Chapter Two

Trade integration in the Economic Community of West African States: Assessing Constraints and Opportunities Using an Augmented Gravity Model

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The proliferation of Regional Economic Communities (REC) in Africa underlines the importance of regional integration, which has become an essential priority for this region. Regional integration is seen as an important tool for the continent's development, since one third of its economies are landlocked and depend on their coastal neighbours for trade. In addition, domestic African markets are small, fragmented and below the critical size needed for companies to grow and achieve significant economies of scale.

Accounting for nearly 17% and 30% of Africa's surface area and population respectively, the Economic Community of West African States (ECOWAS) is one of the most densely populated areas on the continent. Despite its great potential in terms of human and natural resources, the ECOWAS still faces obstacles to achieve effective regional integration. Indeed, the performance of its intraregional trade remains very modest compared to other economic blocs of the world. Intra-regional trade is limited, in fact, to around 10% while, it exceeds 20% in the East African Community for instance and 25% in the Association of Southeast Asian Nations (ASEAN) in 2016. Therefore, it becomes crucial to investigate the existence of a potential for intra-regional trade in the ECOWAS as well as the constraints for its realization.

It is recognized that the potential of regional integration in Africa has been largely untapped (UNCTAD (2013) and ADB (2017)). Studies such as Geda & Seid (2015) and Ebaidalla & Yahia (2015) have shown how significant is this potential between African countries. Using a standard gravity model, they projected the intra-flow of trade and revealed the huge potential for trade expansion. The majority of African countries seems to operate well below the potential and are not reaping the benefits of the trade liberalization. These studies concluded, however, over the necessity to upgrade the quality of infrastructure and diversify their productive fabric to further economic integration. However, the structural poor performance

of trade integration casts doubts over the fitness of standard empirical models and the deployed approach to estimate the trade potential. This calls for an innovative approach and methodology to tackle this issue. Thus, it is imperative to revive this old issue capitalizing on a new approach to assess whether Africa, in the case of ECOWAS, is likely to witness an improvement in its integration dynamic in the medium term.

This chapter contributes to the literature in three main ways. First, it estimates a gravity model to explain trade flows inside a REC with a Free Trade Area (FTA) to address the heterogeneity of trade policies adopted towards economic partners outside the REC. Second, it simulates trade potential inside the ECOWAS region, using coefficients estimated over a well-integrated region, such as ASEAN. If, otherwise, we perform the estimation over the ECOWAS region (with their economic partners in this case) and then simulate the potential, the simulation is likely to project the same dynamics and end up with trade potential around the observed data. Third, it deploys an augmented version of the gravity model that controls for the quality of infrastructure and the bilateral complementarity between economic partners and then compares simulations to those of a basic form of the gravity model.

Following this spirit, the chapter is organized as follows: a first section is dedicated to a brief overview of the trade structure of the ECOWAS countries and analyses some relevant trade indicators. A second section attempt to overview the literature on this issue. The third section describes the model and the data while the fourth section discusses the result estimation and the simulations output for the ECOWAS. By offering policy recommendations, section five concludes.

Economic Overview of the ECOWAS

The ECOWAS is a regional grouping of 15 West African states founded in 1975. It is a free trade area whose main objective is to foster regional cooperation and integration in all economic fields, with the intent of creating an economic union. Within the ECOWAS, eight member countries[1] form the West African Economic and Monetary Union (WAEMU), which became operational in 2000. The WAEMU is a custom union that uses the CFA franc as a common currency. The ECOWAS has witnessed a sustained economic growth—despite a drop in 2010 amid the economic and financial

1. Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo.

