively. This finding is consistent with Roy's (2017) finding.

## 5. Conclusions and recommendations

In this study, we provide the first empirical investigation of the services trade openness effect on the development of infrastructure measured by three indicators: telecommunications, trade/transport-related, and port infrastructure. Applying the system, GMM to a panel of 38 African countries our empirical strategy revealed that services trade promotes the development of infrastructure in African countries. In addition, the study observed that GDP, financial development, external debt, and service value-added have contributed to the development of telecommunications, trade/transport-related, and port infrastructures. Gross fixed capital formation increases trade/transport-related and reduces port infrastructure, while population density increases trade/transport-related and port infrastructure but asserts no significant effect on telecommunications. Urbanization increases telecommunications and reduces trade/transport-related infrastructure. The exchange rate hinders the growth of telecommunications and port infrastructure.

These findings are new and provide the first empirical support for the services trade effect on infrastructure in African countries. Given this fact, the findings are vital to present policies related to services trade and infrastructure development in the continent. Therefore, in this study, we recommend that African countries' government should reconsider their restrictive trade policy that is reducing the flows of various foreign services for better development of infrastructural services. This is important because the study observed that a rise in services trade is closely linked to the development of telecommunication, trade/transport-related, and port infrastructure. There is also the need to promote policies aimed at increasing the significant role of the services industry, GDP, financial development, external debt, and population density as they contributed to the development of infrastructure in the continent. A stable exchange rate policy is needed to halt its negative effect on the development of infrastructure in the continent. Since gross fixed capital formation and urbanization asserts both positive and negative impacts on different infrastructural indicators, it is recommended that the continent need to checkmate the increase in capital stock and urbanization in line with the development of a different category of infrastructure. This can be done by weighing the positive and negative effects of these factors on a given infrastructural sector and focusing on the right path to sustainable growth and development of infrastructure.

**Funding**
The authors received no direct funding for this research.

**Author details**
Kabiru Hannafi Ibrahim[1,2]
ORCID ID: http://orcid.org/0000-0002-2252-5735
Rossanto Dwi Handoyo[2]
E-mail: rossanto_dh@feb.unair.ac.id
ORCID ID: http://orcid.org/0000-0002-4133-1207
Wasiaturrahma Wasiaturrahma[2]
ORCID ID: http://orcid.org/0000-0001-6055-0790
Tamat Sarmidi[3]
ORCID ID: http://orcid.org/0000-0001-6064-0999
[1] Department of Economics, Federal University Birnin-Kebbi, Birnin-Kebbi, Nigeria.
[2] Department of Economics, Universitas Airlangga, Surabaya, Indonesia.
[3] School of Economics, Faculty of Economics and Management, Universiti Kebangsaan Malaysia, Bangi, Malaysia.

**Disclosure statement**
No potential conflict of interest was reported by the author(s).

**Citation information**
Cite this article as: Services trade and infrastructure development: Evidence from African countries, Kabiru Hannafi Ibrahim, Rossanto Dwi Handoyo, Wasiaturrahma Wasiaturrahma & Tamat Sarmidi, *Cogent Economics & Finance* (2022), 10: 2143147.

**References**

Abeliansky, A. L., & Hilbert, M. (2017). Digital technology and international trade: Is it the quantity of subscriptions or the quality of data speed that matters? *Telecommunications Policy*, *41*(1), 35–48. https://doi.org/10.1016/j.telpol.2016.11.001

Akpan, U. (2014). Impact of regional road infrastructure improvement on intra-regional trade in ECOWAS. *African Development Review*, *26*(S1), 64–76. https://doi.org/10.1111/1467-8268.12093

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, *58* (2), 277–297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Babatunde, S. A. (2018). Government spending on infrastructure and economic growth in Nigeria. *Economic Research-Ekonomska Istrazivanja*, *31*(1), 997–1014. https://doi.org/10.1080/1331677X.2018.1436453

