Impact of Regional Road Infrastructure Improvement on Intra-Regional Trade in ECOWAS

Uduak S. Akpan[+]

Infrastructure Consortium for Africa (ICA), c/o African Development Bank (AfDB), Tunis, Tunisia.

ABSTRACT

This study employs the gravity model of trade to examine the impact of improving the quality of a regional road infrastructure in the ECOWAS sub-region, from its current level to the level of roads in South Africa, on intra-regional trade. The study augments the traditional gravity model to include variables for language, common border, and road quality. The positive difference in per capita GDP of trading partners is also included to test the Linder hypothesis. The parameters in the model are estimated using the Tobit postulation and the result shows that such improvement will lead to a US$397.80million (5.27%) increase in intra-regional trade relative to the 2012 level, ceteris paribus. Moreover, the ancillary benefits of improvement in road quality in terms of increased movement of factors of production will foster further intra-regional trade in the medium and long terms. To enhance the benefits of the improvement in the road quality, ECOWAS governments needs to put in place other "soft" infrastructures to fast-track the achievement of the objectives of the ECOWAS trade liberalization scheme. However, increasing the quality of roads demands huge financial investment, thus a cost-benefit trade-off must be carefully considered.

Keywords: *Road quality, Regional Infrastructure, Lagos-Dakar corridor, Intra-regional trade, ECOWAS.*

Disclaimer: The author thanks the staff of Infrastructure Consortium for Africa (ICA) for their significant inputs to this article. Also thanked are Jonas Chianu, Snott Mukukumira, Salisu Isihak, Simplice Asongu, Uduakobong Obot and Christian Nguena for their comments on the article. The views contained in this article are solely those of the author and should neither be interpreted nor construed to represent the views of ICA or any of her members and partners. The author takes full responsibility for any error or omission in the article.

1.0 Introduction

Despite her potentials in human and natural resources, Africa's human development indices have been appalling over the years. According to the 2012 Human Development Report of the United Nations Development Programme (UNDP), 31 of the 44 countries in Sub-Saharan Africa (i.e. about 70%) have Human Development Index (HDI) less than 0.5 (UNDP, 2013). Unfortunately, the situation has been similar for the past two decades. Some of the reasons for this low level of development are weak institutions, non-conducive socio-political environment, unfavorable geographical location, and lack of quality infrastructure. As part of the Africa Infrastructure Country Diagnostic reports, Yepes *et al*. (2008), Foster (2008), and Foster & Briceño-Garmendia (2010) highlight Africa's extensive infrastructure deficit. Low-

[+] Corresponding author. *Tel: +2348064740389*
E-mail address: uduaksakpan@gmail.com
This paper was written during the author's internship with the African Development Bank where he was assigned to the NEPAD, Regional Integration and Trade Department (ONRI) in the Infrastructure Consortium for Africa (ICA) Division.

income countries in Africa lag behind low-income countries in other regions in almost all infrastructure indicators especially in transport and energy sectors as shown in Table 1.

The African Development Bank (AfDB) complements these studies by providing detailed statistics on the infrastructure situation in Africa (AfDB, 2011). To salvage this situation, African countries, together with multilateral and regional institutions like the AfDB and New Partnership for African Development (NEPAD) have increased efforts, through policies and programmes, to explore and develop the economic potentials of Africa, one of which is through promotion of regional infrastructure projects in the transport sector. The importance of regional infrastructure projects is multifarious. Infrastructure provides necessary social services and acts as an input to private sector production of goods and services, augments capital and labour, and reduces overall cost of production due to reduced overhead cost (Ayogu, 2007).

Studies have examined the importance and/or role of infrastructure to economic development of Africa (Calderón & Servén, 2010; Ajakaiye & Ncube, 2010, etc). Other studies have examined the role of (regional) infrastructure, especially good road networks, in promoting intra-regional trade, economic development, cooperation and integration (Buys *et al.*, 2010; Ndulu, 2006; Mbekeani, 2010; Bafoil & Ruiwen, 2010; AfDB, 2012; UNCTAD, 2013; etc). Mbekeani (2010) conducted a comprehensive review of global experiences on the role of infrastructure in promoting trade and regional economic integration and provided lessons for Africa. Ndulu (2006) highlighted the disadvantages of geography, sovereign, and ethno-linguistic fragmentation in developing infrastructure that will promote regional integration and growth in sub-Saharan Africa and advocated a regional approach in promoting investments in regional infrastructure. In summary, these studies have noted that the availability of good regional infrastructure promotes economic exchange between countries in close geographical proximity across different sectors. Infrastructure provides access to key economic inputs such as knowledge, resources, and technology; reduces the barriers to free movement of goods and persons, and increases access to the market for goods and services. Transport infrastructure promotes cross-border trade and investment, improves countries' competitiveness, and raises domestic output, thus fostering regional integration. In contrast, poor infrastructure reduces the mobility of different factors of production which in-turn reduces firms' productivity by increasing the overhead, logistics, and transportation costs, thus reducing firms' ability to compete internationally.

Table 1: Africa's infrastructure deficit

Normalized units	countries in sub-Saharan Africa	Other low-income countries
Paved road density (km/km^2)	31	134
Total road density (km/km^2)	137	211
Mobile density (lines per thousand population)	55	76
Electricity generation capacity (MW/1million people)	37	326
Electricity coverage (% of population)	16	41
Improved water (% of population)	60	72
Improved sanitation (% of population)	34	51

Source: Yepes *et al*. (2008)

Given the importance of regional road infrastructure, several transit networks have been proposed by the African Development Bank to ease land transportation across Africa, and in-turn, promote intra-African trade and integration (AfDB, 2003). Moreover, initiatives like the Programme for Infrastructure Development in Africa (PIDA) and Infrastructure Consortium for Africa (ICA) have been established to mobilize funds and fast-track the development of these infrastructures.