Figure 1. GDP growth (percentage) of ECOWAS and Sub-Saharan Africa during the period 2005-2018

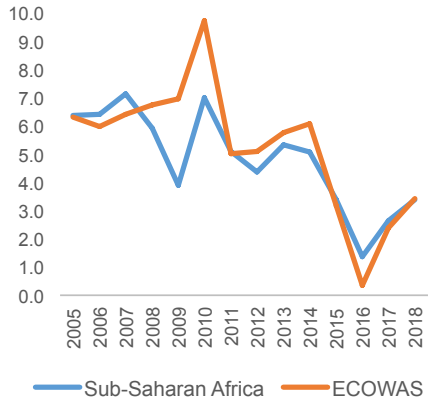
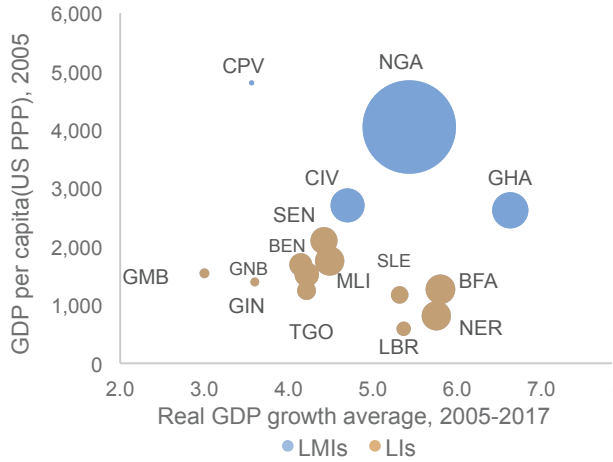


Figure 2. GDP growth average (2005-2017) and GDP per capita (2005) of ECOWAS countries[a,b,c]



Source: International Monetary Fund.
a. Bubble size represents population
b."Low-income economies (LIs) are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of $1,005 or less in 2016; lower middle-income economies (LICs) are those with a GNI per capita between $1,006 and $3,955". Source: World Bank.
c. Benin (BEN), Burkina Faso (BFA), Cape Verde (CPV), Côte d'Ivoire (CIV), Gambia (GMB), Ghana (GHA), Guinea (GIN), Guinea-Bissau (GNB), Liberia (LBR), Mali (MLI), Niger (NER), Nigeria (NGA), Senegal (SEN), Sierra Leone (SLE), and Togo (TGO).

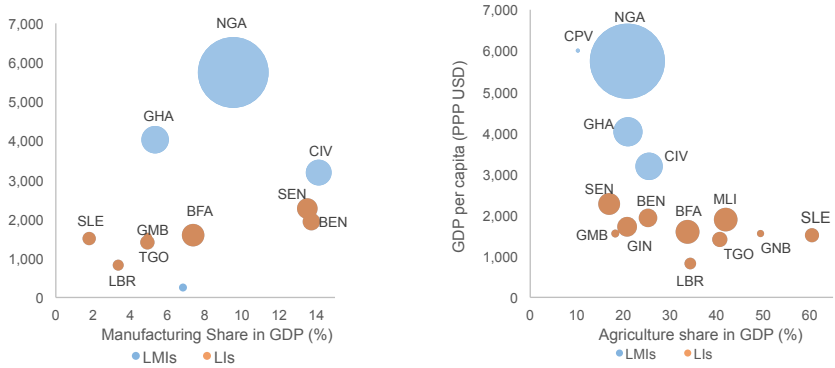
crisis—with rates ranging from 5 percent to 10 percent. In 2014, however, a sharp slowdown has been observed due to the decline in commodity prices in general and oil prices specifically, when GDP growth decreased from 6 percent in 2014 to 0.4 percent in 2016, given the negative performance of the biggest economy of the region Nigeria. In fact, Nigeria remains the largest contributor of wealth creation in the ECOWAS and the largest in terms of population. According to the latest estimations[2], GDP growth is likely to pick up in 2017 and 2018.

With the exceptions of Cape Verde, Nigeria, Ghana, and Côte d'Ivoire, all ECOWAS members are classified as Least Developed Countries.[5] Hence, their growth performances vary quite sharply, reflecting their diversity. Between 2005 and 2017, average growth rates of real GDP ranged from 3 percent in Gambia to 6.6 percent in Ghana. When taking into consideration population growth, real GDP per capita goes from -0.3 percent in Gambia to 4 percent in Ghana. Despite a slowdown in real GDP growth the latest years, Nigeria still accounts for 70 percent of this bloc's GDP with $395 billion for 2017, nearly ten times the GDP of the region's second largest economy, Ghana, which accounted for only 8 percent with $45 billion for the same year. Nigeria has also the second highest GDP per capita estimated at $5,402 behind that of Cape Verde estimated at $6,327 in 2017. In terms of economic structure, only a few member countries have developed relatively bigger manufacturing industries such as Benin, Côte d'Ivoire and Senegal whose share of manufacturing in their GDP vary between 13 percent and 14 percent in 2015, while most others, notably Sierra Leone, Gambia and Mali depend primarily on agriculture as shown in figure 3.