Bankole, F. O., Osei-Bryson, K., & Brown, N. (2015). The impacts of telecommunications infrastructure and institutional quality on trade efficiency in Africa. *Information Technology for Development*, *21*(1), 29–43. https://doi.org/10.1080/02681102.2013.874324

Bensassi, S., Márquez-Ramos, L., Martínez-Zarzoso, I., & Suárez-Burguet, C. (2015, February). Relationship between logistics infrastructure and trade: Evidence from Spanish regional exports. *Transportation Research Part A: Policy and Practice*, *72*, 47–61. https://doi.org/10.1016/j.tra.2014.11.007

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bond, S., Hoeffler, A., & Temple, J. (2001). *GMM estimation of empirical growth models*. Centre for Economic Policy Research Discussion Paper No. 3048. Retrieved August 19, 2019, from https://www.researchgate.net/publication/4753417_GMM_Estimation_and_Empirical_Growth_Models

Borchert, I., Gootiiz, B., Grover Goswami, A., & Mattoo, A. (2017). Services trade protection and economic isolation. *The World Economy*, *40*(3), 632–652. https://doi.org/10.1111/twec.12327

Bottasso, A., Conti, M., de Sa Portoc, P. C., Ferrari, C., & Tei, A. (2018). Port infrastructures and trade: Empirical evidence from Brazil. *Transportation Research Part A*, *107*(2018), 126–139. https://doi.org/10.1016/j.tra.2017.11.013

Calderón, C., & Chong, A. (2004). Volume and quality of infrastructure and the distribution of income: An empirical investigation. *Review of Income and Wealth*, *50*(1), 87–106. https://doi.org/10.1111/j.0034-6586.2004.00113.x

Calderón, C., Moral-Benito, E., & Servén, L. (2015). Is infrastructure capital productive? A dynamic heterogeneous approach. *Journal of Applied Econometrics*, *30*(2), 177–198. https://doi.org/10.1002/jae.2373

Celbis, M. G., Nijkamp, P., & Poot, J. (2014). Infrastructure and trade: A meta-analysis. *Region*, *1*(1), 25–65. https://hdl.handle.net/10419/110933

Cerra, V., Cuevas, A., Goes, C., Karpowicz, I., Matheson, T., Samake, I., & Vtyurina, S. (2017). Determinants of Infrastructure and Its Financing. *Emerging Economy Studies*, *3*(2), 113–126. https://doi.org/10.1177/2394901517730739

Chotia, V., & Rao, N. V. M. (2018). Estimating the determinants of public private partnerships in infrastructure: The case of India. *International Journal of Critical Infrastructures*, *14*(3), 248–267. https://doi.org/10.1504/IJCIS.2018.10015615

Cigu, E., Agheorghiesei, D. T., Gavriluță, A. F., & Toader, E. (2018). Transport infrastructure development, public performance and long-run economic growth: A case study for the Eu-28 Countries. *Sustainability*, *11*(1), 1–22. https://doi.org/10.3390/su11010067

Collier, P. (2014). Attracting international private finance for African infrastructure. *Journal of African Trade*, *1*(1–2), 37–44. https://doi.org/10.1016/j.joat.2014.09.002

Cook, R. D. (1977). Detection of influential observation in linear regression. *Technometrics*, *19*(1), 15–18. https://doi.org/10.2307/1268249

Coşar, A. K., & Demir, B. (2016). Domestic road infrastructure and international trade: Evidence from Turkey. *Journal of Development Economics*, *118*(2016), 232–244. https://doi.org/10.1016/j.jdeveco.2015.10.001

Daniel, F. R., Erol, K. Y., & Sundar, R. R. (2019). *Achieving sustainability through Quality infrastructure*. Center for Strategic and International Studies: Briefs. Retrieved March 7, 2021, from https://www.csis.org/analysis/achieving-sustainability-through-quality-infrastructure

Dao, M. Q. (2008). The determinants of infrastructure development in developing countries. *Journal for Studies in Economics and Econometrics*, *32*(3), 43–54. https://doi.org/10.1080/10800379.2008.12106456