While there is an agreement that regional road infrastructure plays a crucial role in promoting intra-regional trade and movement of other factors of production, the extent of trade fostered by existing infrastructure may differ across regions depending on the socio-economic, geographic, or political differences of the countries in a given region, as well as the extent to which such infrastructure creates a sustainable flow of services valued by the end-users. Thus, assessing the impact of regional infrastructure on intra-regional trade is necessary since it will indicate how improvements on the infrastructure will promote intra-regional trade. This study intends to contribute to the existing literature on the impact of regional road infrastructure on intra-regional trade. In particular, the study will employ the gravity model of trade to examine how improvement in road quality of the Dakar-Lagos highway will promote intra-regional trade in the Economic Community of West African States (ECOWAS) sub-region following a similar work by Buys *et al.* (2010).

The remaining part of the study is organized as follows: section two will provide a brief overview of the ECOWAS sub-region highlighting the level of intra-regional trade, and the Dakar-Lagos corridor; section three will briefly review some literature on gravity model of trade; section four will present the methodology used in the study; section five will present the result; while section six will be the concluding remarks.

2.0 The ECOWAS sub-region[1]

ECOWAS is a regional group of 15 countries[2], founded on May 28, 1975 with the adoption of the ECOWAS treaty in Lagos, Nigeria. Its mission is to promote economic integration in all fields of economic activity, particularly industry, transport, telecommunications, energy, agriculture, natural resources, commerce, monetary and financial questions, social and cultural matters etc. In 1993, the ECOWAS treaty was revised to accelerate the process of regional integration. ECOWAS has a combined population of 318.5 million and GDP of $US264.2billion (constant 2005) based on 2012 figures from the World Bank, and covers a total surface area of 6.1 million km^2.

In an effort to promote intra-regional trade and establish a common market in the sub-region, the ECOWAS trade liberalization scheme was established in 1979 (adopted in 1990 and amended in 2003). The objectives of the scheme include:

i. elimination of customs duties and taxes having equivalent effect on products from member states
ii. abolition of non-tariff barriers between member state exchanges
iii. establishment of a common external tariff (CET) on products from other countries imported in the community
iv. organization of trade fairs etc.

In 2000, the sub-region was proclaimed a free trade area and plans are still ongoing to transform the sub-region into a functional custom union. Despite its efforts in promoting intra-regional trade, available data show that contrary to the expectations of the trade liberalization scheme which is to promote intra-regional trade, there has been little improvement in the level of intra-regional trade by member countries when compared to bilateral trade with trading partners and the rest of the world. The share of intra-regional exports in the total export of member countries in the sub-region is decreasing, albeit slowly, while export to the rest of the world (i.e. world excluding other ECOWAS countries, mainland China, France, Japan, United Kingdom, and U.S.A.) is steadily increasing. In addition, the share of intra-regional imports in the total imports of member countries is decreasing steadily while imports from mainland China are increasing (see Fig. 1 for aggregated trade flows and Appendices 1 and 2 for trade flows at country level).The reasons

[1] Unless stated otherwise, all information presented in this section is obtained from the websites of ECOWAS, UEMOA and AfDB (2003).
[2] Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

for the current situation may be the increase in demand from ECOWAS member countries for low-cost technology-based products manufactured in China, poor interconnection between member countries due to poor regional infrastructure, among others.

Some member countries of the ECOWAS sub-region also belong to a regional economic community. The West African Economic Monetary Union (*Union Économique et Monétaire Ouest-Africaine, UEMOA*, in French) is a custom union and currency union established in 1994 to promote economic integration among ECOWAS member countries that share the CFA franc as a common currency (Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo). The objectives of UEMOA include: greater economic competitiveness, through open markets, in addition to the rationalization and harmonization of the legal environment; the creation of a common market; the harmonization of fiscal policies; among others.

The Lagos-Dakar Corridor, also called the Trans Coastal West African highway, is one of the nine trans-African highways proposed by the African Development Bank to promote land transport in Africa. The main importance of the Highway is that it provides the most direct, and in some cases the only, road connection between the capitals of the countries along its alignment. It also provides the starting points for the roads leading from the ports to the landlocked countries in the hinterland. The highway covers a total of 4010 km of which 3260 are paved in various areas. Fig. 2 shows the span of the Lagos-Dakar corridor.

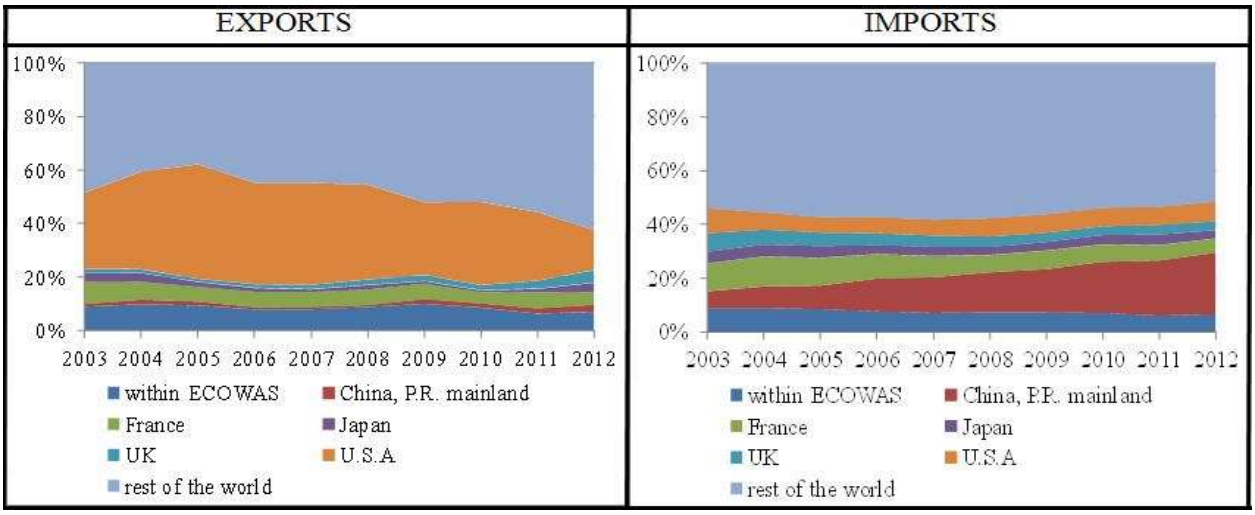


Figure 1: Aggregated trade flows of ECOWAS sub-region
Source of data: IMF-direction of trade

