

Bilateral Trade Performance in West Africa: A Gravity Model Estimation*

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Abstract: This study provides empirical insights on the functioning of regional trade agreements within the Economic Community of West African States (ECOWAS) by identifying bilateral trade barriers that affect the extent of trade flows among member countries. Also, it highlights some trade barrier indicators that are rarely covered in extant studies, such as the multilateral resistance term, the extent of trade complementarity, and the presence of economic integration agreements among ECOWAS member countries. We then provide augmented gravity model estimation on the determinants of bilateral trade in the region. We find, among other things, that trade complementarity had a positive and significant effect on bilateral trade within the sub-region region. Other important determinants of intra-regional trade include multilateral trade resistance and economic integration agreements — meaning that countries with some kind of agreement like the West African Economic and Monetary Union (WAEMU) tend to trade more among themselves than other member countries.

1. Introduction

This study provides empirical insight into the functioning of regional trade agreements (RTAs) by identifying the bilateral trade barriers that may affect the extent of trade flows within the Economic Community of West African States (ECOWAS). It offers an extensive review of the factors that affect intra-regional trade by using more recent data sets that are fitted into the augmented gravity analytical framework. In addition, it highlights some trade barrier indicators that are rarely covered in existing studies, such as the multilateral resistance term (MRT), the extent of trade complementarity (TC) and the presence of economic integration agreements between ECOWAS member countries.

ECOWAS was established on 25 May 1975 to foster mutual cooperation and integration among its member states, eventually leading to the establishment of an economic union in West Africa. The ultimate purpose was to raise member country citizens'

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living standards, maintain and enhance economic stability, reinforce relations among member countries and contribute to the overall development of the African continent (ECOWAS, 2016). Some of the agreements signed by ECOWAS to foster intra-regional trade and investment include the protocol relating to the free movement of labour (signed in 1979), agreements relating to inter-state road transportation and mutual administrative assistance in customs matters (signed in 1982), and the agreement on the rights of residency and establishment (signed in 1990). The ECOWAS trade liberalization scheme of 1990 is another important agreement that, with the support of the Authority of Heads of State and Government of ECOWAS, resulted in the proclamation of the region as a free trade area in 2000 and a customs union in 2001 (Shuaibu, 2015; Ukaoha and Ukpe, 2013).

Despite these protocols and agreements signed by ECOWAS member countries, progress in the development of trade and economic relations within the region has not been satisfactory. For instance, the share of intra-regional exports in total exports of ECOWAS members, which was 10.1 per cent in 1980, increased only to 10.7 per cent in 1998 and 12 per cent in 2010 (Osabuohien *et al.*, 2017). This reflects the somewhat low level of mutual cooperation within ECOWAS, at least judging from trade perspectives. This could be due to a number of reasons. First, member states' trade baskets consist of similar products, resulting in low TC. Second, trade is concentrated in just a few sectors, which, together with the low value added to tradable commodities resulting from low levels of industrialization, limits the capacity for the diversification of trade. Third, despite the ECOWAS Treaty that is supposed to foster trade within the region, barriers to intra-regional trade still restrict the free movement of goods and people. Fourth, the quality of trade-related infrastructure impedes trade within the region and the establishment of the regional community. All these reasons are validated empirically (e.g. Ackah *et al.*, 2012; Eveslage, 2015; Ukaoha and Ukpe, 2013). The implication of this low intra-regional trade within the sub-region is immense (Anyanwu, 2014), with the main issue being that it slows down the potential for deep integration, which has long been a desire of the region.

From this background, this paper specifically identifies those factors that affect intra-regional trade performance within the ECOWAS sub-region. We achieve this objective using the augmented gravity model of trade. The gravity model considers the trade flows between two countries as being a function of the economic mass of both countries and the distance between them. Specifically, the gravity model supposes that trade flow between two countries is positively related to their economic size, and inversely related to the distance between both countries. The relevance of the gravity model in explaining bilateral trade flow among ECOWAS countries includes its remarkable explanatory power in analysing bilateral trade flows between and among countries (Ackah *et al.*, 2012). As an innovation in this paper, we include the extent of TC, the presence of economic integration agreements among ECOWAS member countries, the multilateral resistance to trade and the extent of financial depth. To validate the importance of these augmentation variables, Anderson and van Wincoop (2003) argue that the gravity models will most likely be overstated if they are not formulated to account for some of these augmentation variables. They emphasize multilateral resistance to trade — the average trade resistance between a country and its trading partners with the rest of the world. Economic integration agreements and the extent of TC illustrate the extent to which the gravity model for ECOWAS countries is influenced by the quality of agreements among member countries. Including a variable that captures the extent to which the demand of given ECOWAS countries is easily met by other member countries would reduce the likelihood of the ECOWAS gravity model being biased.

