The nexus of transport connectivity and infrastructure with trade growth in the ECOWAS region.

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Abstract
The impact of transport connectivity and infrastructure on trade and overall economic development in the West African region cannot be over emphasized. Generally, it has been established that poor transportation systems have negative knock-on effects on the economies of countries. Thus, this study identifies and discussed the barriers and facilitators regarding transport connectivity， performance of trade and overall economic development of member countries of the ECOWAS region. We develop a gravity model to assess the impact of transport connectivity and infrastructure on bilateral and intra-regional trade across the study region. Also, multilateral trade resistance (MTR) terms are included in the modelling structure as a variable to capture the comparative trade cost between transacting partner economies. The outcome of the analysis indicates a positive connection between transport connectivity and infrastructure along with international and intra-regional trade. This implies that transport connectivity and infrastructure impact the overall growth and performance of trade in the ECOWAS region and the level of impact is statistically significant. The analysis show that including a rail connection between trading country partners in the study area will result in an average upsurge of trade performance by 3.5 per cent. Similarly, the results also prove that a 10 per cent decrease in the distance of sea and air upsurges trade by 0.52 per cent and 0.31 per cent, respectively. Likewise, improving the rail and road density of the trading partner countries ranked as the second factor that contributes greatly to improving trade performance in the study area. Similarly, the performance of logistics (such as LPI) indicates a substantial and comparatively robust impact on the flow of international and intra-regional trades.
Key words: ECOWAS, MTR, LPI, LSCI, transport connectivity, transport infrastructure, gravity model

1. Introduction

Multimodal transport connectivity comprises of discrete modes of transportation (such as land, sea and air) along with the intermodal connections. Per se, it involves a system of linkages (such as the railway, airways, and roadway transport routes) with infrastructures (such as road networks, airports and marine ports). According to the research of Battaglia (2007), these transport infrastructures offer easy entree to consumer markets, links resources and raw materials to production markets, encourages regional incorporation and expands connectivity to both continental and global trade and economy. Additionally, there is a direct influence on a nation's capacity in handling imports and exports activities, the expansion of supply routes, regularity of shipments, and the cost of cargo management, storage, delivery and interrelated services. These are all factors which impact the competitiveness of businesses in a market. Notwithstanding the enormous human and natural resource capacities in the African region, intra-regional trade and economic development indices in the Economic Community of West African States (ECOWAS) and the Africa at large have been awful in recent years. The sub-Saharan Africa, especially the ECOWAS region is overwhelmed by underdeveloped, poor, and inept transportation structures, which has resulted in a poor regional, intra-regional and international linkages and unproductive logistical services. Unfortunately, this has been also the case in the past decades and keeps getting worst as the days go by.

The West African region is made up of 15 economies which are varied across many scopes of growth and development. Most economies in this region are ranked as least developed countries. The economic performance of all countries in the ECOWAS region as at 2019 is represented in Figure 1. From the figure, it is observed that the income per capita fluctuated from $450 in Niger to $3,700 in Nigeria. The income per capita for Nigeria income is projected at $3,700, while her GDP was projected at $2,500 billion which is about two-thirds of the total of the ECOWAS economies. Lesser GDP per capita is an indicative factor of brittle trade performance in a region with a growing population like the ECOWAS states.

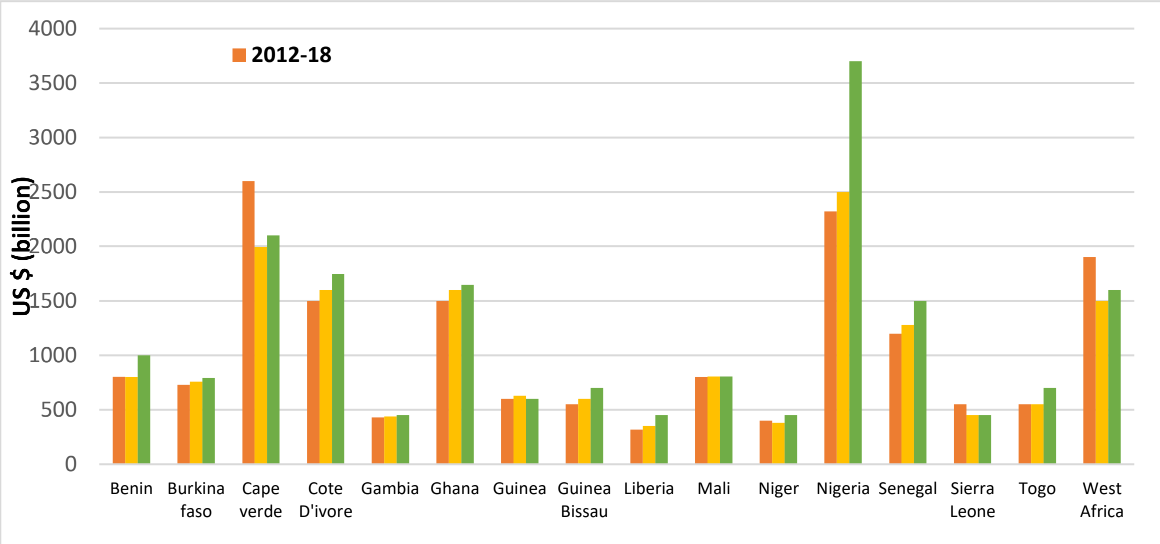


Figure 1: GDP per capita of West African countries (2012 – 2020)

In the past, this poor trade performance and economic development has been attributed to issues like, non-conducive socio-political atmosphere, frail institutions, hostile terrestrial location, and lack of quality infrastructural development Foster & Briceño-Garmendia (2010). However, asides these vices, it is believed that the conditions of multimodal transport connectivity have a lot to contribute to the economic development in this region. Particularly in the transportation sector, low-income countries in Africa lag behind. This claim is complimented by the African Development Bank (AfDB) research which provides thorough statistics on the infrastructure situation in Africa (AfDB, 2011). In order to rescue this condition, African nations, in corporation with regional and multilateral institutions like the AfDB have amplified energies, through programmes and strategies, to discover and improve the economic capacities of the continent, one of which is through elevation of infrastructural projects in the regional, particularly in the transportation sector.

With recent trade and transport statistic (UNCOMTRADE, 2019), the West African region accounts for the highest proportional global cost of transportation and extreme time of commutation. Likewise, this region has the highest transport and logistics costs in the world. For example, it takes an average cost of about US$ 2.43 per kilometer to transport a container across West African countries. This is about 1.5 and 2.2 times the cargo fare that is applicable in South Africa and the United States, respectively. On the other hand, transport costs for land-locked countries covers an average 45 percent of the value of imports and 35 percent of exports. This value represents a much higher percentage of global averages of 5.4 percent (for imports) and 8.8 percent (for exports). These high costs have been attributed to poor and underdeveloped physical infrastructure, lack of regional and international transport connectivity, inefficient logistics services, piracy, mutual mistrust among operators, cartels of transport providers, freight sharing schemes and access to shipping services. Compared to Southern Africa, transport and logistics infrastructure in West Africa is very poor; infrastructure is inadequately maintained which have resulted in poor road condition and over-congested roads, poorly functioning railway systems and inadequate airports. There is also a significant lack of infrastructure in Central Africa which is a key barrier to connectivity between north, east, west and southern Africa.

These factors limit accessibility to consumers, hamper intra-regional trade and increase the costs of imports and exports. Thus, understanding their impacts and other non-tariff measures on intra-regional trade among West African countries is the focal point of this research.

Effective transport systems are believed to be the key to Africa's economic integration. By ensuring that transport systems between countries are designed in such a way that production centers are linked with distribution hubs across the continent, greater efficiencies will be created. Such integrated transport networks will allow African countries to compete effectively and, importantly, tap into regional markets. Productivity, growth and economic competitiveness are higher in countries with effective transport infrastructure services. Effective and efficient transport infrastructure (road, rail, air, etc.) is a pre-requisite for opening up production zones in landlocked countries. Reliable road and rail transport allow companies to import and export goods.

The impact of transport on trade and economic development of West Africa cannot be over emphasized. Inferior transport systems have negative knock-on effects on the economies of countries. The relationship between effective transport systems and economic development is shown by African economies that exhibit the lowest levels of productivity and are the least competitive in the world.

In summary, this study is focused on examining the following:

1. To identify the barriers that presently hinder multimodal transport connectivity in the ECOWAS region
2. To investigate and establish the possible economic impact(s) of improved multimodal transport connectivity on the ECOWAS region with respect to economic growth, trade and investment flows, and regional economic integration.
3. To suggest measure that can holistically tackle and unclog these barriers.