Figure 2: The Lagos-Dakar highway
Source: AfDB (2003)

3.0 Review of Gravity Model of Trade

The gravity model is used in social science to describe economic activities that have the properties of the Newton's law of gravity i.e. contains some elements of volume and distance, e.g. trade and immigration. The most basic form of the model assumes that the volume of trade between two countries is directly proportional to the relative sizes of the origin and destination countries and inversely proportional to the distance between them. The model was originated by Tinbergen (1962) and Poyhonen (1963) and over the years it has been rationalized from several theoretical viewpoints such as the Heckscher-Ohlin relative factor abundance trade theory (Deardorff, 1998). Empirical studies employing the model often extend the number of variables to account for linguistic differences, political and economic ties between trading partners, border and exchange rate regimes between trading partners, political tensions, trade association membership, road quality etc. (Frankel, 1997; Carrillo-Tudela & Li, 2004; Longo & Sekkat, 2004; Coulibaly & Fontagne, 2005; Buys *et al*., 2010; etc.).

Longo & Sekkat (2004) examined the impact of infrastructure availability, economic policy, and internal political tensions using gravity model. Geda & Kebret (2007) assessed the problems and prospects of regional economic integration in Africa and thereafter employed the gravity model to empirically determine the most important factor influencing intra-regional trade using common market for Eastern and Southern Africa (COMESA) as a case study. Musila (2005) applied the gravity model to estimate the intensity of trade creation and trade diversion in three regional economic communities in Africa: common market for

Eastern and Southern Africa (COMESA), Economic Community of Central African States (ECCAS), and ECOWAS. The result of the study indicated that trade creation varies from region to region with ECOWAS having the highest intensity of trade creation. Coulibaly & Fontagne (2005) examined the impact of geographical impediments on intra and extra-regional trade of countries belonging to the West African Economic and Monetary union.

Buys *et al*. (2010) used spatial network techniques and gravity model estimations to quantify the impact of upgrading road networks connecting major African urban areas. The results of the simulations of the study indicated that the initial financial requirements for upgrading the road networks will be about $20billion and will require $1billion for annual maintenance while the resulting impact will create an overland trade expansion in sub-Saharan Africa which might expand up to $250billion within 15 years. Shepherd & Wilson (2007) also examined the impact of road upgrade on trade expansion in Eastern Europe and Central Asia using the gravity model.

4.0 Methodology

In its basic form, the gravity model is specified as follows:

$$Export_{ij} = K\left(\frac{{GDP_i}^{\alpha_i} {GDP_j}^{\alpha_j}}{{Dist_{ij}}^{\beta}}\right) e_{ij} \qquad \ldots(1)$$

where the subscripts i and j represents the origin and destination countries respectively; $Export_{ij}$, the volume of export from i to j; GDP_i, the gross domestic product of i; GDP_j, the gross domestic product of j; $Dist_{ij}$, the road distance between i and j; α_i, α_j, and β are parameters; K, a constant; and e_{ij}, a disturbance term such that its expectation, E(e_{ij}) = 1. We convert the model to a lin-log model by taking the natural logarithm of the right hand side, and augment the model to include the following variables: $Qual_{ij}$, an indicator of the average road quality between i and j; $Lang.En_{ij}$, a dummy variable, equal to 1 if i and j have English as their official language, and 0 otherwise; $Lang.Fr_{ij}$, a dummy variable, equal to 1 if i and j have French as their official language, and 0 otherwise; and CB_{ij}, a dummy variable, equal to 1 if i and j share a common border, and 0 otherwise. In addition, to enable us test the Linder hypothesis (which states that countries with similar levels of per capita income will have similar tastes, will produce similar but differentiated products, and trade more among themselves), we add the variable $DGDPPC_{ij}$ defined as the positive difference between the GDP per capita of the originating and destination countries. Consequently, we have:

$$Export_{ij} =$$

$$\alpha_0 + \alpha_1^i lnGDP_i + \alpha_1^j lnGDP_j + \beta_1 lnDist_{ij} + \beta_2 lnQual_{ij} + \beta_3 lnDGDPPC_{ij} +$$

$$\lambda_1 Lang.En_{ij} + \lambda_2 Lang.Fr_{ij} + \lambda_3 CB_{ij} + \varepsilon_{ij}\,;\ \mathrm{E}(\varepsilon_{ij}) = 0 \qquad \ldots(2)$$

where ε_{ij} is the disturbance term and α_0, α_1^i, α_1^j, β_1, β_2, β_3, λ_1, λ_2 and λ_3 are parameters to be estimated. A lin-log model is used because where there is no export between two countries (i.e. $Export_{ij} = 0$) the natural logarithm of export, $lnExport_{ij}$, cannot be obtained. Estimating the lin-log specification presented in equation (2) using ordinary least squares (OLS) will produce biased and inconsistent results since the dependent variable is truncated at zero, thus, the Tobit model is used (Longo & Sekkat, 2004; Geda & Kebret, 2007).

The gravity model assumes that the volume of trade between two countries is directly proportional to the economic size of the countries and inversely proportional to the distance between the countries. Thus, *a priori*, the study expects α_1^i and α_1^j to have positive values, and β_1 to have a negative value. Good quality roads will generally reduce the cost of transporting goods by road thus increase trade, consequently, β_2 is expected to have a positive sign. Based on Linder's hypothesis, it is expected that the smaller the absolute value of the difference between the GDP per capita of *i* and *j*, the larger the volume of export. Therefore, β_3 is expected to be negative. There is likely to be more trade between countries that have a common border or speak the same language than with those that do not have these qualities, thus λ_1, λ_2, and λ_3 are expected to be positive.

The study covers only the 11 coastal countries along the Lagos-Dakar highway (i.e. excluding Burkina Faso, Cape Verde, Mali, and Niger). Data on the volume of exports are obtained from the International Monetary Fund Direction of Trade database, IMF-DOT, for year 2012 (expressed in current million US$; and GDP and GDP per capita from the World Bank database (current US$, expressed in millions), for year 2012. Data on road distance between two countries (measured as the distance between the capital/reference cities of the countries on the Lagos-Dakar highway, are obtained from AfDB (2003). For example, distance between Senegal and Sierra Leone is calculated as distance between Dakar (Senegal) and Masiaka (Sierra Leone) on the Lagos-Dakar highway. The computed distances are provided in appendix 3.