Donaldson, D. (2018). Railroads of the Raj: estimating the impact of transportation infrastructure. *American Economic Review*, *108*(4–5), 899–934. https://doi.org/10.1257/aer.20101199

Edame, G. E., & Fonta, W. M. (2014). The impact of government expenditure on infrastructure in Nigeria: A co-integration & error correction specification. *International Journal of African and Asian Studies*, *3* (2014), 50–63. https://www.iiste.org/Journals/index.php/JAAS/article/view/9128

Edame, G. E., Udude, C. C., & Dave, U. U. (2014). Trend analysis of public expenditure on infrastructure and

economic growth in Nigeria. *International Journal of Asian Social Science*, *4*(4), 480–491. https://archive.aessweb.com/index.php/5007/article/view/2650

Edmonds, C., & Fujimura, M. (2006). Impact of cross-border road infrastructure on trade and investment in the greater Mekong subregion. Discussion Paper No. 48. Asian Development Bank Institute. Retrieved January 9, 2020, from http://hdl.handle.net/11540/3636

Fedderke, J. W., Perkins, P., & Luiz, J. M. (2006). Infrastructural investment in long-run economic growth: South Africa 1875-2001. *World Development*, *34*(6), 1037–1059. https://doi.org/10.1016/j.worlddev.2005.11.004

Felbermayr, G. J., & Tarasov, A. (2022, July). Trade and the spatial distribution of transport infrastructure. *Journal of Urban Economics*, *130*, 103473. https://doi.org/10.1016/j.jue.2022.103473

Firdausy, C. M. (2018). Potential financial instruments towards sustainable urban infrastructural development in Indonesia. *International Journal of Critical Infrastructures*, *14*(4), 295–310. https://doi.org/10.1504/IJCIS.2018.095615

Francois, J., & Manchin, M. (2013). Institutions, infrastructure, and trade. *World Development*, *46*(2013), 165–175. https://doi.org/10.1016/j.worlddev.2013.02.009

Gill, S. (2008). Globalization, market civilization and disciplinary Neo-Liberalism. In Hovden, E., & Keene, E. (eds.) *The Globalization of Liberalism. Millennium* (pp. 123–149). Palgrave Macmillan, London. https://doi.org/10.1057/9780230519381_7

Gourevitch, P. (1978). The second image reversed: The international sources of domestic politics. *International Organization*, *32*(4), 881–912. https://doi.org/10.1017/S002081830003201X

Harmes-Liedtke, U., & Di Matteo, J. J. O. (2011). Measurement of quality infrastructure. Physikalisch Technische Bundesanstalt Discussion Paper 5/2011. Physikalisch Technische Bundesanstalt. Retrieved January 22, 2020, from https://www.researchgate.net/publication/274638349_Measurement_of_Quality_Infrastructure

Hocman, G., Tabakis, C., & Zilberman, D. (2013). The impact of international trade on institutions and infrastructure. *Journal of Comparative Economics*, *41* (2013), 126–140. https://doi.org/10.1016/j.jce.2012.07.001

Holtz-Eakin, D., & Schwartz, A. E. (1995). Infrastructure in a structural model of economic growth. *Regional Science and Urban Economics*, *25*(1995), 131–151. https://doi.org/10.1016/0166-0462(94)02080-Z

Ibrahim, K. H. (2021). *Impact of international trade on environmental quality: New evidence from African countries* [Doctoral Dissertation]. Universitas Airlangga.