Specifically, this study will utilize the gravity model of trade to investigate the extent improved transport connectivity and infrastructure will encourage intra-regional trade in the ECOWAS sub-region and other neighboring African countries.

The remaining part of the study is organized as follows: section two will provide a robust review of several related previous researches on gravity model of trade while; the empirical methodology and data analysis will be presented in section three. The results of the gravity model analysis will be illustrated in section four. Section five will contain the overall summary of all the study findings. Policies and recommendations will be given in section six.

2. Literature review

The significance of regional transport infrastructural projects in Africa is diverse. Several studies (such as Buys et al., 2010; Ndulu, 2006; Mbekeani, 2010; Bafoil & Ruiwen, 2010; AfDB, 2012; UNCTAD, 2013; etc) have elaborated the role of (regional) transport connectivity, particularly quality road networks, in encouraging intra-regional trade and economic development. Considering these significances of regional transport connectivity, the AfBD has propose numerous transit networks to ease transportation issues in the ECOWAS region and African at large and in-turn, encourage intra-African trade and intra-regional economic growth (AfDB, 2003).

In a nutshell, some of these researches have established that the accessibility of good regional transport connectivity is important in promoting trade and economic exchange amongst nations in close ecological vicinity through several sectors. They have also submitted that transport infrastructures enhance cross-border investments and trade, expands nations' competitiveness, and promotes internal production, thus promotion regional incorporation. Contrarily, poor transportation infrastructure diminishes the flexibility capacity of diverse production factors which in-turn decreases the productivity of firms' by aggregating the logistics, overheads and transportation costs, thus minimizing businesses' aptitude to globally thrive.

In recent times, improved transport connectivity has been established as a permitting factor for intra-regional connection, which subsequently results in a spatial distribution of economic activity and trade growth. By means of cross-country data, Limão and Venables (2001) mainly established empirical evidence on this. Several econometric investigations have observed some level of statistical significance of transport connectivity on the flow and performance of international, bilateral and intra-regional trades. To begin with, some the impact of transport costs on inter-and-intra trade flows have been reviewed by some scholars. For instance, the study of Limão and Venables (2001), utilized several measures such as, Insurance Cost and Freight, Free on Board and shipping rates to establish that the trade elasticity pertaining to freight costs is in the range –2 to –3.5. Their sample indicates that increasing the cost of transport from the median value to the 75th percentile will warrant in a slash of trade volumes by two-thirds. Similarly, the research of Clark et al. (2004) employed a comparable procedure to establish a trade flow elasticity of about –1.3 for country-specific freight transport costs. Primarily, the results of these researches are based on the use of cross-section deviation in classifying the impact of freight costs on trade. Notwithstanding establishing a comparable elasticity, the outcomes of Baier and Bergstrand (2001) research propose that the role transport costs play on trade flow is relatively minor; but, the results in Limão and Venables (2001) suggest a very high significance of transport costs. The inconsistency in their results could be described to be due to the differences in the sample size of the two researches.

In contrast, several other empirical studies have extensive utilized the gravity models as established by Anderson 1979, 2011 to examine and establish the impact of several transport costs measures, transport connectivity along with other factors has on the flow of trade (see Behar and Venables 2010). The gravity models conform to a comparable procedure of Newton's Law of Universal Gravitation, assuming that mutual flow of trades is a function of the distance between two market destinations and individual market sizes. Transport connectivity and other related factors may better replicate the friction between markets.

The studies of Nordas and Piermartini (2004) and Shepherd et al. (2011) quantified the impact of transport infrastructure and connectivity on the flows of trade by utilizing gravity models with transport costs. For example, the study of Shepherd et al. (2011) discovers that if the multimodal transport infrastructure is improved by 5 per cent, it would result in a 2 and 5 per cent increase of trade between the OECD countries. Nevertheless, there is need to highlight that in such a study, it is difficult to identify the relationships due to endogeneity problems, mainly the fact that transport infrastructures (like, railway and roads) are more probable to be constructed in areas that has fast growing productivity and economic demand, therefore, the impact of providing such infrastructure may be over exaggerated, generally. While the direction of causality for trade growth and transport infrastructure still remain a known issue, earlier researches observes a positive relationship between trade expansion and transport infrastructure

Using gravity model, Longo & Sekkat (2004) investigated the impact of transport infrastructure accessibility, internal political tensions and economic policy. Using Common Market for Eastern and Southern Africa (COMESA) as their case study, the study of Geda & Kebret (2007) measured the prospects and challenges of African regional economic incorporation and subsequently utilized the gravity model to analytically establish the most significant factor which impacts trade at the intra-regional level. On the other hand, Musila (2005) made use of the gravity model to measure the concentration of trade digression and trade formation in three regional economic communities in Africa: Economic Community of Central African States (ECCAS), Economic community of west African states (ECOWAS) and common market for Eastern and Southern Africa (COMESA). The outcome of their investigation proved that trade formation differs according to regions, however, the ECOWAS region has the uppermost concentration of trade formation. The study of Coulibaly & Fontagne (2005) analyzed the impact of geographical obstructions on intra and extra-regional trade of countries which are member states of the West African Economic and Monetary union.

Buys *et al*. (2010) employed the estimates of gravity model along with spatial network approaches to measure the impact of improving road networks linking main African municipal zones. The outcomes of their simulations show that the preliminary cost necessary to improve these road networks will be about $20billion while the annual maintenance will require about $1billion, however, the subsequent impact will generate an overland increase of trade in sub-Saharan Africa which is projected to enlarge up to $250billion within a 15 years interval. Also, using gravity model, the study of Shepherd & Wilson (2007) also inspected the impact of improved road network on trade growth in the Central Asia and Eastern Europe.

Concerning industrialization, several literatures such as Carruthers et al. (2003), proposes that improved transport connectivity enhances the process of industrialization as well as allows additional effective intra-regional and global manufacturing networks. Subsequently, the outcome of this is seen in a more employment creation, positively affecting productions and other industrial sectors.

Generally, it has been established that transport infrastructure has a substantial impact on transport costs reduction and influences trade growth. Following this, our research will examine the impact of improved transport infrastructure on a broader economic such as, integration of regional economic and general national and regional welfare.

3. Empirical methodology and data

In this section, we establish the quantitative analysis which is expected to aid us in designing an empirical model to measure the impact of eliminating physical obstacles, particularly, improving transport connectivity crosswise the Western African region with respect to intra-regional bilateral trade. Just as we already established in the earlier sections, series of broad-based indicators are utilized in measuring the transport connectivity. Thus, these measurements are incorporated into a gravity model in order to estimate the level of their impacts on trade.

Several studies such as, the studies of Shepherd, (2012) and Anderson, (2011) have extensively utilized the gravity model to examine different trade patterns and trade impacts. The theoretical economic basis of the gravity model was first established in the study of Anderson (1979). However, the use of gravity model in this research is inspired by the model established by Anderson and van Wincoop (2003), which adopts that mutual flow of trade is a determinant factor of comparative trade costs instead of exclusively by complete costs of trade. Using this as a yardstick, we therefore established the gravity model of our research as follows:

$$A_{mn} = \frac{A_m A_n}{A}\left(\frac{S_{mn}}{D_m E_n}\right)^{(1-\sigma)} \tag{1}$$

$$D_m = \sum_{n=1}^{C}\left(\frac{S_{mn}}{E_n}\right)^{(1-\sigma)}\frac{A_n}{A} \tag{2}$$

$$E_n = \sum_{m=1}^{C}\left(\frac{S_{mn}}{D_m}\right)^{(1-\sigma)}\frac{A_m}{A} \tag{3}$$

where A_{mn} is used to represent performance of exports activities from country m to country n, A_m represents the GDP of country m, A_n represents the GDP of country n. The parameter A denotes the world's GDP, while the exchange elasticity between variety of product is represented as σ and S_{mn} denotes the cost of intra-regional trade, (i.e., the cost of transporting goods from country m to country n. D_m and E_n are utilized to establish the external and internal multidimensional resistances (i.e., multilateral trade resistance [MTR]), which implies that costs across all conceivable export and import markets is the determinate factor of the export from country m to country n.

In this research, the MTR signifies the barriers (which in this case might be the comparative trade cost) which country n and country m encounter in the event of trade transactions with all their trading partners (as well as inward trade). For example, trade between Nigeria and Ghana is not determined by the cost between the two countries alone, but also based on the costs of trading with other West African countries. If the bilateral trade cost between Nigeria and another third country like, Niger Republic is reduced, then Nigerians' MTR will experience reduction, too. Although the bilateral trade cost between Nigeria and Ghana remains unaffected, the decrease in Nigeria's MTR (owing to the decrease in the cost of trade between Nigeria and Niger Republic) would result in a re-direction of trade from Nigeria–Ghana to Nigeria-Niger Republic (leading to a spillover effect). If the effects of the multilateral resistance are not accounted for, then it would result in an upward unfairness in the estimations of gains from advances.