This study is related to Ackah *et al.* (2012) and Osabuohien *et al.* (2017), but we expand theirs in a number of ways. First, in terms of scope, this study includes data for 15 ECOWAS countries for the period 2006–2013 compared to Ackah *et al.* (2012) that used only 10 ECOWAS countries for the period 2007–2009. Second, we employ a battery of estimation techniques in testing the relationship, including the baseline ordinary least squares (OLS) regression to show baseline relationships, the fixed effect estimate to control for time-invariant factors that may affect the relationship and the Poisson pseudo-maximum likelihood (PPML) test, which controls for the problem of heteroscedasticity that may exist in the gravity model and also takes care of problem of zero trade flow, which, if not addressed, may bias the model. Third, in addition to the inclusion of financial development (of both the exporting and importing ECOWAS member countries) utilized by Osabuohien *et al.* (2017), we include a novel variable — TC — to examine how it influences bilateral trade in ECOWAS. The inclusion of this variable draws from the fact that, as an indicator, the trade complementarity index (TCI) measures the extent to which two countries are 'natural trading partners'. The TCI does this by examining if the export composition of a country tallies with the import composition of her trading partner(s). The greater this value, the higher the trade possibilities between both countries. To the best of our knowledge, this variable is not popular in the gravity model studies that have considered the ECOWAS sub-region.

The study finds that the traditional gravity model holds for ECOWAS member countries such that bilateral trade flow increases with the size of the economy and decreases with distance. The existence of economic integration agreements and the degree of TC are very important variables in the augmented gravity model while the financial development variable is less important. The remainder of the study is divided as follows. The next section briefly presents the review of empirical literature while the econometric evaluation of bilateral trade flows in ECOWAS is in the third section. The fourth section presents the results, while the last section concludes.

2. Brief Review of Empirical Literature

There is a growing literature on the factors affecting intra-regional trade in the ECOWAS sub-region. Torres and Seters (2016), for example, highlight five major issues that affect the extent of intra-regional trade performance in the region, such as structural or foundational factors; formal and informal rules of the game; actors, agency and incentives; subsector specific technical and political characteristics; and other forms of exogenous shocks. Some other studies like Osabuohien *et al.* (2017) considered the importance of the formal financial development in facilitating intra-regional trade, which aligns with Babatunde and Odularu (2017) who emphasized the importance of strengthening the productive capacity of member states to boost intra-regional trade. Ackah *et al.* (2012) focused on infrastructural development, especially the improvement of logistic infrastructure for common trade among member states. Afesorgbor and van Bergeijk (2014) and Olayiwola *et al.* (2015) yet considered structural issues like multi-memberships, institutional framework and high transport cost as being among the key impediments to intra-regional trade in the sub-region.

The gravity model is seen to be a veritable tool in the study and analysis of trade barriers, especially in a bilateral framework. The popularity of this model is traced to Tinbergen (1962) and Anderson (1979). Other authors that have used this model to study trade flows, custom or currency unions are Deardorff (1998), Hummels (1999), Baier and Bergstrand (2001), Glick and Rose (2002). For the ECOWAS region, Ackah *et al.* (2012) and Osabuohien *et al.* (2017) are the recent studies that have used the gravity model to study intra-regional trade. Despite the uniqueness of these studies, it is yet unknown how variables that reflect contextual issues within the sub-region, such as within region agreements, demand and supply conditions of trade partners within the region, and financial development of trading partners influence bilateral trade performance. This particular paper contributes in this regard.

3. Econometric Evaluation of Bilateral Trade Flows in ECOWAS

The aim of this section is to provide a deeper understanding of the factors that could exert influence on intra-regional trade flows in the ECOWAS region.

3.1 Empirical Model and Estimation Techniques

This section employs the augmented gravity model of trade. The gravity model considers trade flows between two countries as a function of the economic mass of both countries and the distance between them. It supposes that the trade flow between two countries is positively related to their economic mass or size (usually proxied by GDP), and inversely related to the distance between them. This can be mathematically represented by the following expression:

$$X_{ij} = \frac{Y_i Y_j}{D_{ij}} \quad (1)$$

In multiplicative form, Equation (1) could be rewritten as follows:

$$X_{ij} = Y_i^\beta Y_j^\gamma D_{ij}^{-\delta} \quad (2)$$

where X_{ij} represents the flow of trade (exports) from country i to country j , Y_i and Y_j are country i 's and country j 's GDP and D_{ij} is the distance between the countries.

In its most basic form, the gravity model can be written as follows:

$$\ln(X_{ij}) = \alpha + \beta \ln(Y_i) + \gamma \ln(Y_j) + \delta \ln(D_{ij}) + \mu_{ijt} \quad (3)$$

The above formulation specifies distance as a type of trade barrier. In the empirical trade literature, however, the barriers to trade extend beyond physical distance. Therefore, D_{ij} could be said to represent a vector of trade barriers, and thus in several studies it has been represented by various measures depending on the key issue of interest. In this section, an augmented

gravity model of trade is applied to empirically examine the determinants of bilateral trade flows in the ECOWAS region. The augmented gravity model for this analysis is as follows:

$$\ln X_{ijt} = \alpha + \beta \ln Y_{it} + \gamma \ln Y_{jt} + \delta \ln D_{ij} + \phi \ln Z_{ijt} + \mu_{ijt} \quad (4)$$

where X_{ijt} is the exports of country i (exporter) to country j (importer) at time t , Y_{it} is the GDP of the exporting country i , and Y_{jt} is the GDP of the importing country j . The distance between the importing and exporting country is represented as D_{ij} . Other country-specific and bilateral trade barriers are represented as Z_{ijt} . μ_{ijt} represents the error term. The variables are presented in their logarithmic form (except where otherwise stated) to bring them into a more comparable unit of measurement. The variables in the model, their definition and the data sources are presented in Table 1, together with brief summary statistics.¹

Three estimation techniques are applied to the gravity model. They include pooled OLS, generalized least-squares (GLS) regression (choosing either country-pair fixed effects or random effects, depending on the Hausman test), and PPML. The three estimation techniques were considered for robust and sensitivity checks on the estimations in this paper.