Table 2: Percentage paved roads and road transport quality index

Country	% of paved roads	Road Transport Quality Index	
		Guys et al. (2010)	Present study
South Africa	60.00	100.00	100.00
Gambia, The	35.40	41.60	43.34
Togo	31.60	37.00	34.11
Senegal	29.30	36.00	38.07
Nigeria	30.90	32.30	41.61
Ghana	18.40	27.00	26.51
Benin	20.00	25.10	26.48
Guinea	16.50	23.10	20.35
Core d'Ivoire	9.70	14.40	15.24
Guinua Bissau	10.30	13.20	13.87
Sierra Leone	7.90	9.60	12.07
Liberia	6.20	7.10	8.49

The study adopts road transport quality index methodology used by Buys *et al*. (2010) as follows:

Let Q_i be the road quality index of country *i*. Then:

$$Q_i = R_i^{a_1} G_i^{a_2} C_i^{a_3} \quad \ldots(3)$$

where R_i is the percentage of roads that are paved in country *i* (1999 data obtained from Buys *et al.* 2010)[3]; G_i, the GDP per capita of country *i* as a proxy for capacity to maintain roads[4] (2012 data, purchasing power parity (PPP) constant 2005 US$, World Bank); C_i, the World Bank's Country Policy and Institutional Capacity (CPIA) index for transparency, accountability and corruption for country *i* as a proxy for delays and cost inflicted on truckers (2012 report, World Bank, 2013)[5]; while a_1, a_2 and a_3 are weights assigned to the variables based on the contribution of each variable to the average road quality in a country, such that, $a_1 + a_2 + a_3$ is analogous to returns-to-scale and is expected to be ≥ 1. Usually, $0.5 \leq a_1 \leq 1$, since the percentage of paved roads is the most important measure of road quality, and $0 \leq a_2 \leq 0.5$; $0 \leq a_3 \leq 0.5$. Also note that if $a_1=1$, $a_2=0$, $a_3=0$; then $Q_i = R_i$. We follow Buys *et al*. (2010) and assign a_1 twice the combine weight of a_2 and a_3, and specify a mildly increasing-returns function ($a_1=0.8$, $a_2=0.2$, $a_3=0.2$) as a good approximation to road transport quality differentials. Data on percentage of paved roads show that South Africa has the highest percentage of paved roads in Africa. Thus, the study uses South Africa as a benchmark, calculates Q_i for the countries considered in this study and South Africa, and benchmarks the

[3] There are no updated cross sectional data covering all ECOWAS countries
[4] Government expenditure on infrastructure maintenance as percentage of GDP is a better proxy for capacity to maintain roads. However, data on the variable are unavailable for African countries.
[5] South Africa is not included. The study assigned the highest value (i.e. Kenya = 4.59) to South Africa

calculated Q_i relative to 100, where $Q_{South\ Africa}$ = 100. As noted by Shepherd & Wilson (2007), this approach is valuable as it shows that "upgrading road quality is not just about bitumen, but also requires maintenance capacity and the ability to control unofficial payments". The result is comparable to that calculated by Buys *et al*. (2010) and is presented in Table 2. The road quality between *i* and *j* is measured as the distance-weighted road quality index for transit countries[6]. The model covers 110 observations and is estimated using the method of maximum likelihood with Eviews 6.0.

5.0 Results and Discussions

The summary of our estimated coefficients which show the marginal effects of the regressors on the latent variable of export, *Export**, is presented in Table 3 (the complete result is presented in Appendix 4). From Table 3, we observe that all the main regressors possess the expected signs. In contrast, only one dummy variable, *Lang.Fr*, has the expected positive sign. The negative sign of *Lang.En* suggests that English speaking countries in the ECOWAS sub-region are more likely to trade with Francophone countries than with other Anglophone countries in the sub-region. The dummy variable *CB* also has a negative sign contrary to expectation. This suggests that ECOWAS countries are more likely to trade with member countries not having a common border than with those having a common border. However, although the result suggests this, a more plausible explanation for this contradiction may be that the IMF-DOT data for 2012 does not fully capture cross border trade flows in the sub-region, or the volume of trade via shipment to member countries with non-adjoining borders is generally higher than that via roads to countries that have a common border.

Table 3: Estimated results

Dependent Variable: EXPORT					
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**	**Significance at 5%**
C	-888.6383	539.1377	-1.6483	0.0993	significant
LOG(GDPI)	68.7819	13.9106	4.9446	0.0000	very significant
LOG(GDPJ)	40.9301	13.6378	3.0012	0.0027	very significant
LOG(DIST)	-39.5187	38.3979	-1.0292	0.3034	not significant
LOG(QUAL)	101.8236	100.4585	1.0136	0.3108	not significant
LOG(DGDPPC)	-9.7858	18.0272	-0.5428	0.5872	not significant
LANG_EN	-20.9760	56.8879	-0.3687	0.7123	not significant
LANG_FR	31.2284	58.4328	0.5344	0.5930	not significant
CB	-36.6205	71.3304	-0.5134	0.6077	not significant

[6] For example, road quality between Guinea and Cote d'Ivoire = $\frac{20.35(102)+12.07(115)+12.07(292)+8.49(119)+8.49(412)+15.25(614)}{1654} = 12.6081$

We now proceed to the marginal effects of the regressors. First, we note that in the Tobit model, the marginal effects of the estimated coefficients on the latent form of the dependent variable are the estimated coefficients[7]. The result shows that *ceteris paribus*: if the GDP of an originating country increases by 1%, on average, intra-regional export will increase by US$0.69million; if the GDP of a destination country increases by 1%, on average, intra-regional export will increase by US$0.41million; and if the average quality of road between the originating country increases by 1%, on average, intra-regional export will increase by US$1.01million. The coefficient of the distance suggests that if the distance that will be covered in transporting goods increases by 1%, on average, there will be a US$0.40 reduction in the value of intra-regional exports. The Linder's hypothesis holds true for intra-regional trade in ECOWAS sub-region for year 2012. The result shows that for every 1% decrease in the absolute value of the difference between the GDP per capita of the originating and destination countries, on average, trade will increase by US$0.1 million. This further shows that policies that support macroeconomic convergence in the ECOWAS sub-region inadvertently promote intra-regional trade.