Ibrahim, K. H., Sari, D. W., & Handoyo, R. D. (2021a). Revisiting Squalli-Wilson's measure of trade openness in the context of services trade. *Iranian Economic Review*, *25*(4), 727–749. https://doi.org/10.22059/IER.2020.76106

Ibrahim, K. H., Sari, D. W., & Handoyo, R. D. (2021b). Environmental impact of services trade: New evidence from African countries. *Polish Journal of Environmental Studies*, *30*(6), 5039–5050. https://doi.org/10.15244/pjoes/134294

Ibrahim, K. H., Sari, D. W., & Handoyo, R. D. (2022). The role of trade and energy in generating carbon emissions and environmental degradation. *Journal of Sustainable Development of Energy, Water and Environment Systems*, *10*(3), 1090397. https://doi.org/10.13044/j.sdewes.d9.0397

Jansen, M., & Nordås, H. K. (2004). Institutions, trade policy and trade flows. WTO staff working paper ERSD-2004-02. World Trade Organization (WTO), Geneva. Retrieved January 7, 2020, from https://doi.org/10.2139/ssrn.923544

Jiya, A. N., Sama, M. C., & Ouedraogo, I. (2020). *Infrastructure, trade openness and economic transformation in common market for Eastern and Southern Africa member countries* (Vol. 2, pp. 100072). Social Sciences & Humanities Open. https://doi.org/10.1016/j.ssaho.2020.100072

Joseph, A. B. (2018). *Determinants of public expenditure on Infrastructure in Uganda*. Makerere University. Retrieved January 23, 2020, from http://makir.mak.ac.ug/handle/10570/7044?show=full

Kasri, R. A., & Wibowo, F. A. (2015). Determinants of public-private partnerships in infrastructure provision: Evidence from Muslim developing countries. *Journal of Economic Cooperation and Development*, *36*(2), 1–34. https://www.sesric.org/publications-jecd-articles.php?jec_id=95

Kodongo, O., & Ojah, K. (2016). Does infrastructure really explain economic growth in Sub-Saharan Africa? *Review of Development Finance*, *6*(2), 105–125. https://doi.org/10.1016/j.rdf.2016.12.001

Liang, R., & Liu, Z. (2020). Port infrastructure connectivity, logistics performance and seaborne trade on economic Growth. *Journal of Coastal Research*, *106*(sp1), 319–324. https://doi.org/10.2112/SI106-074.1

Lorz, O. (2020, December). Investment in tradefacilitating infrastructure: A political-economy analysis. *European Journal of Political Economy*, *65*, 101928. https://doi.org/10.1016/j.ejpoleco.2020.101928

Makovsek, D., Hasselgren, B., & Perkins, S. (2015). Public private partnerships for transport infrastructure: Renegotiations, how to approach them and economic outcomes: Roundtable summary and conclusions. International transport forum discussion paper, no. 2014/25. International Transport Forum, Paris France. Retrieved February 9, 2020, from http://hdl.handle.net/10419/109171

Maria, C., & Bagado, M. (2015). Determinants of infrastructure investment through public-private partnership in Latin America and the Caribbean [IESEG School of Management]. Retrieved January 23, 2020, from https://www.stp.gov.py/v1/wp-content/uploads/2017/04/Final-Thesis.pdf

Mlambo, C. (2021). The impact of port performance on trade: The case of selected African states. *Economies*, *9*(4), 135. https://doi.org/10.3390/economies9040135

Müller, W. C. (1994). Political traditions and the role of the state. *West European Politics*, *17*(3), 32–51. https://doi.org/10.1080/01402389408425029

Munim, Z. H., & Schramm, H. (2018). The impacts of port infrastructure and logistics performance on economic growth: The mediating role of seaborne trade. *Journal of Shipping and Trade*, *3*(1), 1–19. https://doi.org/10.1186/s41072-018-0027-0

Nordås, H. K., & Piermartini, R. (2004). Trade and infrastructure. Staff Working Paper ERSD-2004/04. World Trade Organization, Geneva Switzerland. Retrieved September 18, 2020, from https://ideas.repec.org/p/zbw/wtowps/ersd200404.html

Nordås, H. K., & Rouzet, D. (2016). The impact of services trade restrictiveness on trade flows. *The World Economy*, *40*(6), 1155–1183. https://doi.org/10.1111/twec.12424

OECD & WTO. (2017). *Aid for trade at a glance 2017: Promoting trade inclusiveness and connectivity for sustainable development*. OECD and WTO Report. Retrieved September 18, 2020, from https://www.