To choose between the fixed- or random-effects models, we apply the Hausman test. To be precise, the basic test of the Hausman analysis is whether the unique errors (ui) in the empirical model are correlated with the regressors. If they are not (i.e., when the p -value is more than 0.05), the null hypothesis cannot be rejected. This is the case in all our regressions, which is why we only report the results from the random-effects estimator and not the fixed-effects estimator. However, noting that the RE could be mis-specified in the gravity equations because trade flows between different pairs of countries within the ECOWAS region are quite heterogeneous, we rely on the PPML technique as proposed by Santos Silva and Tenreyro (2006, 2011) as the main technique for this study. The PPML is further substantiated because of the tendency of the log-linearized gravity models to be misleading in the presence of heteroscedasticity because of Jensen's inequality. Jensen's inequality can be expressed as

$$E(\ln Y) \neq \ln E(Y) \quad (5)$$

Given any variable, say (Y), the expected value of the log of a variable given as $E(\ln Y)$ is not equal to the log of the expected value of the same variable $\ln E(Y)$. By implication, Santos Silva and Tenreyro (2006, 2011) showed theoretically how the problem of heteroscedasticity might cause biased results when estimating log-linearized gravity models and interpreting the elasticities. They posited that results could be grossly misleading, and recommended the PPML estimator, although, according to them, a few authors in the empirical literature have addressed the problem with other methods. In addition to solving the problem of heteroscedasticity, the PPML estimator also addresses the problem that X_{ijt} sometimes takes the value of zero, in which case $\ln X_{ijt}$ is not defined. We include the distance cluster in two PPML specifications because our data consist of multiple levels of aggregation and pairing, and the errors are likely to be correlated by country pair in the gravity model, which may likely understate the standard errors. Therefore, we include the distance clustering because it can separately identify each country pair independent from the direction of trade.

3.2 Data Sources and Definition of Variables

The 15 members of ECOWAS are covered: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The period used for the econometric analysis ranges from 2006 to 2013.² This is primarily determined by data availability and to avoid the problem of having a highly unbalanced panel. Details on the respective variables, how they are measured, their sources and summary statistics (mean and standard deviation) are presented in Table 1.

3.3 Rationale for Including Trade Barriers in the Augmented Gravity Model

Five trade barriers are included to augment the gravity model. As noted in the introduction in Section 1, we highlight some constraints of interest with regards to bilateral trade in the ECOWAS region. Financial development, customs procedures and non-tariff barriers, infrastructure challenges and preferential access to markets outside ECOWAS are among the main

Table 1: Definition of variables, means and sources of data

Identifier	Definition	Measurement	Mean (standard deviation)	Source
<i>Trade_{ij}</i>	Exports of country <i>i</i> to country <i>j</i>	Total merchandise exports in constant 2005 US dollars	485.26 (397.61)	World Development Indicators-WDI (World Bank, 2017)
<i>Exporter_GDP</i>	Income (GDP) of exporting country	Real GDP in constant 2005 US dollars	15,912.50 (3,726.60)	WDI
<i>Importer_GDP</i>	Income (GDP) of importing country	Real GDP in constant 2005 US dollars	15,912.50 (3,726.67)	WDI
<i>Distance</i>	Distance between the exporting and importing country	Distance between the capital cities of the exporting and importing countries	1,313.00 (721.80)	Index by Mayer and Zignago (2011)
<i>Mrt</i>	Multilateral resistance term	Computed based on the Baier and Bergstrand (2009) framework. Lower values signify remoteness while higher values signify closeness to ECOWAS market. Lower values signify isolation from the ECOWAS market and vice versa.	0.95 (1.46)	Computed by the authors*
<i>Tc_{ij}</i>	Trade complementarity index	Index that measures complementarity of trade between two countries: 0 means no complementarity, 1 implies perfect complementarity.	0.15 (0.11)	Statistics from the UN Conference on Trade and Development
<i>Agr</i>	Economic integration agreement (EIA)	Captures trade agreement between countries: 0 = no existing EIA; 1 = one-way PTA; 2 = two-way PTA; 3 = free trade agreement; 4 = customs union; 5 = common market; 6 = economic union.	3.01 (1.74)	NSF-Kellogg Institute Database on Economic Integration Agreements
<i>Lock_imp</i>	If importer is landlocked	0 implies that the importer is not landlocked and 1 otherwise	0.16 (0.11)	Index by Mayer and Zignago (2011)
<i>Lock_exp</i>	If exporter is landlocked	0 implies that the exporter is not landlocked and 1 otherwise	0.22 (0.41)	Index by Mayer and Zignago (2011)

Continued

Table 1 (Continued)