Efforts to reduce trade barriers within the ECOWAS have not yielded effective results since intra-trade remains low. The share of exports from ECOWAS countries sold within the bloc has stayed relatively steady 1995 to 2016, around 10 percent. As it can be seen in Figure 4, Nigeria and Côte d'Ivoire, given their size, dominate trade within the ECOWAS by supplying the highest volume of merchandises. Their share in total intra-regional exports to the ECOWAS is estimated at 35.6 percent and 28.9 on average between 2005 and 2016 respectively. Yet, Nigeria's exports to ECOWAS represents only a small percentage—around 4 percent—of its total exports to the world, while this share reaches 24 percent for Côte d'Ivoire. This means that Nigeria relies less on ECOWAS partners in terms of its trade relations. During the same period, Senegal, (which is the next most import-

2. IMF. 2017. Fiscal Adjustment and Economic Diversification. Sub-Saharan Africa Regional Economic Outlook.

Figure 3. Size and Economic structure of ECOWAS Members in 2015[a,b]



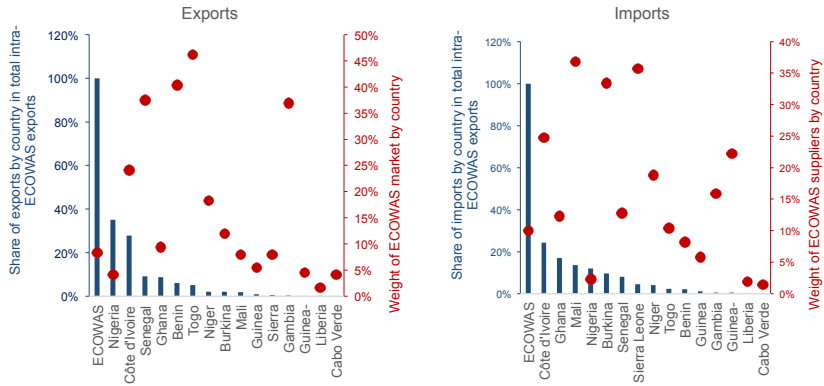
Source: World Development Indicators, *World Economic Outlook*.
a. Bubble size represents population.
b. Data regarding the share of manufacturing in GDP is not available for Cabo Verde, Guinea, Guinea Bissau, Mali and Niger.

ant exporter to the region) Togo and Gambia account for 9.3 percent, 5.4 percent and 0.1 percent of the total exports to ECOWAS partners respectively, yet they rely heavily on ECOWAS. Indeed, their exports account for 37 percent, 47 percent and 26 percent of their total exports to the world respectively.

The same observation can be drawn for imports. Between 2005 and 2016, Côte d'Ivoire, Ghana and to a lesser extent Mali and Nigeria imported high volume of merchandises from the ECOWAS, ranging from $984 million to $2.0 billion. Nevertheless, imports' share of Ghana and Nigeria from ECOWAS make up a relatively low percentage. This point stands out the most for Nigeria in particular; whose import from ECOWAS partners represents only 2 percent of its total imports from the world. Unlike Nigeria, other countries, namely Burkina Faso, Sierra Leone, Niger, Gambia and Guinea Bissau, are heavily supplied by the ECOWAS. Therefore, even though intra-regional trade in ECOWAS remains low, particularly for large economies, compared to other developing economic blocs of the world, few countries rely on it for a large portion of their trade.

The range of products traded within the ECOWAS has not been submitted to significant changes. As shown in Table 1, during the period 2005-

Figure 4. Intra ECOWAS export and imports, average 2005-2016, by country.