Considering the multiplicative state of the model, the gravity expression in (1) can be modified by measuring the logarithms to a log-linear form and expressed as (4):

$$lnA_{mn} - lnA_m + lnA_n - lnA + (1-\sigma)(lnS_{mn} - lnD_m - lnE_n) \tag{4}$$

Because there is no direct estimation of cost of trade, S_{mn} is generally and empirically quantified as a function of variables that are noticeable and are considered as directly connected to cost of trade. In a nut shell and according to the research of Mayer and Zignago, (2011), a log-linear description is frequently implemented thus;

$$ln(S_{mn}) = \beta_1 \ln(dist_{mn}) + \beta_2(deft_{mn}) + \beta_3(coml_{mn}) + \beta_4(coly_{mn}). \tag{5}$$

Considering $dist$ as the terrestrial distance from countries m to country n, $deft$ denotes a definite variable which equals to one assuming that the countries share a mutual land boundary. Assuming the trading countries share a common language, then $coml$ is equal to one while. On the other hand, if these countries (m and n) has a unique colonial tie, then $coly$ is equal to one. In this research, these factors replicate the hypotheses that if distance between two paired trading countries is increased, then costs of transportation is higher as well, however, same is lower for countries border almost within same neighborhood. The colonial tie and common language indicators are associated to costs of information with respect to trade. Apparently, these costs are lower for trade allies who are well acquainted with the business activities and culture of their partners. Analytically, all these influences have been proven to be important drivers of both intra-regional and overall bilateral trade.

Further, this research measures the constraints of a gravity model which reflects the patterns of trade for the ECOWAS countries and other African countries that are selected in the research. The model comprises of a total of 30 countries (15 ECOWAS, 4 East African, 3 South African, 5 North African and 3 Central African countries). Due to insufficient or an entire lack of data, some countries were not included in the model.

3.1. Baseline gravity model

The researches of Head and Mayer (2000) and Anderson and van Wincoop (2003) proposed a structural description of the gravity model to estimate the multilateral resistance effect. But, sometimes, it is difficult for the included non-linear estimation to converge, thus may be delicate for the choice and selection of the initial parameter. However, the study of Baier and Bergstrand (2009) recommended an easier and effective method which implements a first-order Tylor series expansion approach in obtaining a linear estimation of the multilateral resistance terms (MRTs) to evade the complications which comes with the non-linear technique in a conventional structural description gravity model. Adopting this approach (due to its simplicity and effectiveness), this study establishes the MRTs as follows:

$$\ln D_m = \left[\sum_{n=1}^{C} x_n \ln\left(S_{mn}\right) - \tfrac{1}{2} \sum_{d=1}^{C} \sum_{p=1}^{C} x_d x_p \ln\left(S_{dp}\right) \right] \quad (6)$$

$$\ln E_m = \left[\sum_{m=1}^{C} x_m \ln\left(S_{mn}\right) - \tfrac{1}{2} \sum_{d=1}^{C} \sum_{p=1}^{C} x_d x_p \ln\left(S_{dp}\right) \right] \quad (7)$$

Considering the multilateral resistance terms above, x refers to the share of gross domestic product (GDP) for each country while, d and p represents the country pairs in the study.

By substituting (6), (7) and (8) into (3), (9) and (10) is realized and expressed as follows:

$$lnA_{mn} = lnB_m + lnB_n - lnB + \left(1-\sigma\right)\left(lnS_{mn}^{*}\right) \quad (8)$$

$$lnS'_{mn} = lnS_{mn} - \sum_{n=1}^{C} x_m \ln\left(S_{mn}\right) - \sum_{m=1}^{C} x_m \ln\left(S_{mn}\right) - \sum_{d=1}^{C} \sum_{p=1}^{C} x_d x_p \ln\left(S_{dp}\right) \quad (9)$$

Each index of transport is specified in (10) for adequate capturing of the MTR. For example, the variable representing the distance of road transportation is fused into the model and expressed as:

$$\begin{aligned} \ln\left(distroad'_{mn}\right) = ln\left(distroad_{mn}\right) - \sum_{n=1}^{C} x_m \ln\left(S_{mn}\right) - \sum_{n=1}^{C} x_n \ln\left(distroad_{mn}\right) \\ - \sum_{m=1}^{C} x_m \ln\left(distroad_{mn}\right) - \sum_{d=1}^{C} \sum_{p=1}^{C} x_d x_p \ln\left(distroad_{dp}\right) \end{aligned} \quad (10)$$

Thus, the distance in road transport between one bilateral and intra-regional transacting pair of countries will definitely rub off on all the other importers and exporters via the terms of MTR. Similarly, the terms of MTR are also selected according to the exporting/importing relative size.

Considering the hypothesis of our research which states that improved multimodal transport connectivity between ECOWAS countries can impact the cost of trade S_{mn} and the overall bilateral and intra-regional trade performance. We therefore establish and estimates the requirement of trade cost as:

$$\begin{aligned}\ln\left(S'_{mn}\right) &= \beta_{1rail}\ln\left(distrail'_{mn}\right)+\beta_{1NoRail}\left(WithNoRail'\right)\\ &+\beta_{1sea}\ln\left(distsea_{mn}'\right)+\beta_{1air}\ln\left(distair_{mn}{}'\right)\\ &+\beta_{2}\ln\left(rail\_density_{mn}'\right)+\beta_{3}\ln\left(road\_density_{mn}{}'\right)+\beta_{4}\ln\left(airport\_density_{mn}{}'\right)\\ &+\beta_{5}\ln\left(logistics_{mn}'\right)+\beta_{6}\ln\left(tarrif_{mn}{}'\right)\\ &+\beta_{7}\left(deft_{mn}\right)+\beta_{8}\left(coml_{mn}\right)+\beta_{9}\left(coly_{mn}\right)\end{aligned} \tag{11}$$

In (11), we elaborated transport infrastructure (such as airport, road and rail densities, respectively), transport connectivity (such as air, seaport and rail distance with the 'No rail connection' term), 'Tariff' term and logistics performance indices (LPI and LSCI). It is expected that the geographical variables def , $coml$ and $coly$ will be stable, therefore, they are expressed in a very simple terms in the gravity model. Therefore, by utilizing these parameters which are projected from the gravity model, we can forecast the impact of a variation in one or more of these variables on the intra-regional and bilateral trade which will be discussed in the section 5. But before then, the data source and descriptive analysis is presented in the next section.

3.2. Data sources

In this section, the proposed gravity model employs normal data sources, coupled with the multimodal transport connectivity indices which are discussed in the earlier section. Table 1 offers a detailed outline of the data sources and dataset. Data for the intra-regional and bilateral trade are obtained from African Development Bank (AfDB) and COMTRADE, respectively. These sources are considered as the most standard and reliable source of data on disaggregated trade by product. The selected data for this study is dated from 2000, while values of trade are converted in US$ from respective country's currencies. Data about GDP is obtained from the database of the World Bank Development Indicator (World Bank 2019). The UNCTAD TRAINS database provides data for the bilateral trade tariff. Tariff rates are real bilateral rates which incorporates privileged and regional trade treaties. These rates are averaged by inputting weights of trade. Some of the countries selected in this study are void of data from 2000, therefore, for such countries, we selected data from 2001 and above or as the case may be.

Already, we had discussed the sources of transport connectivity and infrastructure quantifications in the earlier section. In that section, some of the control variables that make up the standard gravity model includes history colonial ties (*coly*), mutual border (*deft*) and mutual language (*coml*). Data about these variables are generated from the CEPII GeoDist database. According to the report of Mayer and Zignago (2011), language constants are divided into two: the first indicates countries sharing the same language as their official language, while the second represents a language which is spoken by at least 9 per cent of the population in both countries. However, the first is used as the language indicator in this research.