Identifier	Definition	Measurement	Mean (standard deviation)	Source
<i>Infraq_Imp</i>	Infrastructure quality of importing country	Computed by interacting the quality of the trade- and transport-related infrastructure aspect of the Logistic Performance Index and port efficiency of the importing country. Higher values imply better infrastructural quality and vice versa.	9.46 (6.71)	WDI
<i>Infraq_Exp</i>	Infrastructure quality of exporting country	Computed by interacting the quality of the trade- and transport-related infrastructure aspect of the Logistic Performance Index and port efficiency of the exporting country. Higher values imply better infrastructural quality and vice versa.	9.47 (6.72)	WDI
<i>Cust_Exp</i>	Burden of customs procedures of exporting country	Measures the efficiency of customs procedures of the importing country. Variable is categorized as 1 = extremely inefficient to 7 = extremely efficient.	2.99 (1.93)	WDI
<i>Cust_imp</i>	Burden of customs procedures of importing country	Measures the efficiency of customs procedures of the importing country. Variable is categorized as 1 = extremely inefficient to 7 = extremely efficient.	3.03 (1.93)	WDI
<i>FD_Exp</i>	Financial development of exporting country	Credit to the private sector as a percentage of GDP	18.72 (12.65)	WDI
<i>FD_Imp</i>	Financial development of importing country	Credit to the private sector as a percentage of GDP	18.72 (12.65)	WDI

Notes: *We acknowledge the assistance of Julia Seiermann of the UNCTAD Virtual Institute on the multilateral resistance term computations.

Source: The Authors.

BOX 1: Visa Openness Index: ECOWAS

According to the Agenda 2063 of the African Union (AU), Africa will be a continent of flawless borders. Visa openness is about facilitating free movement of people. The visa openness index measures how open African countries are when it comes to visas by looking at what they ask of citizens from other countries in Africa when they travel. It ranges from 0 to 1 (highest). The Index aims to show at a glance which countries are facilitating travel for citizens of other countries and whether they allow people to travel to their country without a visa or if travellers can get a visa on arrival in the country or if visitors need to get a visa before travel.

Since 2015 notable progress has been made in Africa. In 2016, Africans do not need a visa to travel to 22 per cent of other African countries compared to 20 per cent in 2015. The top 20 most visa open countries are made of 35 per cent of Economic Community of West African States (ECOWAS) countries (namely: Ghana, Cape Verde, Togo, Guinea-Bissau, Senegal, Gambia and Burkina Faso) following 40 per cent of East African Community (EAC) countries. In 2016, Ghana has made the most progress in Africa in opening up its borders for other African travellers, moving into the 6th place in the Index (0.833) that is up 16 places from 2015. Senegal, on the other hand, offers free access to 42 countries from 16 countries in 2015. Senegal therefore, moved into the 15th place of the top 20 most open countries with an index of 0.778, up nine places from 2015. The Benin President has been inspired by Rwanda's experience of visas free on arrival to African countries and decided to remove visas on arrival for all African passport/national identity card holders to stay in the country for up to 90 days. The decision is part of the government's vision to build a proactive tourism industry.

In addition, reciprocal open visa policies (measuring 'no visa' policies) are highest in ECOWAS (100 per cent), EAC (100 per cent), Arab Maghreb Union-UMA (60 per cent) and Southern African Development Community-SADC (52 per cent). This matches findings from the Index, which show that ECOWAS (0.800), EAC (0.715) and SADC (0.530) are the highest performing RECs on free movement of people as measured by the ratification of protocols, no visa and visa-on-arrival policies.

Source: African Development Bank Group (2017). African Visa Openness Report 2017.

constraints to intra-regional trade. To empirically test these claims, we have plugged them into the standard gravity model by including them as our measures of trade barriers. We attempt to explain the reasons for their inclusion in the gravity model, as well as providing justification for other trade barriers that are included.

The five measures are the MRT, TC, the extent to which the exporting and importing countries are landlocked (referred to as 'landlockedness') (*lock*), infrastructure quality of the exporting and importing country (*Infraq*) and the burden of customs procedures of the exporting and importing country (*Cust*). The rationale for including the MRT is that, all things being equal, two ECOWAS countries that are surrounded by other large trading economies will trade less between themselves than if they were surrounded by oceans or by vast stretches of deserts and mountains. This is tied to the trade cost across all other possible export markets within the region apart from the trading partners. The MRT is low if a country is remote from the ECOWAS market and high if the country is closer to the ECOWAS market. Remoteness is captured by physical factors such as distance from large markets as well as by policy barriers such as tariff and trade cost (Hoekman and Nicita, 2011). It is, therefore, important to consider the effect of this variable in our gravity model. TC was included in order to consider the extent to which trading partners in ECOWAS countries complement each other in terms of their traded commodities.

Landlockedness captures the effect of physical barriers to trade. There are two intuitions as to the effect of this variable on bilateral trade. First, all things being equal, ECOWAS countries that are surrounded by other countries are likely to trade less because of higher trade costs of importing capital input that may be needed to enhance their efficiency of production (due to having to use road transport from neighbouring seaports to transport these inputs). Therefore, they may be disadvantaged in the production of goods and commodities to export to neighbouring ECOWAS countries (Osabuohien *et al.*, 2018). On the other hand, landlockedness may enhance bilateral trade because a member country that does not have a port may find it more difficult to ship goods to other countries. As a result, road transport becomes a viable way to export to other neighbour countries. In this case, trade with other ECOWAS countries would tend to increase with landlockedness. Infrastructure quality