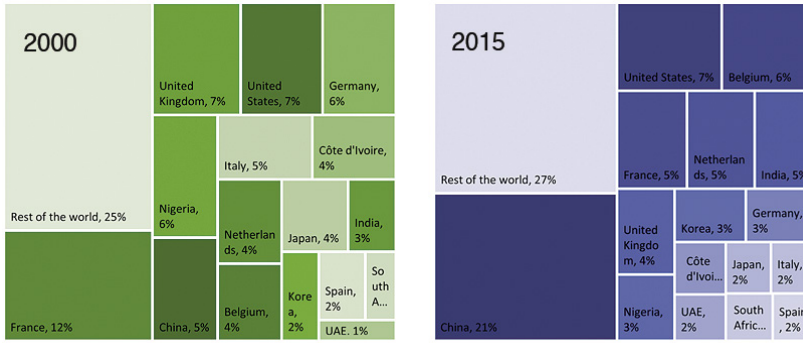
Source: UNCTAD

Table 1. Top 10 products traded by the ECOWAS (in value, average 2005-2016)

Top 10 intra-regional Trade in the ECOWAS		Top 10 ECOWAS EXPORTS to the World		Top 10 ECOWAS IMPORTS from the World	
Fuels	54%	Fuels	72%	Machinery and Electrics	20%
Chemicals	7%	Food Products	7%	Fuels	15%
Food Products	7%	Stone And Glass	6%	Transportation	13%
Vegetable	5%	Plastic OR Rubber	3%	Vegetable	9%
Transportation	4%	Vegetable	3%	Chemicals	8%
Minerals	4%	Transportation	2%	Metals	8%
Plastic OR Rubber	4%	Minerals	1%	Food Products	6%
Animal	3%	Textiles and Clothing	1%	Plastic OR Rubber	6%
Metals	3%	Chemicals	1%	Animal	4%
Wood	3%	Wood	1%	Textiles and Clothing	2%

Source: World Integrated Trade Solution (WITS).

Figure 5. Evolution of ECOWAS imports structure by country



Source: UNCTAD.

2016, trade concerns mainly fuel products (oil), which accounted for 54 percent of intra-regional trade in the ECOWAS, followed by chemicals and food products. It is important to note however, that official intra-regional trade volumes data are underestimated since it does not include informal trade, which accounts for a large share of trade between ECOWAS countries.[3] In addition, misreporting and inconsistencies in data results in the difference between volumes in monetary units of intra-regional export and intra-regional import. Regarding trade with the world, exports of the ECOWAS are concentrated in fuels, followed by food products, stone, and glass, whereas imports of the ECOWAS concern machinery and electrics, followed by fuel and transportation.

When it comes to imports structure by economic partner, the figures above indicate how the Chinese economy is positioning itself as a major supplier of ECOWAS's market, as it captures around 21 percent of total imports. It is worth mentioning that in 2000, Chinese products was representing only 5 percent of total imported goods, below United Kingdom and France with respectively 7 percent and 12 percent. The Indian economy is being considered as a major economic partner of the ECOWAS, with a positive dynamic since 2000, suppling around 5 percent of total imported goods in 2015 after 3 percent in 2000. The favourable dynamics of Asian economies, especially China and India, was achieved to the detriment of European economies that have witnessed a shrink in their market share in

3. European Centre for Development Policy Management, "Overview of trade barriers to trade in West Africa: Insights in political economy dynamics, with particular focus on agricultural and food trade". DP No. 195, July 2016.

the last two decades. France and United Kingdom and Germany have been in 2000 at the top of economic partners of the ECOWAS, while in 2015 they have been overtaken by China and United States. For instance, the prominence of France, given historical and cultural links especially with francophone countries, made it one of the most important partners in the beginning of the 21th century. This relationship has lost momentum during this century, with France being in fourth position. In the European Union, Belgium could be considered as an exception, with a stronger market presence. Its share has, thus, increased from 4 to 6 percent. For the United States of America, it has been able to maintain its share in the ECOWAS market, at around 7 percent.