Table 1: Sources of data for Gravity model econometric analysis

	Variable	Description	Source
Economic Indices	Exports	Total export from	UN COMTRADE
	GDP	Nominal GDP USD	WDI
	Rate of Tariff	Effectively applied, trade weighted average	UNCTAD
Distance	Distance	Intra-regional and bilateral distance that exists between the capitals of trading countries	CEPII GeoDist
Transport Connectivity indicators	Distance (air)	The bilateral distance in air transport between capitals of trading countries	Rome2rio
	Distance (sea)	Distance of seaport between capitals of trading countries.	CERDI
	Distance (road and rail)	The bilateral distance of road and rail connection between capitals of trading countries	Google navigator
	No rail connection	The indicator variable that equals unity is no direct rail connection is found between trading countries capitals	Google navigator
Transport infrastructure indicators	Rail density	Length of rail network with respect to land coverage of the country	CIA world factbook
	Airport density	Number of functional primary and secondary airport facilities.	CIA world factbook
	Road density	Length of road network with respect to land coverage of the country	CIA world factbook
	Sea transport	Score of linear shipping index (LSI) on aptitude and logistic service quality	UNCTAD
	Logistics service performance	Score of LPI on the competence and quality of logistic services	World bank
Control variables	Mutual boundaries	Dummy variable is equal to unity if trading pairs share mutual land borders	CEPII GeoDist
	Mutual language	Dummy variable is equal to unity if trading pairs share mutual language and is spoken by more than 9 per cent of the population	CEPII GeoDist
	Colonial tie	Dummy variable is equal to unity if one of the trading pairs was once a colony of the other.	CEPII GeoDist

3.3. Descriptive analysis

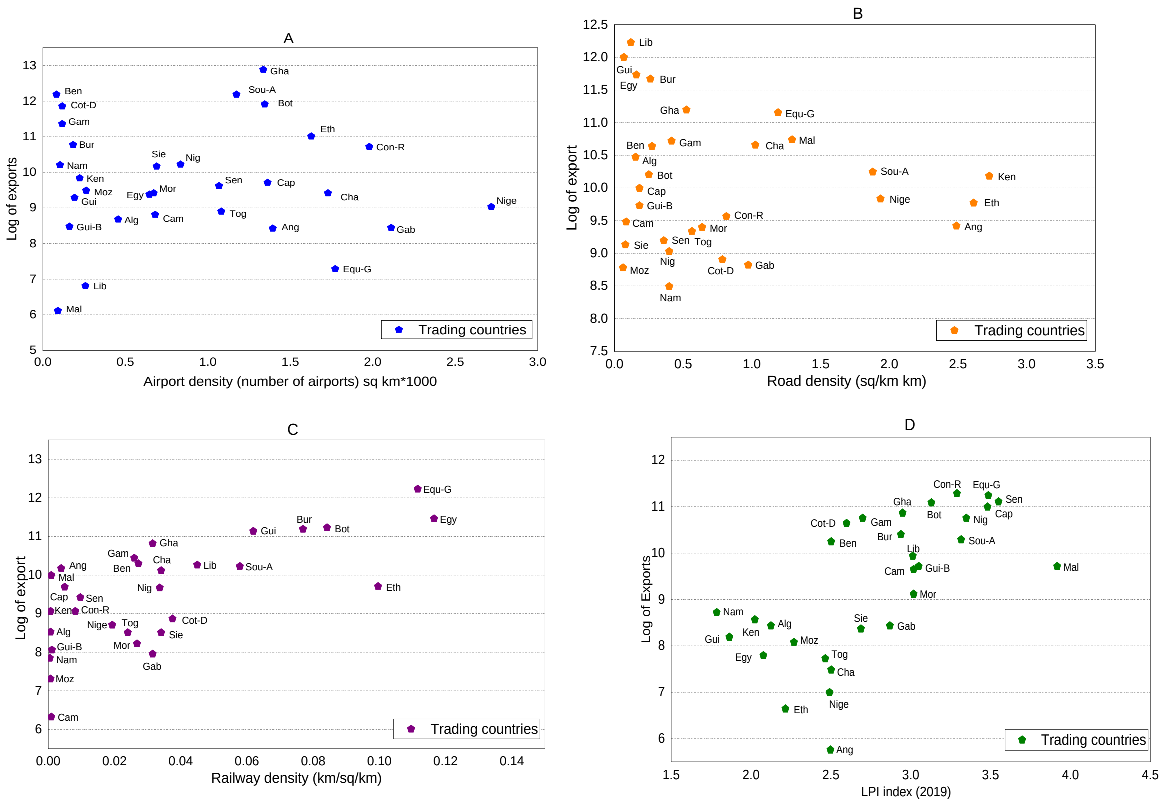
In table 2, a descriptive analysis of the econometric data for the 15 ECOWAS countries and other 15 selected African countries are presented (see **Appendix A** for the list of 30 selected countries). To a great extent, our observation shows GDP and export variations for each countries and regions. Such as, for the ECOWAS region, Nigeria records the highest amount of GDP at about US$7.54 trillion while, Liberia records the lowest GDP in 2019 at US$2.4billion.

Table 2: Descriptive analysis of econometric data according to ECOWAS and other selected countries

GDP (US$ trillion)	**Max**		**Min**		**Average**
ECOWAS	7.54	NIGE	0.024	LIB	0.46
Other selected countries	8.25	ANG	0.013	BOT	0.43
Trade values (US$ billion)					
ECOWAS	0.49	NIGE			
Other selected countries	0.26	ETH			
Tariff (US$)					
ECOWAS	342.21	GHA			3.23
Other countries selected	3,231.34	EGY			5.21

Note: The source of data is presented in Table 1

The demonstrations in Figure 2 illustrates the connection between different transport indices and export performances. From the plots, it is observed there a positive correlation exists between all the indices and trade performance.



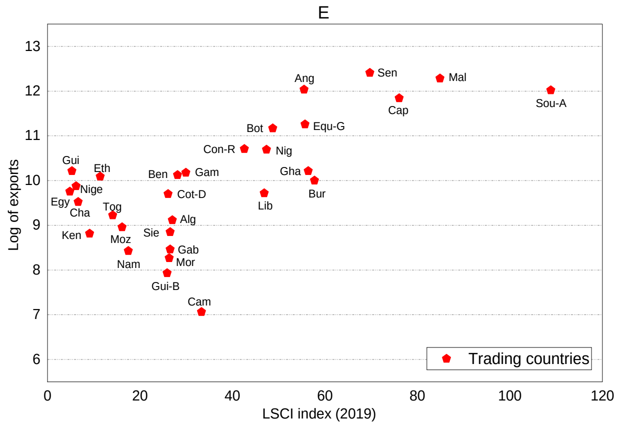


Figure 2: Correlation between different transport indices and total exports (2019)

4. Empirical results

4.1. Model specification

Firstly, using the Poisson Pseudo-Maximum Likelihood (PPML) and the Ordinary Least Squares (OLS) as designed by Silva and Tenreyro, (2006), we estimated the parameters of the gravity model in (9), with careful consideration of the error terms which are clustering within groups of selected parameters. According to the study of Moulton, (1990), if an analysis fails to consider this error term clustering's, then some understated errors can occur the econometric analysis. Therefore, there are several tendencies that errors can be connected by pair of countries. Using the analysis in (10), we infused the MTR terms into the model valuation by stipulating the variables of interest for transport connectivity and infrastructure.

Generally, the PPML method is designed as a linear model technique for approximating gravity. The model utilizes a log-link and quasi-Poisson distribution. Its advantage is that during the process of estimation, it allows zero trade flows. Also, we included unity to the values of trade which are equal to zero in order to avoid a drop in the zero trade flows in the OLS technique (because we have converted the values of trade in a logarithmic form).

The results from the model estimations are presented in Table 3. From the analysis, Models 1 and 2 are established as the baseline gravity models which incorporates tariff, distance and other control variables. Most of the terms present in models 1 and 2, are estimated suggestively with the predictable sign. Similarly, the terms of tariff and distance are estimated negatively. This infers that as long as the distance between the trading partners is greater, the trade flows becomes smaller.

Distance is a trade constraint in both the PPML and OLS methods, however, the analysis for the PPML model indicates a smaller elasticity. Likewise, there is a positive effect on export flows between the trading partners which share a common boundary as also with those that has colonial history relationship, too. Similarly, common language has a positive effect on export levels, even though this is only observed in the OLS estimations.

The results of Models 3 and 4 indicates the estimated parameters as well as transport connectivity (which is measured according to distance by mode) and the quantity and service of transportation infrastructure. There are no changes observed in the signs of the estimates between the PPML and OLS techniques, apart from that of the tariff term in the OLS model, which is (erroneously) estimated positively. The STATA software was used in the model estimations.

The analysis of the models is with respect to the cross-country dataset from 2000 – 2019. By utilizing the ratio between respectively coefficient and their individual standard clustered errors, we estimated the T-values. For T-values greater than 1.96 (i.e., T-values > 1.96), this implies that the statistical significance of the coefficient is at 95 per cent confidence interval, likewise, for t-values greater than 1.65 (T-values > 1.65) specifies that the statistical significance of the coefficient is established at 90 per cent confidence interval. The STATA *vif* command is utilized in checking the multicollinearity analysis of these model.