Table 2: Regression results of the traditional gravity model

Variables	Ordinary least squares		Generalized least squares		Poisson pseudo-maximum likelihood	
	ln_trade	ln_trade	ln_trade	ln_trade	Trade	Trade
Exporter GDP (<i>ln_gdp_exp</i>)	0.681*** (0.0399)	0.673*** (0.0395)	0.681*** (0.0842)	0.653*** (0.0820)	0.156*** (0.0133)	0.153*** (0.0266)
Importer GDP (<i>ln_gdp_imp</i>)	0.350*** (0.0402)	0.346*** (0.0401)	0.353*** (0.0842)	0.326*** (0.0823)	0.0649*** (0.0135)	0.0638*** (0.0240)
Distance (<i>ln_distance</i>)	-0.816*** (0.0857)	-0.815*** (0.0857)	-0.826*** (0.181)	-0.821*** (0.182)	-0.211*** (0.0280)	-0.211*** (0.0552)
Constant	1.937** (0.762)	2.064*** (0.752)	1.978 (1.623)	2.452 (1.568)	5.751*** (0.251)	5.801*** (0.529)
R-squared	0.219	0.215	0.2184	0.2154	0.099	0.095
Time effect	Yes	No	Yes	No	Yes	No
Distance clustering	No	No	No	No	No	Yes
Observations	1,523	1,523	1,523	1,523	1,523	1,523
Hausman	–	–	0.380	0.380	–	–

Notes: The variables in the third and fourth column contain untransformed values. These variables are not in their logged form. The standard errors are in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Source: Authors' computations.

measures the quality of the available infrastructure in the trading country that is likely to enhance its trading capacity with neighbouring countries. This variable considers two main elements of hard trade infrastructure (i.e., road and port) and was included to capture the importance of the development of this infrastructure for intra-regional trade. Finally, the burden of customs procedures was included to capture soft infrastructure within the ECOWAS region that may hinder intra-regional trade (see also Box 1). Soft infrastructure refers to institutional structures and procedures that have the capacity to determine the efficiency of trading among ECOWAS member countries.

4. Findings from the Econometric Analysis³

4.1 Baseline Gravity Model

To identify the major trade barriers that affect intra-regional ECOWAS trade, we estimate the baseline regression model using OLS, GLS and the PPML. The results of the baseline estimations are presented in Table 2. The variables included in the estimations are those that appear in the traditional gravity model estimations, such as the income of both the exporter and importer and distance. The gravity model generally suggests that trade is directly proportional to the exporting and importing countries' economic 'mass' (GDP) and inversely proportional to the distance between them. In other words, larger country pairs are expected to trade more, and the further apart the countries, the less they are expected to trade, perhaps due to the higher transport cost that comes with distance. The magnitude of impact for a per cent increase in the size of the exporter country varies from 15 per cent to 68 per cent, while for the importer country it varies from 6 per cent to 35 per cent depending on the estimation model being considered. For the distance variable, a km difference in the distance between the exporting and importing country will result in a 2 per cent to 83 per cent decrease in bilateral trade. This is also dependent on the parameters of the regression — that is whether time effect was considered for the different estimation techniques and distance clustering.

From Table 2, the signs and significance of the three explanatory variables follow theoretical expectations. The incomes of both exporter and importer are a significant determinant of the extent of bilateral trade among ECOWAS countries. On the other hand, the distance between the countries hinders bilateral trade. This result provides support to the argument that the extent of bilateral trade among ECOWAS countries tends to improve with economic buoyancy, but tends to decrease with increasing distance. In essence, the farther the countries are from each other, the lower their bilateral trade. For the OLS, this effect is very large; however, when considering the PPML, the effect seems very marginal. It is important to state that the