Trade complementarity index

Another way to evaluate intra-regional trade within the ECOWAS is to look at the trade complementarity index, which measures the potential trade between two partners. It illustrates to what extent the export profile of ECOWAS members corresponds the import profile of other ECOWAS members. It is constructed as follows:

$$TC_{j,k} = 100 * \left(1 - \frac{\sum |X_{i,j} - M_{i,k}}{2}\right)$$

Where $X_{i,}$ is the share of good i in global exports of country j and $M_{i,}$ is the share of good i in all imports of country k. Values close to 100 indicate a great match between country j's export structure and country k's import structure and values close to 0 indicate a low correspondence in their export and import pattern. Countries with a high index suggest a gain from trade expansion.

Results for ECOWAS are shown in Table 2. Trade complementarity index varies considerably across countries of ECOWAS and does not exceed 50 percent. Senegal, as an exporter, displays relatively high levels of bilateral complementarity with almost all ECOWAS members except with Côte d'Ivoire and Liberia. Interestingly enough, Côte d'Ivoire as an exporter has a relatively high bilateral complementarity index with Senegal. This indicates that the exports structure of Côte d'Ivoire match with the imports structure of Senegal, whereas the exports structure of Senegal does not match with the imports structure of Côte d'Ivoire. Benin has also a high complementarity index with a number of ECOWAS countries, namely Burkina Faso, Cabo Verde, Guinea-Bissau and Senegal, and Togo with Burkina Faso, Ghana, Guinea-Bissau and Mali. The lowest level of

Table 2. Trade complementarities index in ECOWAS, 2013*

	BEN	BFA	CPV	CIV	GMB	GHA	GIN	GNB	LBR	MLI	NER	NGA	SEN	SLE	TGO
BEN	_	31	30	17	21	23	30	31	11	27	21	23	35	29	25
BFA	16	_	16	10	14	15	17	16	9	17	13	17	19	16	16
CPV	10	9	_	12	8	12	10	9	4	9	9	11	9	7	10
CIV	29	30	29	_	22	25	29	32	13	30	20	26	41	27	29
GMB	15	11	14	11	_	13	12	12	5	11	12	12	13	12	11
GHA	10	11	12	30	11	_	10	11	8	11	12	11	22	10	9
GIN	4	5	6	26	3	5	_	4	2	4	4	6	15	4	3
GNB	2	1	2	4	1	1	1	_	1	1	1	2	4	2	1
LBR	5	7	7	10	5	6	6	5	_	6	6	8	8	6	5
MLI	10	12	10	10	9	11	10	9	7	_	10	11	11	9	9
NER	20	30	32	8	14	14	28	23	8	22	_	17	23	42	41
NGA	9	9	10	25	8	9	8	10	7	8	6	_	21	9	8
SEN	34	43	43	28	33	33	43	44	13	43	33	35	_	35	34
SLE	5	4	5	5	4	5	4	3	4	4	4	6	4	_	4
TGO	26	30	27	22	29	32	26	32	14	31	27	28	28	24	_

*Latest year available.

Source: UNCTAD

bilateral complementarity is recorded between Guinea-Bissau and several ECOWAS countries, namely Burkina Faso, Gambia, Ghana, Guinea, Liberia, Mali, Niger and Togo.

Empirical Literature

Intra-regional trade in Africa has been the focus of many empirical and theoretical studies since the creation of regional economic communities in the continent, the proliferation of free trade zones and custom unions. Scholars have indeed argued that intra-regional trade holds a great potential for raising the level of welfare of Africans by promoting regional economic development and improving the living standards of their population (Longo and Sekkat, 2001; Geda and Kibret, 2008).

However, the unsatisfactory performance of Africa in boosting intra-regional trade has led to a growing interest for studies that assesses not only the trade patterns, but most importantly the potential of intra-regional trade in several African Regional Economic Communities using gravity models. The latter are commonly used as an ex post analytical framework in empirical studies of bilateral trade flows. They can also be used to address the issue of regionalism by simulating trade potentials between any groupings of countries.