Table 3: Results of econometric analysis from gravity model

	Model_1		Model_2		Model_3		Model_4	
Estimated technique	OLS		PPML		OLS		PPML	
Dependent Variable	Log (exports+1)		Exports		Log (exports+1)		Exports	
Description	coef.	t-value	coef.	t-value	coef.	t-value	coef.	t-value
Exporter GDP	0.643	64.92	0.562	23.12	0.321	35.32	0.489	26.65
Importer GDP	0.421	48.80	0.592	26.35	0.345	23.56	0.303	29.51
Distance	-3.459	-69.34	-0.631	-13.60				
Distance (Air)					-0.734	-8.40	-0.321	-3.65
Distance (Sea)					-0.358	-4.39	-0.045	-1.23
No rail connection (constant)					-0.856	-5.54	-0.502	-1.09
Exporter LPI					15.265	13.96	0.306	3.32
Rail density					0.208	5.32	5.511	14.06
Road density					0.729	19.05	0.195	3.02
Tariff	-0.001	-2.32	-0.021	-1.3	0.021	3.76	-0.006	-3.3
Mutual boundary	-0.221	-1.43	0.395	1.04	1.265	12.49	0.765	5.78
Mutual language	0.217	2.21	0.055	0.41	0.451	13.77	-0.053	-0.13
Colonial tie	1.386	9.45	0.213	0.82	10.032	25.07	0.031	0.45
Obs.	7,321		7,321		7,321		7,321	
Adjusted R^2	0.815		0.462		0.819		0.625	

4.2. Transport connectivity and trade facilitation

Concerning transport connectivity, our research observed that the issue of *'No rail'* between the trading partners in the region has a strong negative impact on bilateral and intra-regional trade performance. The reason for this is because most of the trading countries in the region (about 60 per cent) are landlocked with heavy dependance on both road and rail transportation for viable bilateral trading activities. Consequently, land transport infrastructure is extremely significant in guaranteeing a reliable and smooth distribution of commodities. Although we made exerted numerous efforts, realizing any substantial estimate of rail distance in the model was impossible (comparatively this difficulty could be attributed to correlate with the parameter of *'No rail connection'*).

Sea and Air distances were both negatively and significantly projected, suggesting that any decrease of distance will definitely increase and impact intra-regional and bilateral trade between trading country partners statistically and substantially. Table 4 shows the analysis of the impacts improved transport connectivity has on total exports performance. The analysis show that including a rail connection between trading country partners in the study area will warrant in an average upsurge of trade performance by 3.5 per cent. Similarly, the results also prove that a 10 per cent decrease in the distance of sea and air upsurges trade by 0.52 per cent and 0.31 per cent, respectively.

Table 4: Sensitivity test of the impact of transport connectivity on export trade volumes

Change of transport indices	Change in trade
Added rail connection	3.5 per cent
10 per cent reduction of air distance.	0.52 per cent
10 per cent reduction of seaport distance	0.31 per cent

Compared with the study of Baniya et al. (2017) which estimated the impact of rail connection on trade, the performance of trade is improved by between 1.3 per cent (lower band, for consumers only) and 13 per cent (upper band, for both consumers and producers). At the lower band value, their findings are consistent with the results of our investigation. On the other hand, the research of Herrero and Xu (2016) suggest that a 10 per cent decrease in sea distance and air distance would warrant in an increase of trade by 1.1 per cent and 5.5 per cent, respectively. This finding is somehow much higher than our evaluations. Thus, it is our opinion that the reason for this difference is due to the fact that different set of variables was infused into our trade model. For instance, our study did not only consider travelling time, but have also incorporated the indices of transport infrastructure, which is believed to have engrossed some effect of the variation of trade between trading partner countries.

The study of Hummels (2001b), recorded the following elasticities of transport costs regarding distance, 0.275 (road), 0.46 (air), 0.22 (sea) and 0.39 (rail) which shows that elasticity is higher by air than all other multimodal transport medium. However, the findings of Abe and Wilson (2009) established that elasticity by land than by sea is higher than the rest medium. Generally, the order of magnitude in our investigation is in accordance with these previous empirical submissions.

4.3. Transport infrastructure and trade facilitation

Regarding transport infrastructure, the analysis of our study shows that LPI of exporter, both importer and exporter road density and both importer and exporter rail density were all positively projected and the impact is substantial. This suggests a positive correlation between trade performance and transport infrastructure. Further, our analysis also performed a check for the impacts improved transport infrastructure has on total export performances. The results are presented in Table 5. From the result, it is observed that any 10 per cent increase in the densities of railway and road an increase of total trade volume by 0.54 per cent and 0.42 per cent, respectively will be witnessed.

Table 5: Sensitivity test of the impact of transport infrastructure on export trade volumes

Change of transport indices	**Change in trade**
10 per cent improvement of road density	0.54 per cent
10 per cent improvement of rail density	0.42 per cent

At this point, LSCI and air transport density are removed from the model because as the analysis progress, these two variables became less important (this might be as a result of collinearity with other variables such as LPI or distance of air transport). Remarkably, the significance of transport connectivity (characterized by distance as a transport cost proxy) did not reduce when the indices of service quality and transport infrastructure are involved. Thus, signifying that, similar to the transport services across country boundaries, transport infrastructure within the trading countries (behind borders) is very significant for the reliable and fast delivery of commodities to the individual market.

Similarly, the results show that barriers of tariff have a substantial negative consequence on trade. This implies that, the greater the tariffs fixed by the goods destination country, the lesser the export levels. Regarding the other trading country control variables, assuming the trading country partners has a mutual language, border or colonial history, there is possibility for them to be involved in more trade partnership with each other. Nevertheless, with respect to the PPML model estimates, it is observed that the effect of sharing mutual colonial history and language becomes less important.

In a nutshell, our investigations present that both transport infrastructure and transport connectivity amongst trading country partners (with respect to multimodal distance) are related with a substantial proliferation in both bilateral trade and intra-regional trade performance. Thus, we stipulated several forecast as potential impacts improved transport infrastructure and connectivity has on trade and the overall economic performance the ECOWAS region and perhaps, Africa at large.

4.4. Forecasting the impact of improving transport connectivity on trade in the ECOWAS region

Using model 4, we forecast the impacts of improving transport infrastructure on the total trade in the ECOWAS region. One major issue for predicting these impacts is that the ECOWAS region very deficient inter-connection of transport infrastructures. Therefore, it is difficult to estimate the exact level of effect transport connectivity has on total trade. Nevertheless, some existing infrastructures are used as baselines and they offer some useful clue on the potential effects of further improvements. Once more, we underscore the primary outlook of the gravity model as discussed previously and that the outcomes should only be considered as estimations based on order-of-magnitude.

4.4.1. Simulation Analysis 1 (SA_1): Improving transport connectivity in the ECOWAS region

Considering the first simulation, our investigation assume that all the selected ECOWAS and African countries are interconnected through rail infrastructure and that the cost of sea transportation is reduced by 20 per cent to indicate the new sea transport itineraries and upgrading in proficiency. Consequently, most African countries and the ECOWAS area are expected to have rail connections in this setting.

In order to show the point that country-to-country export is measured by the costs of trade crosswise all likely import and export destinations, we incorporated MTR terms into the model. Thus, the flows of intra-regional and bilateral trade are measured by comparative costs of trade instead of exclusively by complete costs of trade across trading country partners. However, if the MTR is exempted in the model, then there may be an upward bias in forecasting the gains of trade. The results for the first simulation test are shown in Figure 3.

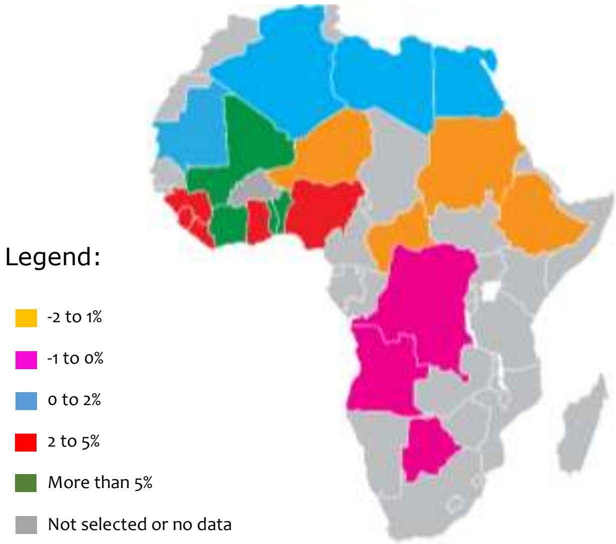


Figure 3: Simulation analysis 3 (SA_3): Effect of improved transport connectivity on total exports (% change)

The result of our simulation shows that there is a comparatively high percentage proliferations in total exports in ECOWAS and Southern and Central Africa with the expected transport connectivity improvement in the ECOWAS and African region, at large. It is important to note that the ECOWAS region presently high underdevelopment with respect to rail connections. Generally, land transport is believed to be a very significant factor intra-regional and international trades. Thus, the results of the simulation examination demonstrate that as long as the rail connectivity is improved in the ECOWAS and a few African region, there will be an enormous growth in trade activities within the ECOWAS trading partners, specifically for those countries that have witnessed several setbacks due to lack of railway connectivity. For some countries, the percentage of change is small. This is attributed to the fact that their current economies are relatively small. With a little increase in the total exports, these countries will witness a comparatively higher percentage change.