wto.org/english/res_e/booksp_e/aid4trade17_poket_e.pdf

Ojo, A. E. (2020). The socio-economic drivers of public infrastructure development in Nigeria. *International Journal of Critical Infrastructures*, *16*(4), 328–341. https://doi.org/10.1504/IJCIS.2020.10034289

Oladipupo, O. A., & Ibadin, O. P. (2016, August). Indirect taxes and infrastructural development in Nigeria. *Igbinedion University Journal of Accounting*, *2*, 331–359. http://iuokada.edu.ng/journals/B1A0CC7890AFAFC.pdf

Peter, B. E., Harold, K. J., & Robert, D. P. (1994). Double-edged diplomacy: International bargaining and domestic politics. *The American Political Science Review*, *88*(4), 1038–1039. 1038–1039. https://doi.org/10.2307/2082776

Portugal-Perez, A., & Wilson, J. S. (2012). Export performance and trade facilitation reform: Hard and soft infrastructure. *World Development*, *40*(7), 1295–1307. https://doi.org/10.1016/j.worlddev.2011.12.002

Pradhan, R. P., Arvin, M. B., Norman, N. R., & Bele, S. K. (2014). Economic growth and the development of telecommunications infrastructure in the G-20 countries: A panel-VAR approach. *Telecommunications Policy*, *38*(7), 634–649. https://doi.org/10.1016/j.telpol.2014.03.001

Rahman, I. U., Shafi, M., Junrong, L., Fetuu, E. T. M. K., Fahad, S., & Sharma, B. P. (2021). Infrastructure and trade: An empirical study based on China and selected Asian economies. *SAGE Open*, *11*(3), 1–16. https://doi.org/10.1177/21582440211036082

Randolph, S., Bogetic, Z., & Hefley, D. (1996). Determinants of public expenditure on infrastructure: Transportation and communication. Policy Research Working Paper 1661. World Bank, Washington D.C. America. Retrieved December 3, 2020, from http://documents1.worldbank.org/curated/en/117111468766218333/pdf/multi-page.pdf

Rehman, F. U., Noman, A. A., & Ding, Y. (2020). Does infrastructure increase exports and reduce trade deficit? Evidence from selected South Asian countries using a new global infrastructure index. *Journal of Economic Structures*, *9*(1), 1–23. https://doi.org/10.1186/s40008-020-0183-x

Roodman, D. (2009). A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158. https://doi.org/10.1111/j.1468-0084.2008.00542.x

Roy, M. (2017). The contribution of services trade policies to connectivity in the context of aid for trade. Staff Working Paper ERSD-2017-12. World Trade Organization, Geneva Switzerland. Retrieved January 7, 2020, from https://papers.ssrn.com/sol3/papers.cfm?Abstract_id=3036946

Roy, M. (2019). Elevating services: Services trade policy, WTO commitments, and their role in economic development and trade integration. *Journal of World Trade*, *53*(6), 923–950. https://doi.org/10.2139/ssrn.3358775

Runde, D. F., Yayboke, E. K., & Ramanujam, S. R. (2019). *Achieving sustainability through quality infrastructure*. CSIS Brief. Retrieved December 2, 2020, from https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/190620_RundeYayboke Ramanujam_QualityInfrastructure_layout_WEB.pdf

Sachs, J. D., Warner, A., Aslund, A., & Fischer, S. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, *1* (1995), 1–118. https://doi.org/10.2307/2534573

Scherrer, C. (2004). Global governance: From fordist trilateralism to Neoliberal constitutionalism. In S. A. Schirm (Ed.), *New rules for global markets: Public and private governance in the world economy* (pp. 109–129). Palgrave Macmillan Limited.

Schneider, V. (2001). *The transformation of telecommunications: From state monopoly to global market (1800-2000)*. Campus Verlag Frankfurt/New York.