Next, we examine the impact of the completion of the Lagos-Dakar highway on intra-regional trade in the ECOWAS sub-region. The study views the completion of the Lagos-Dakar highway as being equivalent to an increase in the average road quality between *i* and *j* ($Qual_{ij}$) from its current level (shown in the road transport quality index) to the level of South Africa i.e. 100. Based on the distance-weighted road quality used in this study, the average road quality from Dakar to Lagos, relative to the index of quality of road in South Africa (i.e. 100), is 20.38. Thus, *ceteris paribus*, increasing the Lagos-Dakar average road quality from 20.38 to 100 (i.e. 391% increase), has the potential of increasing intra-regional trade by US$397.80million, which is equivalent to a 5.27 increase from its current level.

6.0 Concluding Remarks

The nexus between transport infrastructure and trade has long been established in the literature. Infrastructure provides access to key economic inputs such as knowledge, resources, and technology; reduces the barriers to free movement of goods and persons, and increases the market for goods and services. Regional transport infrastructure promotes cross-border trade and investment, improve countries' competitiveness, and raise domestic output,

[7] This is different from the marginal effects of the estimated coefficient on the observed dependent variable which is usually multiplied by a scaled factor (which shows the probability of an uncensored observation at given values of the independent variable(s)).

thus fostering regional integration. This study set out to examine the impact of improving the quality of regional road infrastructure in the ECOWAS region from its current level to the level of roads in South Africa on intra-regional trade and observed that such improvement will lead to a US$397.80million (5.27%) increase in intra-regional trade relative to the 2012 level, all other things being equal. Moreover, the ancillary benefits of improvement in road quality in terms of increased movement of factors of production will foster further intra-regional trade in the medium and long terms. To enhance the benefits of the improvement in the road quality, ECOWAS governments needs to put in place other "soft" infrastructures to fast-track the achievement of the objectives of the ECOWAS trade liberalization scheme. However, increasing the quality of roads demands huge financial investment, thus a cost-benefit trade-off must be carefully considered.

References

AfDB. (2003). Review of the Implementation Status of the Trans-African Highway and the Missing Links. Tunis: African Development Bank and United Nations Economic Commission for Africa.

AfDB. (2011, December). *Africa Infrastructure Knowledge Programme: Handbook on Infratsructure Statistics*. Retrieved August 13, 2013, from African Development Bank: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AfDB%20Infrastructure_web.pdf

AfDB. (2012). *Development Effectiveness Review 2012: Promoting Regional Integration* . Retrieved August 13, 2013, from African Development Bank : http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Development%20Effectiveness%20Review%202012%20-%20Promoting%20Regional%20integration.pdf

Ajakaiye, O., & Ncube, M. (2010). Infrastructure and Economic Development in Africa: An Overview. *Journal of African Economies , 19*, 3-12.

Ayogu, M. (2007). Infrastructure and Economic Development in Africa: A Review. *Journal of African Economies , 16*, 75–126.

Bafoil, F., & Ruiwen, L. (2010). Re-examining the Role of Transport Infrastructure in Trade, Regional Growth and Governance: Comparing the Greater Mekong Subregion (GMS) and Central Eastern Europe (CEE). *Journal of Current Southeast Asian Affairs , 29* (2), 73-119.

Buys, P., Deichmanna, U., & Wheelerb, D. (2010). Road Network Upgrading and Overland Trade Expansion in Sub-Saharan Africa. *Journal of African Economies , 19* (3), 399–432.

Calderón, C., & Servén, L. (2010). Infrastructure and Economic Development in Sub-Saharan Africa. *Journal of African Economies , 19*, 13-87.

Carrillo-Tudela, C., & Li, C. (2004). Trade Blocks and the Gravity Model: Evidence from Latin American Countries. *Journal of Economic Integration , 19* (4), 667–89.

Coulibaly, S., & Fontagne, L. (2005). South–South Trade: Geography Matters. *Journal of African Economies , 15* (2), 313–41.

Deardorff, A. V. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Classical World? In J. A. Frankel (ed.), *The Regionalization of the World Economy.* Chicago: University of Chicago Press.

Foster, V. (2008, September). *Overhauling the Engine of Growth: Infrastructure in Africa*. Retrieved August 12, 2013, from World Bank: http://siteresources.worldbank.org/INTAFRICA/Resources/AICD_exec_summ_9-30-08a.pdf

Frankel, J. A. (1997). *Regional Trading Blocs in the World Trading System.* Washington DC: Institute for International Economics.

Foster, V., & Briceño-Garmendia, C. (2010). Africa's Infrastructure: A time for transformation. Retrieved August 13, 2013, from Infrastructure Africa: http://infrastructureafrica.org/system/files/AIATT_Consolidated_smaller.pdf

Geda, A., & Kebret, H. (2007). Regional Economic Integration in Africa: A Review of Problems and Prospects with a Case Study of COMESA. *Journal of African Economies , 17* (3), 357–394.

Longo, R., & Sekkat, K. (2004). Economic Obstacles to Expanding. *World Development , 32* (8), 1309–1321.

Mbekeani, K. K. (2010). Infrastructure, Trade Expansion and Regional Integration: Global Experience and Lessons for Africa. *Journal of African Economies , 19*, 88-113.

Musila, J. W. (2005). The Intensity of Trade Creation and Trade Diversion in COMESA, ECCAS and ECOWAS: A Comparative Analysis. *Journal of African Economies , 14* (1), 117–141.

Ndulu, B. (2006). Infrastructure, Regional Integration and Growth in Sub-Saharan Africa: Dealing with the Disadvantages of Geography and Sovereign Fragmentation. *Journal of African Economies , 15*, 212-244 .