Furthermore, the estimations of the model measure the direct and static impact of improved transport connectivity trade performance. Nevertheless, the results show that improved transport connectivity will lead to improving the productivity of the manufactures and the entire supply chain at large. Thus, the results of our investigations are probable to be in the lower range and may have undervalued the impact.

4.4.2. Simulation Analysis 2 (SA_2): Transport infrastructure improvement and impact on ECOWAS countries

Transport infrastructure improvement and service quality control in the ECOWAS region are focal consideration factors tested in the second simulation. The first test we performed was to check the impact improving road density by 10 per cent has on trade performance. Then, we went further to check the impact of improving LPI by 5 per cent. In the simulation, the impact of road and rail density for both importing and exporting economies are modelled according to the hypothesis that there is a common impact on the trade. Likewise, exporter's LPI is included into the model in order to estimate the overall quality of logistics service. Notice that only the exporters LPI is incorporated. This is because there is no significant impact observed in the importer's LPI.

In Figure 4, we illustrate the impact of improving service quality and transport infrastructure between trading county partners. We observed that West African countries and Central African trade partners has the highest improvement in their export activities for road connectivity. However, when compared with improving rail connectivity, a relatively lower percentage of increase is observed. Also, other African countries witnessed a comparatively low proliferation.

Generally, assuming transport infrastructure is improved by 10 per cent increment and LPI increased by two per cent in ECOWAS countries, there will be an increment of trade in the ECOWAS regions and their trade partners. Likewise, more than 5 per cent average upsurge is seen for countries in the ECOWAS region while, a minor increase (up to two per cent) is observed in the rest of African countries that were selected in the study. Generally, the results of our findings are consistent with observations of Shepherd et al. (2011) which established the impact of a 5 per cent improvement of multimodal transport infrastructure on trade between the OECD countries (2 to 5 per cent).

Furthermore, although both impacts were tested on the trade model, the impact of improving transport infrastructure is minor compared to that of improving transport connectivity. This implies that regarding transport services crosswise country boundaries, it is rather vital to improve transport infrastructure within the transacting nations in order to achieve a consistent and faster delivery of commodities to the individual market destinations. Therefore, improvement of transport infrastructure can better be of profit to trading countries within their economy. Once more, owing to the reservations in the different ongoing transport projects in the ECOWAS region, our investigation accentuate that the findings should be implemented with caution. Additionally, improving transport connectivity and infrastructure in the ECOWAS region are just one of the factors; reducing financial and trade obstacles in line with other systems of intercontinental collaboration are probable contributions to the poor economic and trade dealings between trading countries in the ECOWAS region. As a result, our findings may denote a conventional estimation.

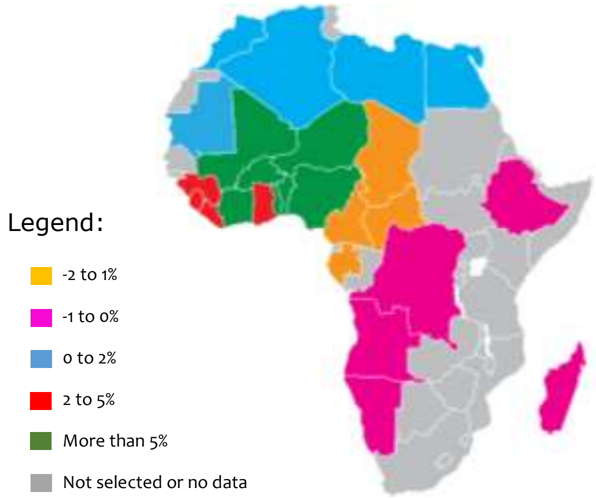


Figure 4: Simulation analysis 3 (SA_3): Effect of improved transport infrastructure and service quality on total exports (% change)

4.4.3. *Simulation Analysis 2 (SA_2): Effect of improving transport connectivity and infrastructure*

The third simulation is to illustrate the effect of improving both the transport connectivity and infrastructure (which is blend of both simulation 1 and 2). Result of the simulation is presented in Figure 5. The results shows that there is a comparative vigorous growth of trade in some ECOWAS countries and a few other surrounding African countries. Partly, the increase in percentage is attributed to the fairly low economic state in these countries. The investigate also detected minor improvements in trade and some minor setbacks of trade in some ECOWAS countries. These is as a result of unavailability of data.

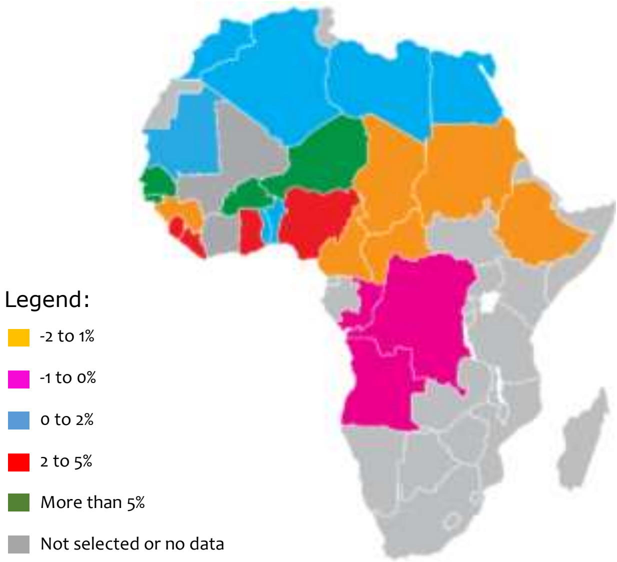


Figure 5: Simulation analysis 3 (SA_3): Effect of improved transport connectivity and infrastructure on total exports (% change)

4.4.3. Summary of the simulation analysis

A concise result of the simulation analysis is presented in Table 6 and 7 according to changes in percentage and the values of total export, with respect to ECOWAS and other trading partners in the African continent.

Table 6: Forecasting the level of impact improved connectivity and infrastructure has on total export (change %)

	SA_1 (Connectivity)	SA_2 (Infrastructure)	SA_3 (Connectivity + Infrastructure)
ECOWAS region	5.7 per cent	2.4 per cent	6.5 per cent
Other selected countries	3.1 per cent	0.3 per cent	1.8 per cent

Table 7: Forecasting the level of impact improved connectivity and infrastructure has on total export (US$bn)

	SA_1 (Connectivity)	SA_2 Infrastructure	SA_3 (Connectivity + Infrastructure)
ECOWAS region	185	135	231
Other selected countries	287	121	318

Based on the simulation analysis, we forecasted some possible changes that will occur in trade for the ECOWAS and African region at large and the results are presented in Figure 6 and Figure 7. In the results, the impact of improving transport connectivity on trade in the ECOWAS region (simulation 1) is slightly greater than that of simulation 2 (the impact of improving transport infrastructure in the ECOWAS region).

In summary, our results show that the improvement of transport connectivity and infrastructure in the West African region will result in an increased trade volume for the ECOWAS region and the rest of the African continent. Generally, as presented in Figure 6, the ECOWAS countries will witness a total trade volume increment by US$290bn while, trade volumes for the surrounding African countries will rise by US$95bn.