Table 3: Regression results of the augmented gravity model

Variables	Ordinary least squares		Generalized least squares		Poisson pseudo-maximum likelihood			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln_trade	ln_trade	ln_trade	ln_trade	Trade	Trade	Trade	Trade
Exporter GDP (<i>ln_gdp_exp</i>)	0.705*** (0.0646)	0.772*** (0.0618)	0.827*** (0.120)	0.826*** (0.120)	0.170*** (0.0239)	0.172*** (0.0414)	0.186*** (0.0226)	0.184*** (0.0406)
Importer GDP (<i>ln_gdp_imp</i>)	0.401*** (0.0632)	0.437*** (0.0602)	0.539*** (0.119)	0.531*** (0.118)	0.0733*** (0.0214)	0.0771** (0.0374)	0.0841*** (0.0200)	0.0845** (0.0356)
Distance (<i>ln_distance</i>)	-0.703*** (0.0845)	-0.735*** (0.0844)	-0.740*** (0.175)	-0.746*** (0.176)	-0.192*** (0.0273)	-0.195*** (0.0520)	-0.197*** (0.0272)	-0.198*** (0.0527)
Multilateral resistance to trade (<i>mrt</i>)	-0.213*** (0.0701)	-0.246*** (0.0694)	-0.298** (0.138)	-0.293** (0.139)	-0.0438* (0.0229)	-0.0437 (0.0356)	-0.0530** (0.0224)	-0.0509 (0.0351)
Trade complementarity (<i>tcij</i>)	0.715 (0.594)	0.748 (0.592)	-0.152 (0.768)	-0.0177 (0.773)	0.582*** (0.198)	0.618** (0.273)	0.590*** (0.195)	0.616** (0.269)
Economic integration agreement (<i>agr</i>)	0.142*** (0.0361)	0.156*** (0.0362)	0.149** (0.0726)	0.151** (0.0731)	0.0219* (0.0126)	0.0232 (0.0252)	0.0243* (0.0125)	0.0245 (0.0250)
Importer is landlocked (<i>llock_imp</i>)	-0.546*** (0.148)	-0.617*** (0.148)	-0.587* (0.305)	-0.585* (0.306)	-0.126** (0.0524)	-0.127 (0.0937)	-0.142*** (0.0527)	-0.138 (0.0944)
Exporter is landlocked (<i>llock_exp</i>)	-0.183 (0.157)	-0.256 (0.157)	-0.277 (0.310)	-0.289 (0.311)	0.00945 (0.0549)	0.0171 (0.0760)	-0.00309 (0.0551)	0.0100 (0.0761)
Exporter's infrastructure quality (<i>infra_exp</i>)	0.0503*** (0.0104)	-	0.0153 (0.0111)	-	0.00849** (0.00409)	0.00497 (0.00455)	-	-
Importer's infrastructure quality (<i>infra_imp</i>)	0.0397*** (0.0103)	-	-0.00265 (0.0110)	-	0.00874** (0.00373)	0.00515 (0.00482)	-	-
Exporting country's burden of customs procedures (<i>cust_exp</i>)	-	0.126*** (0.0343)	-	0.0612 (0.0375)	-	-	0.0171 (0.0140)	0.00661 (0.0161)
Importing country's burden of customs procedures (<i>cust_imp</i>)	-	0.141*** (0.0336)	-	-0.00397 (0.0374)	-	-	0.0269** (0.0124)	0.0170 (0.0166)
Constant	0.0546 (1.033)	-0.588 (1.013)	-1.594 (2.077)	-1.605 (2.083)	5.278*** (0.354)	5.215*** (0.720)	5.098*** (0.342)	5.101*** (0.714)
R-squared	0.270	0.267	0.255	0.254	0.128	0.122	0.127	0.121
Time effect	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Distance clustering	No	No	No	No	No	Yes	No	Yes
Observations	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523
Hausman	-	-	0.632	0.668	-	-	-	-

Notes: The variables in the third and fourth column contain untransformed values. The variables are not in their logged form. The standard errors are in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Source: Authors' computations.

PPML is estimated with non-linearized variables (only for the trade variable) and it is likely that this must have explained the volume of the impact. Be that as it may, the behaviour of the variables is in line with traditional gravity model expectations.

Having ascertained the applicability of the traditional gravity model in the ECOWAS context, we augment the gravity model by including other likely trade barriers of interest to this analysis. They include landlockedness of the countries, TC between the paired countries, multilateral resistance to trade, the presence of economic integration between the paired countries and infrastructure provision. The financial development variable was also included as one of the variables because while arguments for financial development as an important trade barrier in ECOWAS are still in their infancy, it would be interesting to understand how financial development behaves in our gravity model.

Table 3 displays the regression result using both the OLS regression that controls for time effect, the random-effects model and the PPML regression approach. The collinear variables were included separately in the different regression columns in

Table 4: Regression result of the augmented gravity model (including financial development)

Variables	Ordinary least squares		Generalized least squares		Poisson pseudo-maximum likelihood			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln_trade	ln_trade	ln_trade	ln_trade	Trade	Trade	Trade	Trade
Exporter GDP (<i>ln_gdp_exp</i>)	0.694*** (0.065)	0.745*** (0.062)	0.815*** (0.117)	0.811*** (0.117)	0.168*** (0.024)	0.169*** (0.041)	0.179*** (0.023)	0.178*** (0.040)
Importer GDP (<i>ln_gdp_imp</i>)	0.377*** (0.064)	0.409*** (0.061)	0.517*** (0.116)	0.513*** (0.115)	0.066*** (0.021)	0.069* (0.036)	0.074*** (0.020)	0.074** (0.034)
Distance (<i>ln_distance</i>)	-0.681*** (0.089)	-0.681*** (0.089)	-0.708*** (0.175)	-0.708*** (0.176)	-0.170*** (0.028)	-0.170*** (0.054)	-0.171*** (0.028)	-0.171*** (0.053)
Multilateral resistance to trade (<i>mrt</i>)	-0.183** (0.071)	-0.209*** (0.070)	-0.278** (0.134)	-0.273** (0.135)	-0.0348 (0.023)	-0.0355 (0.034)	-0.0411* (0.022)	-0.0406 (0.034)
Trade complementarity (<i>tcij</i>)	1.064* (0.643)	1.227* (0.639)	0.0443 (0.788)	0.195 (0.792)	0.748*** (0.214)	0.777*** (0.274)	0.766*** (0.211)	0.786*** (0.270)
Economic integration agreement (<i>agr</i>)	0.151*** (0.037)	0.164*** (0.037)	0.152** (0.071)	0.155** (0.072)	0.028** (0.013)	0.029 (0.029)	0.031** (0.013)	0.031 (0.026)
Importer is landlocked (<i>llock_imp</i>)	-0.549*** (0.151)	-0.635*** (0.151)	-0.568* (0.297)	-0.570* (0.299)	-0.152*** (0.053)	-0.155* (0.094)	-0.171*** (0.053)	-0.170* (0.095)
Exporter is landlocked (<i>llock_exp</i>)	-0.190 (0.159)	-0.271* (0.160)	-0.289 (0.302)	-0.311 (0.304)	-0.001 (0.055)	0.002 (0.077)	-0.016 (0.055)	-0.008 (0.078)
Exporter's infrastructure quality (<i>infra_exp</i>)	0.048*** (0.011)	- -	0.015 (0.012)	- -	0.008** (0.004)	0.006 (0.005)	- -	- -
Importer's infrastructure quality (<i>infra_imp</i>)	0.042*** (0.011)	- -	0.000 (0.011)	- -	0.009** (0.004)	0.007 (0.005)	- -	- -
Financial development exporter (<i>FD_Exp</i>)	-0.011** (0.005)	-0.015*** (0.005)	-0.010 (0.007)	-0.012* (0.007)	-0.005** (0.002)	-0.005 (0.003)	-0.006** (0.002)	-0.006 (0.004)
Financial development Importer (<i>FD_Imp</i>)	0.002 (0.005)	-0.003 (0.005)	0.005 (0.007)	0.005 (0.007)	-0.003 (0.002)	-0.004 (0.003)	-0.004** (0.002)	-0.004 (0.003)
Exporting country's burden of customs procedures (<i>cust_exp</i>)	- -	0.145*** (0.0352)	- -	0.0701* (0.0387)	- -	- -	0.0242* (0.0144)	0.0159 (0.0173)
Importing country's burden of customs procedures (<i>cust_imp</i>)	- -	0.151*** (0.0348)	- -	0.00260 (0.0389)	- -	- -	0.0339*** (0.0128)	0.0261 (0.0171)
Constant	0.203 (1.054)	-0.417 (1.031)	-1.527 (2.025)	-1.565 (2.031)	5.258*** (0.357)	5.227*** (0.721)	5.125*** (0.343)	5.133*** (0.707)
R-squared	0.276	0.276	0.261	0.261	0.134	0.129	0.134	0.129
Time effect	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Distance clustering	No	No	No	No	No	Yes	No	Yes
Observations	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475
Hausman	-	-	0.255	0.245	-	-	-	-