Tinbergen (1962) analysed the determinants of bilateral trade patterns and the effect of regional trading arrangements (RTAs). He applied a gravity model on 42 countries. His findings demonstrate the positive impact of the Gross Domestic Product (GDP) of both the exporting and importing country on trade flows on the one hand and the negative impact of distance on trade on the other hand. Following on Tinbergen (1962), Eichengreen and Irwin (1995) introduced historical variables to a dynamic gravity model to analyse whether countries with a history of trading continue to trade with each other. They found that the exclusion of historical factors exaggerates the impact of trading blocs. Further studies have expanded the gravity model and used variables like contiguity, common colonizer, common language, tariffs, exchange rates etc. (Hacker and Einarsson, 2003; Cardamone, 2006; Adekunle and Gitau, 2011).

With particular emphasis to the Sub-Saharan Africa (SSA), Foroutan and Pritchett (1993) applied the traditional gravity model for 19 SSA countries based on proximity, economy size and other characteristics. They used the Tobit maximum likelihood estimation method to correct censoring bias produced by the Ordinary Least Square (OLS) method. They compared actual trade data with the prediction of the model. Despite the low intra-African trade, Foroutan and Pritchett (1993) found that the reported intra-trade is higher than the potential predicted by the model. The actual share of SSA's trade was an average of 8.1 percent whereas the gravity model estimated a slightly lower mean of 7.5 percent.

Cassim (2001) conducted an empirical study on the determinants of intra-regional trade in Southern African countries employing the gravity model with a Tobit maximum likelihood estimation method. He found that intra-regional trade in the South African Development Community (SADC)[4] is actually in line with international standards, meaning that this region's trade is beyond its potential. He confirmed that fundamental economic factors like economic and geographic size of the trading partners measured by GDP and land areas have significant impact on trade flows, while transport costs adversely affect the bilateral trade. However, this result is biased by the high volumes of exports from South Africa to the rest of the members. In fact, the model uses by Cassim (2001) shows that intra-SADC trade excluding South Africa is low, indicating the existence of a potential for increased exports.

4. SADC includes Angola, Botswana, Dem. Rep. Of the Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, United Republic of Tanzania, Zambia, Zimbabwe.

Alemayehu and Haile (2008) replicated the gravity model using a Tobit formulation to test the determinants of bilateral trade flows and assess the outlooks and challenges of regional integration in the Common Market for Eastern and Southern Africa (COMESA).[5] The findings demonstrate that the standard gravity model variables such as the GDP of both the exporting and partner countries, bilateral distance and contiguity have the expected signs except for the common language variable. This strengthen the hypothesis that trade between similar countries tend to be higher. However, the coefficient of regional integration dummy was negative and non-significant, meaning that regional trading blocs in Africa fail to promote intra-regional trade.

Alemayehu and Edris (2015) re-examined the potential for intra-Africa trade with the objective of advancing regional economic integration by trade. They used a variety of gravity models to two groups of countries- a group characterized by an advanced level of integration (West and Central Africa) and a group that comprises the rest of the continent (North, East and Southern Africa). They estimated the model using the Pseudo Poisson Maximum Likelihood (PPML) technique. A simulation exercise was conducted afterwards to analyse the potential of intra-Africa trade for each group of countries, given the parameters of the model. This was then compared with actual trade of each country. The results showed the existence of significant potential for intra-Africa trade, which is however dampened by lack of complementarities of exports and imports, weak infrastructure as well as the relative competitive position of African potential export suppliers.

Regarding the ECOWAS specifically, Luqman et al. (2015) analyse bilateral trade patterns and the openness level of ECOWAS through a gravity model using three techniques: the PPML, the fully modified ordinary least squares (FMOLS) and canonical cointegrating regression (CCR), for the period 1981-2003. Trade openness was negatively significant under PPML, whereas financial openness was negatively significant under FMOLS and CCR. Contiguity (common border) and distance had a strong effect on ECOWAS trade, while there is a negative effect of trade flow among ECOWAS members.

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5. The COMESA includes Burundi, Comoros, Dem. Rep. Of the Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia, Zimbabwe.