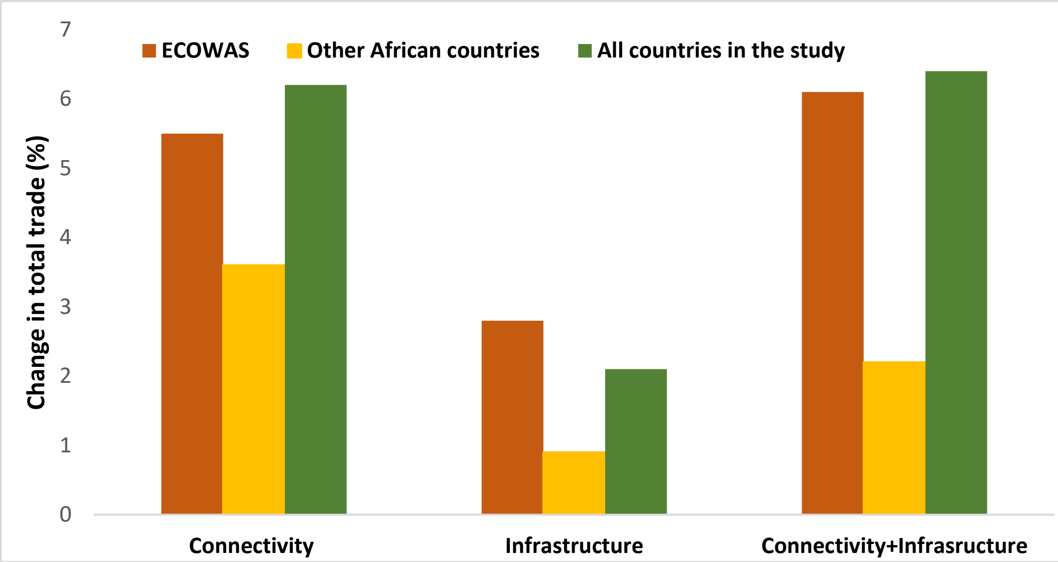


Figure 4: Result of simulation analysis: impacts of improving transport infrastructure and service quality on total exports by region (change %)

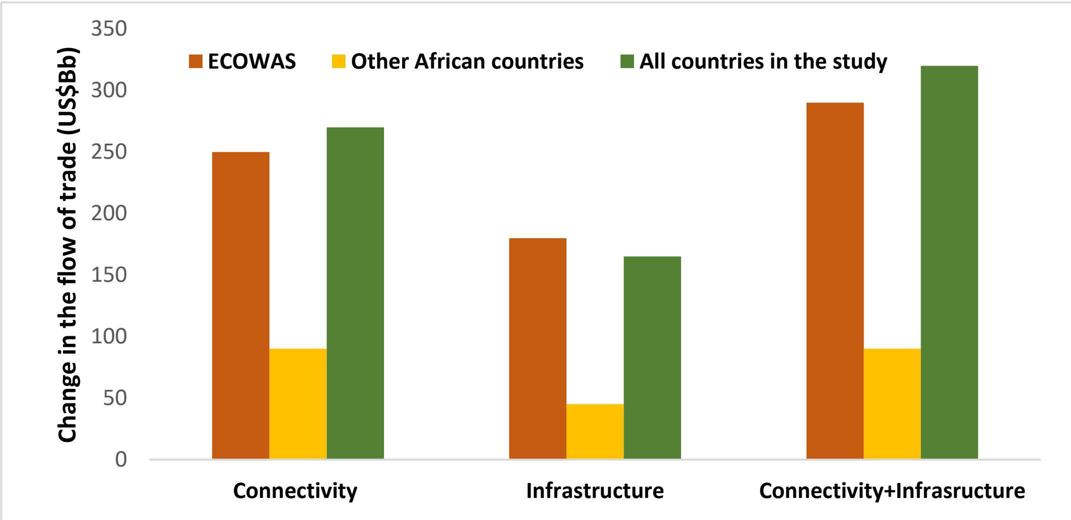


Figure: Result of simulation analysis: impacts of improving transport infrastructure and service quality on total exports by region (absolute change US$Bn)

5. Summary of the findings

The overall results of this research are in line with the results of several previous studies which established that improved multimodal transport connectivity and infrastructure is a major factor towards enhanced intra-regional trade, bilateral international trade and economic growth at large. Particularly, the results of improved transport infrastructure are noticeable in the reduction of transport cost and enables trade increase. Also, it has been established that competent transport infrastructure enables the process of industrialization and encourages better regional, intra-regional and international production networks, offers adequate regional incorporation and nurtures development and regional and national welfare.

In this study, we identified and discussed the physical and soft barriers along with the facilitators regarding transport connectivity，performance of trade and economic development in the ECOWAS. The results of our findings show that the physical barriers/facilitators include cost and speed of transporting goods, deficient size of infrastructure and unfriendly environments. On the other hand, the soft barriers/facilitators comprise of governing and legal barriers, project funding, tracking and safety of commodities and trade paths security. Therefore, these results imply that if the barriers are solved and the outcomes properly harnessed, they could become facilitators.

With respect to the results of our qualitative analysis, our research hypothesis is developed and thus stated: that by improving transport connectivity and infrastructure (removing the physical barriers), trade performance would be facilitated and a higher positive impact on economic growth will be observed in the ECOWAS region.

Further, we developed a gravity model which helps us to test the research stated hypothesis. This testing includes investigating the relationship between trade performance and transport connectivity/infrastructure. To begin with, we constructed several indices to estimate transport infrastructure (which includes logistics performance, airport density and road/rail density) along with transport connectivity (by utilizing the distance by diverse transport modes as a proxy of transport cost). For an elaborate understanding of the impacts transport connectivity and infrastructure has on trade performance in Africa large, we selected not just the ECOWAS region, but also included a few other African countries. The selected African countries are supposed to have meaningful trade relations with the ECOWAS region.

From the analysis of our descriptive statistics, we are able to establish that there are a few availabilities of quality transport infrastructure (road density, rail density and airport density) than in other countries. And within the ECOWAS region, the level of transport infrastructure varies with respect to countries and their economy. In addition, our findings show that some of the ECOWAS countries are suffering from inefficient transport connectivity between countries and a comparatively little road/rail density in some areas.

Following the descriptive analysis, we developed a gravity model to evaluate the impact of transport connectivity and infrastructure on bilateral and intra-regional trade across the study region. Also, the study included MTR terms in the modelling structure as a variable to capture the comparative trade cost between transacting partner economies. The investigation observed a positive connection between transport connectivity and infrastructure along with international and intra-regional trade. This imply that transport connectivity and infrastructure impact the overall growth of trade in the ECOWAS region and the impact level is statistically significant. Moreover, having a functional rail connection in the ECOWAS region, is observed as the most impacting factor in the with respect to trade performance improvement (with a total exports improvement of about 3.5 per cent in investigated region). Likewise, improving the rail and road density of the trading partner countries ranked as the second factor that contributes greatly to improving trade performance in the study area. Similarly, the performance of logistics (such as LPI) indicates a substantial and comparatively robust impact on the flow of international and intra-regional trades.

Including the indices of transport infrastructure and quality of service into the models does not in any way reduce the significance of transport connectivity (characterized by distance by diverse transport modes as a proxy of transport cost). This shows that, besides transport services across trading countries borders, internal transport infrastructure of trading partner countries (behind borders) is correspondingly significant for consistency and speed of delivering of commodities to the individual trading destinations.

Using simulation analysis, we were able to forecast the level of the impact improved transport connectivity and infrastructure has on trade performance as regards several assumptions pertaining to transport improvement. Generally, the results of our simulations show that he projected level of improvement of transport connectivity and infrastructural improvement in the ECOWAS region will result in an increase in the total trade volumes, however, this increment will not only be witness in the ECOWAS region, but the effects will be felt in the trade performance of the entire African continent. Thus, improving transport connectivity and infrastructure seems to proffer a balanced setup with respect to of the impact on trade in the ECOWAS region.

6. Policy implications and recommendations

In this study, we have been able to establish transport connectivity, infrastructure and service quality as major constraints of bilateral trade growth within the ECOWAS region and African continent at large. The unavailability of improved and standard transport infrastructures impedes the performance of trade in this region and its effect will by extension affect the entire countries in continent. Therefore, as a matter of urgency and priority there is need for investments and sufficient funding to be channeled towards trade-and transport-related infrastructure such constructions and maintenance of standard road networks, seaports, good railway linkage and airports. However, for countries with poor GDP, achieving this could be a challenge. Thus, a framework should be put in place to enable cooperation between countries of this regional in order to overcome this challenge. For this purpose, the ECOWAS can play a significant part by making funds available for member countries that are in dire need of it.

ECOWAS countries should synchronize their plans for development of transport infrastructure and pursue to enable collaboration. This collaborative infrastructural development should be targeted at ensuring smooth and continuous transportation of commodities and travelers in the respective market and the range of the strategies should cover both the route to surrounding African countries. In a nutshell, it is essential for all countries in the ECOWAS region to synchronize their development plans to accomplish complementarity and compatibility among their strategies and the execution of their plans of infrastructure.