Notes: The variables in the third and fourth column contain untransformed values. The variables are not in their logged form. The standard errors are in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Source: Authors' computations.

order to retain them since they are important measures in the intra-regional trade restriction analysis. Focusing on the overall effect of the combinations of the variables on the main explained variable, we consider the *R*-squared across the columns. The value of the *R*-squared reveals that, on average, between 12 per cent and 27 per cent of bilateral trade flows in the region are explained by the combinations of our explanatory variables.

In Table 3, the GDP of the exporter and importer country show consistent behaviour, in the sense that the coefficient is consistently positive and significant. For the entire column, where the time effect was considered and where it was not considered, the sign and significant values of the income of the exporter and importer follow the intuition of the gravity model — that is, larger countries tend to trade with themselves. The magnitude of the effect varies from 17 per cent to 83 per cent for the exporter country and from 7 per cent to 54 per cent for the importer country. These variances are also influenced by the estimation technique and the parameters imposed on the regression analysis. This result suggests that with economic buoyancy, ECOWAS countries tend to export and import more with each other. From Table 3, it is clear that controlling for the time dimension does not affect the behaviour of the baseline gravity model (in terms of signs and significant values), even when other intervening/control variables are included in the model. Therefore, we can say that the intuition of the gravity model is applicable among ECOWAS member countries — as in Table 2. Even for the variable ‘distance’, the model maintains consistent negative and significant values all through the columns of Table 3. This is also consistent with what is shown in Table 2.

The main intuition from our results is that in the case of trade among ECOWAS countries, on average, consumers in member countries tend to consume more imports from other member countries as their income increases. Our results contradict the findings of Ackah *et al.* (2012) who observed a negative relationship between intra-regional trade and the income of ECOWAS countries. They infer that with increased income, domestic consumers in member countries tend to prefer substitutes from abroad. One possible departure of our findings from those of Ackah *et al.* (2012) is the robustness of our control variables. For instance, in our augmented gravity model, we included controls like economic integration agreements, TC and multilateral resistance to trade, none of which were included in Ackah *et al.* (2012).

4.2 Other Bilateral Trade Facilitators and Barriers

Moving on to the other trade barriers in Table 3, we pay attention to those that are significant and then discuss the implications of their signs. Also, attention is given to only the PPML estimates in this section for the brevity of discussion and as earlier stated, the PPML is efficient in handling the problem of heteroscedasticity than the other estimation techniques (Santos Silva and Tenreiro, 2006, 2011).

An important trade facilitator for the ECOWAS region is the extent of TC. Table 3 shows that the TC variable is positive in all the columns of the PPML estimates. The importance (in terms of significance) of this variable is also seen in all the columns (5–8), which suggest that this variable impacts on bilateral trade within the range of 59 per cent to 62 per cent, depending on the parameters being imposed on the PPML estimation. Compared to the MRT that had a negative influence on bilateral trade, the TC variable has a higher significance and suggests that ECOWAS countries trade more if they can complement each other in terms of export commodities. This implies that each country supplies what the other needs and needs what the other supplies. This is why crude oil remains one of the most traded commodities in the region since most countries need this commodity from Nigeria and Côte d’Ivoire and are not able to produce it themselves. As stated earlier, there is a need for diversification of the economy from primary production, which would encourage the growth of intra-regional trade because TC would tend to improve.