Poyhonen, P. (1963). A Tentative Model for the Volume of Trade between Countries. *Weltwirtschaftliches Archiv , 90*, 93–9.

Shepherd, B., & Wilson, J. S. (2007). Trade, Infrastructure, and Roadways in Europe and Central Asia: New Empirical Evidence. *Journal of Economic Integration , 22* (4), 723-747.

Tinbergen, J. (1962). An analysis of world trade flows. In J. Tinbergen (ed.), *Shaping the World Economy.* New York: The Twentieth Century Fund.

UNCTAD. (2013, April). *Supporting infrastructure development to promote economic integration: the role of the public and private sectors*. Retrieved July 31, 2013, from United Nations Conference on Trade and Development: http://unctad.org/meetings/en/SessionalDocuments/cimem6d2_en.pdf

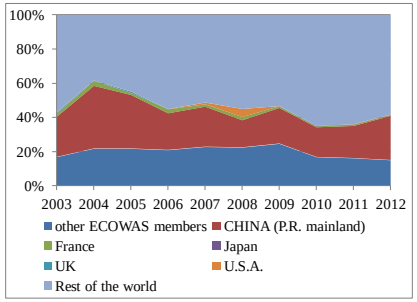
UNDP. (2013). *Human Development Reports*. Retrieved June 26, 2013, from United Nations Development Programme: http://hdr.undp.org/en/reports/global/hdr2013/

World Bank. (2013, June). *2012 CPIA Results for Africa*. Retrieved August 12, 2013, from World Bank: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/06/26/000356161_20130626125251/Rendered/PDF/788430WP0P13200CPIA0Report020130v12.pdf

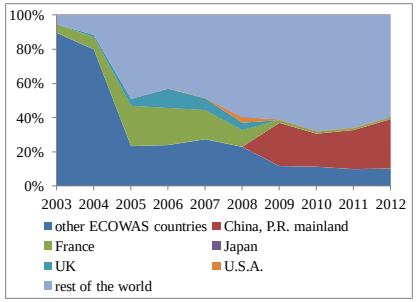
Yepes, T., Pierce, J., & Foster, V. (2008). *Making Sense of Africa's Infrastructure Endowment: A Benchmarking Approach.* New York: World Bank.