In conclusion, procedures that facilitate trade can be measured along two schemes: 'physical' infrastructure (i.e., maritime ports, airports, railways and roadways are clearly deliberated in our quantitative analysis) and 'soft' infrastructure (i.e., project management-related, policies, tariffs, etc.,). Both are very significant to trade growth and performance. In the ECOWAS region, substantial financing for infrastructure is capitalized in the physical infrastructure schemes which targets at improving connectivity in the region and will result in reduction of transport costs and improved trade capacity and performance; nevertheless, there are additional measures concerning soft infrastructure scheme which should go along with these investments strategies to guarantee the ingenuity brings about sustainable economic, environmental and social values.

Appendix A

Countries	**Abbreviation**	**Subregion**
Benin	Ben	West Africa (ECOWAS)
Burkina Faso	Bur	
Cape Verde	Cap	
Cote D'ivore	Cot-D	
Gambia	Gam	
Ghana	Gha	
Guinea	Gui	
Guinea-Bissau	Gui-B	
Liberia	Lib	
Mali	Mal	
Niger	Nig	

Nigeria	Nige	
Senegal	Sen	
Sierra leone	Sie	
Togo	Tog	
Egypt	Egy	
Morocco	Mor	North Africa
Algeria	Alg	
Angola	Ang	
South Africa	Sou	South Africa
Botswana	Bot	
Namibia	Nam	
Chad	Cha	Central Africa
Gabon	Gab	
Cameroon	Cam	
Congo-Republic	Con-R	
Equatorial Guinea	Equi-R	
Kenya	Ken	East Africa
Ethiopia	Eth	
Mozambique	Moz	

References

Anderson, J.E. & Van Wincoop, E. (2003), Gravity with gravitas: a solution to the border puzzle. American Economic Review, 93(1), 170-192.

Anderson, J. & Van Wincoop, E. (2004), Trade costs. Journal of Economic Literature, 42(3), 691-751. APEC Transportation Working Group, and the Australian Department of Transport and Regional Services, 2007. Liberalization of air services in the APEC region, 1995- 2005. Prepared by the Centre for Asia Pacific Aviation.

Arvis, J.-F., Mustra, M., Ojala, L., Shepherd, B., & Saslavsky, D. (2010), connecting to compete 2010: Trade logistics in the global economy. Washington, D.C.: The World Bank.

Bafoil, François. (2010), relooking at the role of transport infrastructure in trade, regional growth and governance: comparing Greater Mekong Subregion (GMS) and Central Eastern Europe (CEE). In: EU Centre Research Seminar. Singapore, 5 May 2010.

Baier, S. and J. Bergstrand. 2001, 'The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity.' Journal of International Economics, 53: 1-27

Baier, S., & Bergstrand, J. (2009), Bonus Vetus OLS: a simple method for approximating international trade cost effects using the Gravity Model. Journal of International Economics, 77(1), 63-76.

Battaglia, Paul. (2007), Modeling intermodal transportation for developing countries. In: The First European Conference on Management of Technology (EuroMOT), 2006. Available at: http://www.iamot.org/conference/index.php/ocs/9/schedConf/presentations [Accessed August 2020]

Banister, D. and J. Berechman. 2000. Transport Investment and Economic Development. London, UK: UCL Press.

Baniya, S., S. Murray, N. Rocha and M. Ruta. 2017. The Trade Effects of the New Silk Road. Research summary. Washington, DC: World Bank. As of 17 May 2018: https://drive.google.com/file/d/0B225GGRQlO7uYVUtRVRnQ0EzdUE/view

Behar, A., A.J. Venables, A. de Palma, R. Lindsey, E. Quinet and R. Vickerman. 2011. Transport Costs and International Trade: A handbook of transport economics, 97–115. Cheltenham, UK: Edward Elgar Publishing.

Bird, J. and S. Straub. 2014. The Brasília Experiment: Road access and the spatial pattern of long-term local development in Brazil. Policy Research Working Paper 6964. July. World Bank.

Buys, P., Deichmann, U., & Wheeler, D. (2006), Road network upgrading and overland trade expansion in Sub-Saharan Africa. Policy Research Working Paper, No. 4097, The World Bank.

Chaney, T. (2008), Distorted Gravity: the intensive and extensive margins of international trade. American Economic Review, 98(4), 1707-1721.

Carruthers, Robin, Bajpai, Jitendra N., & Hummels, D. (2003), Trade and logistics in East Asia: a development agenda, EASTR Working Paper, No. 3, Transport Sector Unit, Infrastructure Department, East Asia and Pacific Region, The World Bank.

Clark, X., D. Dollar and A. Micco. 2004. 'Port Efficiency, Maritime Transport Costs, and Bilateral Trade.' Journal of Development Economics v75(2 Dec): 417–50.

Datta, S. 2012. 'The Impact of Improved Highways on Indian Firms.' Journal of Development Economics 99: 46–57.

Donaldson, D. 2018. 'Railroads of the Raj: Estimating the impact of transportation infrastructure.' American Economic Review 108(4-5): 899–934

Donaldson, D. and R. Hornbeck. 2016. 'Railroads and American Economic Growth: A 'market access' approach.' Quarterly Journal of Economics 131: 799–858.

Dossani, R. 2016. 'Promoting the Sustainable Development of Transport and Economic Corridors Under the Belt and Road Initiative. Scoping Paper 3, 2016 High-level Policy Forum on Global Governance. UNDP/China Center for International Economic Exchanges. As of 10 May 2018: http://www.cn.undp.org/content/china/en/home/library/south-south-cooperation/promoting-the-sustainable-development-of-transport-and-economic-.html

Estache, A. and G. Garsous. 2012. The Impact of Infrastructure on Growth in Developing Countries. International Finance Corporation (IFC) Economics Note 1. As of 10 May 2018: http://www.ifc.org/wps/wcm/connect/054be8804db753a6843aa4ab7d7326c0/INR+Note+1+The+Impact+of+Infrastructure+on+Growth.pdf?MOD=AJPERES

Geloso-Grosso, M., & Shepherd, B. (2009), Liberalizing air cargo services in APEC. GEM Sciences Po. Working Paper.

Glaeser, E.L. and J.E. Kohlhase. 2004. 'Cities, Regions and the Decline of Transport Costs.' Papers in Regional Science 83(1): 197–228.

Guerrero, P., Lucenti, K., & Galarza, S. (2009), Trade logistics and regional integration in Latin America & the Caribbean. Inter-American Development Bank working paper series. 148. Available at: http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=35031936 [Accessed August 2020]

Gunasekera, K., W. Anderson and T.R. Lakshmanan. 2008. 'Highway-induced Development: Evidence from Sri Lanka.' World Development. 36(11): 2,371–389

Helpman, E., Melitz, M. & Rubinstein, Y. (2008), Estimating trade flows: trading partners and trading volumes. Quarterly Journal of Economics, 123(2), 441-487.

Hoekman, B. & Nicita, A. (2008), Trade policy, trade costs, and developing country trade. Policy Research Working Paper, No. 4797, the World Bank.

Heckscher, E. 1919. 'The Effect of Foreign Trade on the Distribution of Income.' Ekonomisk Tidskrift 21.

Hummels, D. 1999. Have International Transportation Costs Declined? Working paper. Purdue University, 2001a. Time as a Trade Barrier. Working Paper. Purdue University, 2001b. Toward a Geography of Trade Costs. Mimeo, 2007. 'Transportation Costs and International Trade in the Second Era of Globalization.' Journal of Economic Perspectives 21(3): 131–54.

Limão, N. and A.J. Venables. 2001, 'Infrastructure, Geographical Disadvantage, Transport Costs and Trade.' World Bank Economic Review 15: 451–79.

Martincus, C.V. and J. Blyde. 2013, 'Shaky Roads and Trembling Exports: Assessing the trade effects of domestic infrastructure using a natural experiment.' Journal of International Economics 90: 148–61.

Mayaki, I. 2017. 'Why Infrastructure Development in Africa Matters.' Africa Renewal Online. As of 11 May 2018:
http://www.un.org/africarenewal/web-features/why-infrastructure-development-africa-matters

Michaels, G. 2008. 'The Effect of Trade on the Demand for Skill: Evidence from the interstate highway system.' Review of Economics and Statistics 90: 683–701.

Nordas, H.K. and R. Piermartini. 2004. Infrastructure and Trade. Staff Working Paper ERSD-2004-04. World Trade Organization

Ohlin, B. 1933. Interregional and International Trade. Cambridge, MA: Harvard University Press.

Prentice, Barry E. (2003), Importance of intermodal connectivity and bottleneck elimination. In: Canadian Transportation Research Forum (CTRF) 38th Annual Conference.

Redding, S.J. and M.A. Turner. 2015. 'Transportation Costs and the Spatial Organization of Economic Activity.' In Handbook of Urban and Regional Economics, Volume 5B, edited by G. Duranton, J.V. Henderson and W. C. Strange, 1,339–98. Elsevier.