Recent studies introduce infrastructure variables to the gravity models in order to capture their impact on bilateral trade in Africa, especially given the fact that the continent faces an important deficit in terms of infrastructure provision, which in turn act as a barrier to the entire process of regional integration. Deen-Swarray et al. (2011) investigate the effect of infrastructure development on intra-regional flows of member countries of the ECOWAS employing a modified gravity model and using both a time series and a cross-sectional analysis for the period 1990-2008. They developed an index for different kind of infrastructure (road, rail, airport etc.) to analyze how they individually influence trade. Deen Swarray et al. (2011) used three estimation methods, namely a pooled model, a fixed effect model and random effects model. The found that GDP, language, common currency and distance variables have a significant and the expected effect on total trade in ECOWAS, whereas infrastructure index variable have a puzzling negative impact on total trade.

Akpan (2014) examines the effect of improving the quality of a regional road infrastructure within ECOWAS if it was at the level of roads in South Africa. He uses a traditional gravity model that includes variables for contiguity, common language and road quality as well as the positive difference in per capita GDP between exporting and partner countries. Akpan (2014) used a Tobit estimation and found that improvement in road infrastructure lead to an increase in intra-regional trade relative to the 2012 level of 5.3 percent.

With regards to another economic grouping, Zarzoro and Lehmann (2003) used the gravity model with fixed effects to evaluate the trade potential between Southern Common Market (MERCOSUL) members and the European Union (EU) following the agreements established between the two blocs. The model includes 20 countries (4 members of MERCOSUL in addition to Chile and 15 members of the EU). The authors fund that variables such as infrastructure, income differences and exchange rates have important determinants of bilateral trade flows.

Methodology: specification and the estimation technique

The gravity model has been derived initially from Newton's Law of Universal Gravitation. Tinbergen (1962) introduced this physical law in the area of international trade. According to the model, the intensity of bilateral trade between two economies, like the gravitational force between two objects, depends positively on their respective 'masses' (in econom-

ics, nominal GDP is often used as a proxy) and inversely on the distance separating them. The distance per se is not the key element, but in fact it captures the cost of transportation or cost of trade in general. Therefore, the distribution of goods or factors across space is determined by gravity forces conditional on the size of economic activities at each location. The equation translates a supply (GDP of the exporting country) and demand (GDP of the importing country) mechanism. The gravity equation can be expressed in its non-linear form as:

$$Trade_{ijt} = \alpha . \frac{GDP_{it} \circ GDP_{jt}}{Distance_{ij}}.$$

The equation has been often transformed into the following linear form:

$$\log Trade_{ijt} = \alpha + \varrho \log GDP_{it} + \beta \log GDP_{jt} + \mu \log Distance_{ij} + \mu_{ijt}$$

Since then, international trade economists have been referring to this equation whenever they study the determinants of international bilateral trade flows (WTO (2016)). Besides, economists have enriched the equation with other characteristics that might hamper/foster trade, such as a free trade agreement, or other types of bilateral costs, usually referred to as bilateral trade resistance. The success of this equation in literature owes it to the ease of estimation and handling. In addition, gravity models enjoy fit of between 60 and 90 percent with aggregate data as well as with sectoral data (WTO (2016)). However, despite being extensively used in empirical literature, the gravity model was lacking solid theoretical microeconomic foundations. Anderson (1979) and Anderson and van Wincoop (2003) derive the gravity equation starting from the assumptions that goods are differentiated by place of origin (Armington, (1969)) and CES utility function in which preferences are homothetic and identical across countries.

Moreover, Anderson and van Wincoop (2003) highlighted that trade intensity between any pair countries depends not only on factors affecting the two economies themselves but also on how difficult it is for each of them to trade with the world, the so-called "multilateral resistance term". Baldwin and Taglioni (2006) generalized Anderson-Van Wincoop's concept to fit panel data estimation and suggested to add systematically time-varying exporter and importer dummies. WTO (2016) pointed out that these dummies will control for the unobservable multilateral resistances, and potentially for any other observable and unobservable characteristics that vary over time for each exporter and importer.