APPENDIX 1: EXPORT FLOWS

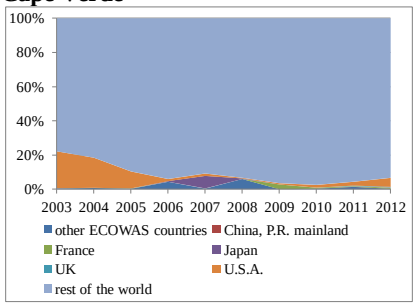
Benin



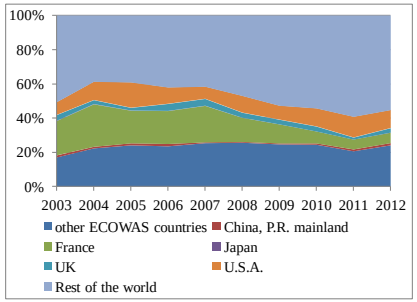
Burkina Faso



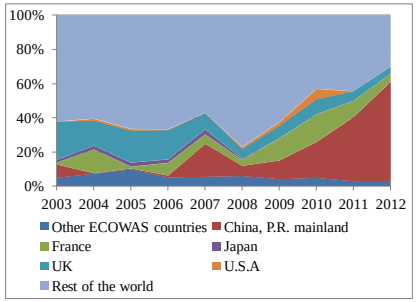
Cape Verde



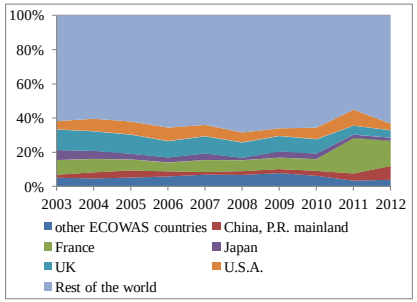
Cote d'Ivoire



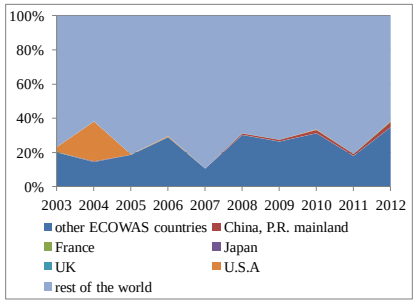
Gambia



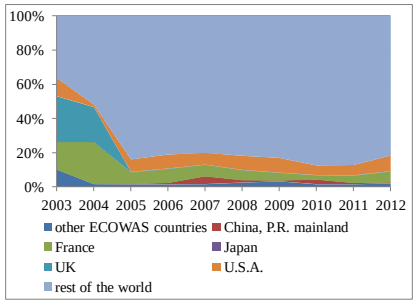
Ghana



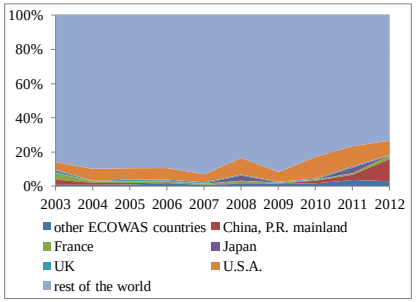
Guinea Bissau



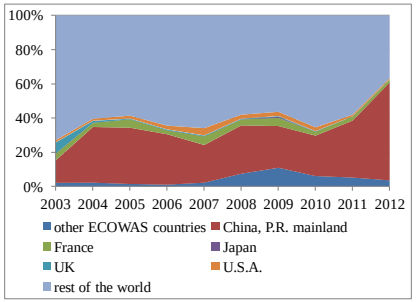
Guinea



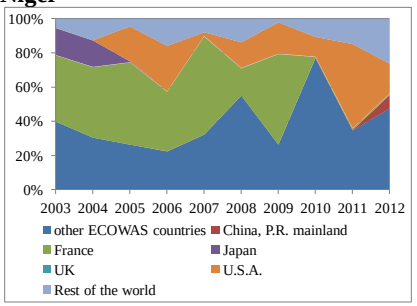
Liberia



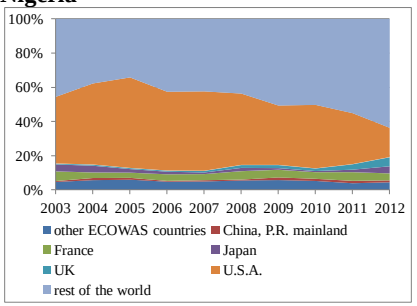
Mali



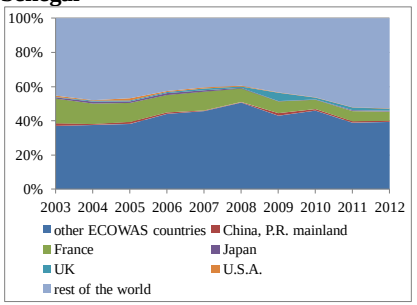
Niger



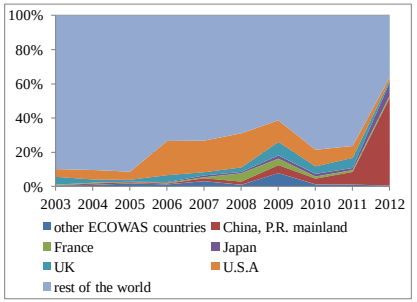
Nigeria



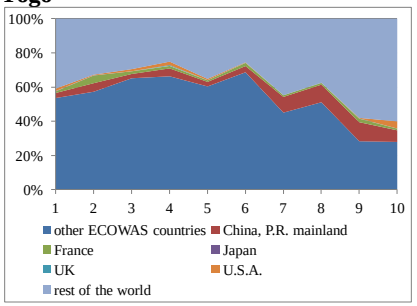
Senegal



Sierra Leone



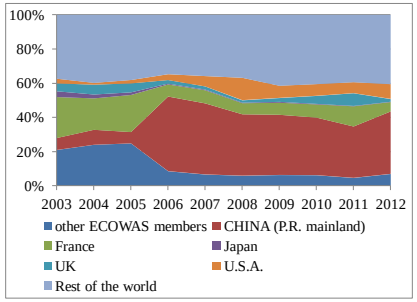
Togo



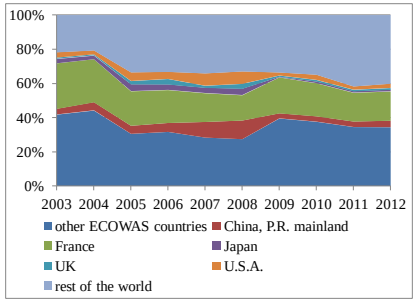
Source of data: IMF-Direction of trade

APPENDIX 2: IMPORT FLOWS

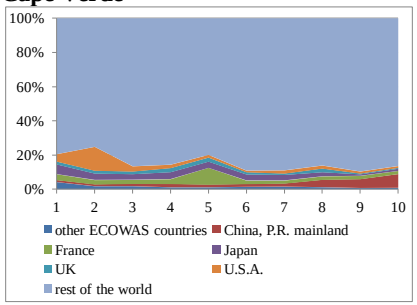
Benin



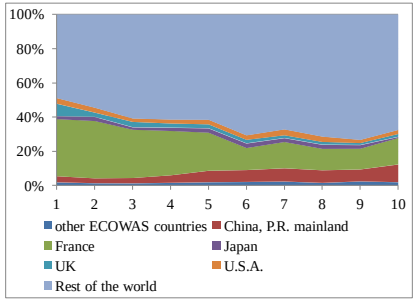
Burkina Faso



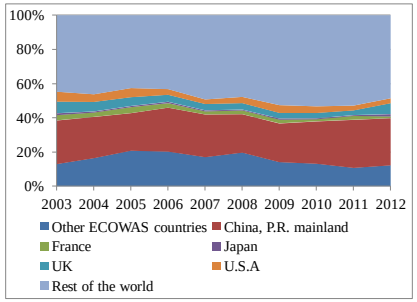
Cape Verde



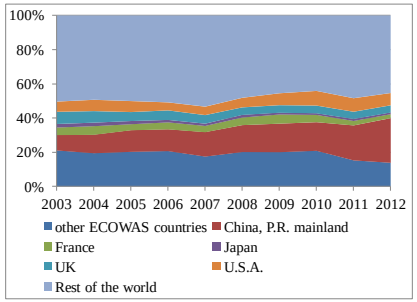
Cote d'Ivoire



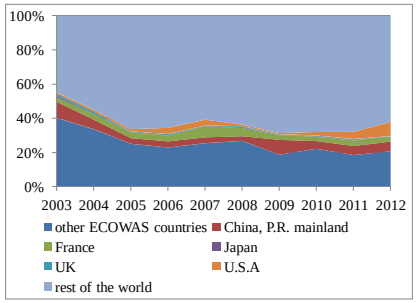
Gambia



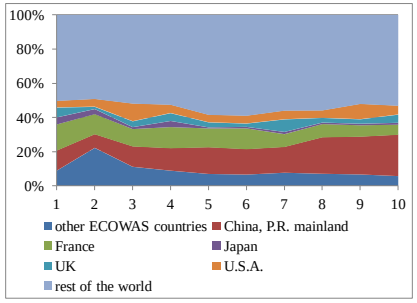
Ghana



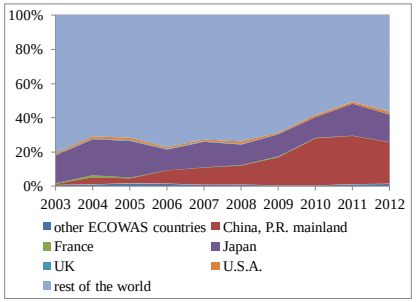
Guinea Bissau



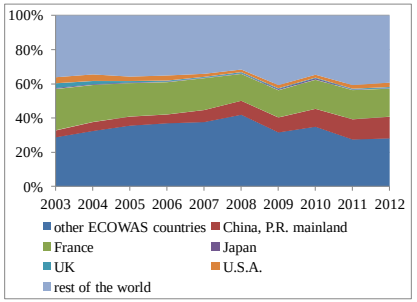
Guinea



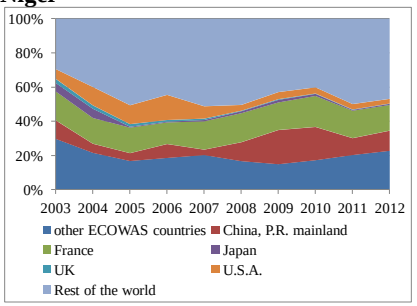
Liberia



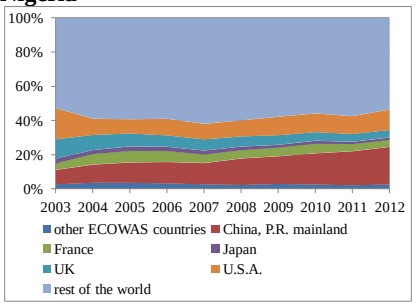
Mali



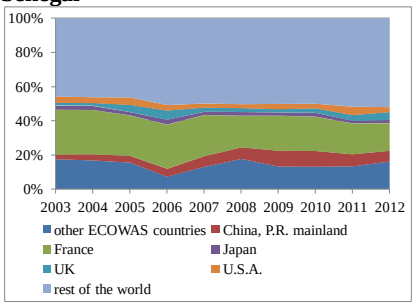
Niger



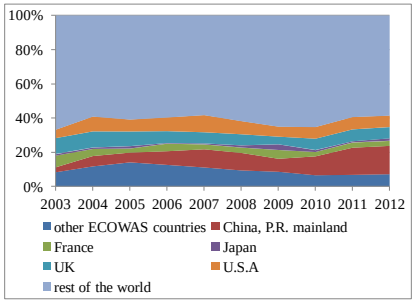
Nigeria



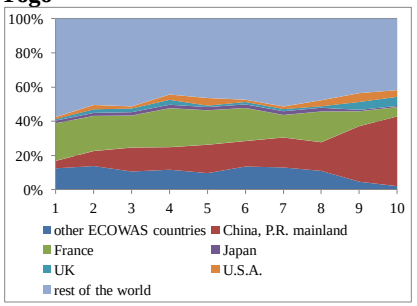
Senegal



Sierra Leone



Togo



Source of data: IMF-Direction of trade

APPENDIX 3: Distance between focal cities on the Lagos-Dakar highway

Span of road	**Country**	**length (km)**
Dakar (Senegal) to Senegal/Gambia border	Senegal	274
Senegal/Gambia border to Barra (Gambia)*	Gambia	25
Banjul* (Gambia) to Gambia/Senegal border	Gambia	72
Gambia/Senegal border to Senegal/Guinea Bissau border	Senegal	117
Senegal/Guinea Bissau border to Safim (Guinea Bissau)**	Guinea Bissau	110
Safim (Guinea Bissau) to Guinea Bissau/Guinea border	Guinea Bissau	285
Guinea Bissau/Guinea border to PK36 (Guinea)**	Guinea	337
PK36 (Guinea) to Guinea/Sierra Leone border	Guinea	102