Schulze, G. G., & Ursprung, H. W. (1999). Globalisation of the economy and the nation state. *The World Economy*, *22*(3), 295–352. https://doi.org/10.1111/1467-9701.00205

Shepherd, B. (2017). Infrastructure, trade facilitation, and network connectivity in Sub-Saharan Africa. *Journal of African Trade*, *3*(2016), 1–22.

Shinyekwa, I. M. B., & Ntale, A. (2017). *The role of economic infrastructure in promoting exports of manufactured products: Trade facilitation and industrialization in the EAC*. EPRC Research Series No. 139. Economic Policy Research Centre, Makerere University, Kampala, Uganda. Retrieved August 6, 2019, from https://ageconsearch.umn.edu/record/265773?ln=en

Squalli, J., & Wilson, K. (2011). A new measure of trade openness. *The World Economy*, *34*(10), 1745–1770. https://doi.org/10.1111/j.1467-9701.2011.01404.x

Tei, A., & Ferrari, C. (2018). PPIs and transport infrastructure: Evidence from Latin America and the Caribbean. *Journal of Transport Geography*, *71* (2016), 204–212. https://doi.org/10.1016/j.jtrangeo.2017.10.012

Thomas, P. H. (1983). Networks of power: Electrification in Western society, 1880-1930. *The Technology and Culture*, *25*(3), 644–647. https://www.press.jhu.edu/books/title/2031/networks-power

Van Der Pijl, K. (2005). *Transnational classes and international relations*. Taylor & Francis or Routledge's collection of thousands of eBooks.

Wessel, J. (2019, June). Evaluating the transport-mode-specific trade effects of different transport infrastructure types. *Transport Policy*, *78*, 42–57. https://doi.org/10.1016/j.tranpol.2019.04.002

Wilson, J. S., Mann, C. L., & Otsuki, T. (2005). Assessing the potential benefit of trade facilitation: A global perspective. *The World Economy*, *28*(6), 841–871. https://doi.org/10.1142/9789812701350_0008

World Bank, World Development Report. (2016). *Digital dividends*. Retrieved February 12, 2019, from https://doi.org/10.1596/978-1-4648-0671-1

World Trade Organization. (2017). *Services trade policies and their contribution to connectivity and development*. Retrieved February 12, 2019, from https://www.oecd-ilibrary.org/development/aid-for-trade-at-a-glance-2017/services-trade-policies-and-their-contribution-to-connectivity-and-development_aid_glance-2017-7-en

Worlu, C. N., & Nkoro, E. (2012). Tax revenue and economic development in Nigeria: A macroeconometric approach. *Academic Journal of Interdisciplinary Studies*, *1*(2), 211–223. https://doi.org/10.5901/ajis.2012.v1n2p211

WTO. (2004). *World trade report 2004: Exploring the linkage between the domestic policy environment and international trade*. WTO, World Trade Report 2004. Retrieved February 12, 2021, from https://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report04_e.pdf

Xu, J., Yi, B., & Fan, Y. (2020, September). Economic viability and regulation effect of infrastructure investments for inter-regional electricity transmission and trade in China. *Energy Economics*, *91*, 104890. https://doi.org/10.1016/j.eneco.2020.104890

cogent economics & finance

## Appendix. List of Countries

| | |
|---|---|
| Algeria | Madagascar |
| Angola | Mali |
| Benin | Mozambique |
| Burkina Faso | Mauritania |
| Burundi | Malawi |
| The central African Republic | Niger |
| Cote d'Ivoire | Nigeria |
| Cameroon | Rwanda |
| Congo, Dem. Rep | Sudan |
| Congo, Rep. | Senegal |
| Egypt, Arab Rep. | Sierra Leone |
| Gabon | Chad |
| Ghana | Togo |
| Guinea | Tunisia |
| The Gambia | Tanzania |
| Guinea-Bissau | Uganda |
| Kenya | South Africa |
| Liberia | Zambia |
| Morocco | Zimbabwe |

***Cogent Economics & Finance* (ISSN: 2332-2039) is published by Cogent OA, part of Taylor & Francis Group.**