The other important trade facilitators for the ECOWAS member countries are economic integration agreements and importer’s burden of customs procedure. Table 3 shows that an intensification of economic integration within the region will result in an increase in the volume of bilateral trade among the ECOWAS countries. However, the level of significance was not consistent in all the columns of the PPML estimate. The positive effect suggests that since the two agreements in the region are the WAEMU and WAMZ, WAEMU members may be trading more with each other than with WAMZ members and vice versa. This fact was earlier highlighted in Ackah *et al.* (2012), who noted that common language is an important determinant of bilateral trade among the ECOWAS member countries. Thus, the WAEMU countries will prefer to trade among themselves because they speak the same language, with the same holding true for WAMZ countries. This has been highlighted as a major stumbling block to the achievement of the ECOWAS regional integration goal: both the francophone member countries and the Anglophone member countries have more affinity with themselves.

The behaviour of the customs procedure variable, though not consistent, suggests that an improvement in the efficiency of customs procedures (especially for the importing country) will lead to higher trade among member countries. The quality of the customs procedures follows the findings of Ackah *et al.* (2012) who submit that customs procedures are the most important

trade barrier in economic integration within the region. As usual, the geographical barrier of the importer was found to exert more of an adverse effect on bilateral trade. In some of the PPML columns, the variable is negative and significant, suggesting that an importer member country that is geographically disadvantaged will incur a higher negative impact on bilateral trade of about 14 per cent. This is probably due to the high cost of transporting products from the trade-originating country. In such situation, the good becomes more expensive when it reaches the importing market, the cost of transporting it (coupled with the poor road infrastructure) will make it unprofitable to demand goods originating within the region. For the exporting country, the landlocked barrier is not significant in all the columns of the PPML. The implication of this, therefore, is that the relative importance of the landlocked barrier to bilateral trade in the region is low because it is not significant in the columns where it is featured. ECOWAS countries may not pay so much attention to this variable because the level of significance suggests that transport constraints may not be a huge hindrance to bilateral trade when it is the exporter that is affected and that other policy issues like infrastructure, customs procedures, economic integration agreement, and TC are most important.

The financial development variables of both the exporter and importer are considered in Table 4. The signs and significant values of the two variables signify that though there is potential for the two variables to affect bilateral trade from a theoretical point of view, the financial development of the exporter was found to be a higher explainer of the volume of bilateral trade within ECOWAS. The negative sign suggests that an improvement in an exporter's financial development will bring about a decrease in the volume of bilateral trade by a magnitude of about 0.06 per cent. For the importing country's financial development, we find it to have a 0.04 per cent negative influence on bilateral trade. These findings are counter-intuitive and are not consistent with our expectations. However, it is possible that an improvement in the volume of credit to the private sector will increase the efficiency of producers, and as a result of this, instead of seeking to export their products to neighbouring countries, they begin to seek markets outside the region. There are possible intuitions to explain this. First, if the demand for intra-regional produce is low, then it is possible that producers will expand their supply beyond the region since there are accessible economic resources that are available to them to achieve this. Second, with the increase in capital supply from the financial sector, producers will become bigger and will begin to seek other markets beyond the region.

It is important to state that we are not discouraging the improvement of the financial sector in support of the private sector. However, as private companies in the member countries become larger, they may begin to try to penetrate other markets outside the region. At this point, the remedy would be for ECOWAS countries to emphasize diversification so that their trade output would be more dissimilar. This would of course depend on the member countries' wanting to enhance bilateral trade among one another. There is, however, an important caveat: the measure of financial development used in this analysis is not specific to trade. It is possible that what is lacking to bolster intra-regional trade is not a credit to the private sector but trade finance more specifically. It will be important for future studies to take this up to complement the findings in the current study.

5. Conclusion

Economic cooperation among countries within a given region takes place in the context of RTAs or regional integration. The forms that such arrangements can take (e.g. preferential trade areas, free trade areas, customs unions, common markets, economic unions or political unions) at a given point in time depend on a number of factors. These include the level of economic development, the resilience of the financial sector (given the relevance of the financial system in intermediating economic transactions), the institutional framework and productive capacity. In view of the above, this study has provided an understanding of regional economic integration using empirical illustrations related to ECOWAS.

The reasons for low intra-regional trade in ECOWAS are numerous. One of them is the fact that ECOWAS member states have trade baskets (especially export baskets) that are similar, which limits their TC. A related factor is the high concentration of trade in few sectors (particularly agriculture and mining) as well as the low value added of traded goods. The cause and simultaneous effect of this situation is the low level of industrialization in almost all ECOWAS countries, which also reduces their trade diversification capabilities. Another issue worth restating is the trade barriers that characterize border trading among ECOWAS member countries and restrict the free movements of goods and people within the region. The low quality and quantity of trade-related infrastructure have also been highlighted in this study as an impediment to intra-regional trade within ECOWAS.

Notes

1. We are mindful of the relevance of the informal trade within the region; however, this is outside the scope of this paper. Thus, this can be considered in further studies.
2. Further studies can extend the period when data become more available, which will also provide comparison with the results in this study.
3. The estimation started with correlation analysis. The results (not reported here for space reasons) indicate that there was no problem of multicollinearity.

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