Guinea/Sierra Leone border to Masiaka (Sierra Leone)**	Sierra Leone	115
Masiaka (Sierra Leone) to Sierra Leone/Liberia border	Sierra Leone	292
Sierra Leone/Liberia border to Monrovia (Liberia)	Liberia	119
Monrovia (Liberia) to Liberia/Cote d'Ivoire border	Liberia	412
Liberia/Cote d'Ivoire border to Abidjan (Cote d'Ivoire)	Cote d'Ivoire	614
Abidjan (Cote d'Ivoire) to Cote d'Ivoire/Ghana border	Cote d'Ivoire	165
Cote d'Ivoire/Ghana border to Accra (Ghana)	Ghana	392
Accra (Ghana) to Ghana/Togo border	Ghana	191
Ghana/Togo border to Lome (Togo)	Togo	10
Lome (Togo) to Togo/Benin border	Togo	55
Togo/Benin border to Cotonou (Benin)	Benin	92
Cotonou (Benin) to Benin/Nigeria border	Benin	30
Benin/Nigeria border to Lagos (Nigeria)	Nigeria	90
Total length (Dakar -Lagos) * **		**3899**
*There is a break between Barra and Banjul		
**Safim to Bissau is connected by a separate trunk. Same as Masiaka to Freetown and PK36 to Conakry		
*** Does not add up to 4010 due to adjoining trunks i.e. Safim - Bissau in Guinea Bissau; PK36 - Conakry in Guinea; and Masiaka - Freetown in Sierra Leone		

Source: AfDB (2003)

APPENDIX 4: Estimated results of Eviews

Dependent Variable: EXPORT

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Date: 08/14/13 Time: 08:31

Sample (adjusted): 1 109

Included observations: 109 after adjustments

Left censoring (value) at zero

Convergence achieved after 5 iterations

Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-888.6383	539.1377	-1.648259	0.0993
LOG(GDPI)	68.78192	13.91057	4.944579	0.0000
LOG(GDPJ)	40.93008	13.63775	3.001235	0.0027
LOG(DIST)	-39.51872	38.39794	-1.029189	0.3034
LOG(QUAL)	101.8236	100.4585	1.013588	0.3108
LOG(DGDPPC)	-9.785767	18.02722	-0.542833	0.5872
LANG_EN	-20.97596	56.88790	-0.368725	0.7123
LANG_FR	31.22842	58.43284	0.534433	0.5930
CB	-36.62054	71.33039	-0.513393	0.6077
Error Distribution				
SCALE:C(10)	216.4357	15.51950	13.94605	0.0000

Mean dependent var	62.82943	S.D. dependent var	240.4221
S.E. of regression	219.5815	Akaike info criterion	12.40941
Sum squared resid	4773388.	Schwarz criterion	12.65632
Log likelihood	-666.3128	Hannan-Quinn criter.	12.50954
Avg. log likelihood	-6.112962		

Left censored obs	12	Right censored obs	0
Uncensored obs	97	Total obs	109