Regarding the estimation technique, Silva and Tenreyro (2006) demonstrated in a pioneer paper how biased the coefficients are when the gravity model is estimated in its log-log form by Ordinary Least Squares (OLS). The heteroscedasticity, which often plagues trade, hampers the consistency of the OLS estimates. In addition, the censored nature of such trade data implies that the log-linearized form disregard zero trade flows. They suggested a Pseudo Poisson Maximum Likelihood (PPML) estimator for gravity models that address all caveats associated with OLS, estimating the function over the exports in monetary units instead of the logarithm of exports.

Several studies have confirmed the advantages of using such technique. WTO (2016) recommended the use of this estimator when dealing with gravity models. Besides, the estimation technique produces robust coefficients that address heteroscedasticity issues. Silva and Tenreyro (2006) pointed out the need to perform a test to assess the specification of the model. Ramsey Reset test is the most recommended one, Silva and Tenreyro (2006) and WTO (2016). The null hypothesis (H0) states that the model is correctly specified, while the hypothesis (H1) states that the model suffers misspecification or omitted variables.

In this paper and in line with these novelties, the following two gravity equations are estimated over bilateral trade flows between the ten members of the ASEAN, covering the period 2007-2014:

Standard basic gravity model:

$$Trade_{ijt} = \alpha + \varrho \log GDP_{it} + \beta \log GDP_{jt} + \mu \log Distance_{ij} + \gamma\, Contiguity_{ij} + \mu_{ijt}$$

Augmented version of the gravity model:

$$Trade_{ijt} = \alpha + \varrho \log GDP_{it} + \beta \log GDP_{jt} + \mu \log Distance_{ij} + \gamma\, Contiguity_{ij} + infrastructure_{it-1} + infrastructure_{jt-1} + Complementarity\_index_{ijt-1} + \mu_{ijt}$$

Where $Trade_{ijt}$ is bilateral trade between pair of countries, contiguity is a dummy variable equals to 1 if a pair country shares borders and 0 if not. Infrastructure is an index that captures the quality and the availability of infrastructure. Regarding the complementarity index, "it measures to what extent the export profile of country ***i*** to the world matches the import profile of country j from the world. The index values range from 0 to 1 with 0 indicating that there is no correspondence between country i's export structure and country ***j***'s import structure and 1 indicating a perfect match in their

export/import pattern" (UNCTAD). A higher indicator, ceteris paribus, implies a chance to increase trade, as the demand fits the supply.

The two models are estimated using the PPML approach, suggested by Silva and Tenreyro (2006), considering the multilateral resistance term captured through time-varying exporter and importer dummies. Following, Donaubauer, Glas & Nunnenkamp (2015) we attempt to evaluate the impact of infrastructure on the performance of bilateral trade. We tried to address endogeneity by integrating the lagged observation of infrastructure index and complementarity index. This latter is included in the equation to address the productive structure and matching issue between the supply side and the demand side. For example, this indicator is expected to bring down the potential between two economies such as Angola and Algeria. Being two of the biggest economies of the continent, the standard gravity equation must expect huge potential of bilateral trade. However, the structure of the two economies is heavily concentrated on energy products and their exports are likely similar.

The estimation of the two models aims to generate two version of the trade potential. ($Estimated\ trade_{ijt}$) and compare it to the observed trade. In case, the ratio is above 100%, we conclude that trade potential between two pair economies has reached a threshold, fully exploited and is hardly expected to grow in the medium term and vice-versa.

Estimation and simulations: results

According to the model presented in Table 3, an estimation has been performed using the PPML technique. Results estimations shows that all variables[6] in the two version of the model are significant and have the expected economic sign. In an alternative version of the specification (not reported in the paper), variables such as being landlocked has enriched the model specification. However, they were not significant and their sign was not following the economic intuition. The same conclusion comes out of the impact analysis of cultural variables, such as common spoken language or colonial links. They do not enrich significantly the model. One explanation is that REC generally gather countries that have already shared history and cultural links.

6. For data description, refer to Annex 1.

Table 3. Intra-trade between ASEAN members (2007-2015): PPML estimation

Variables	Standard version	Augmented version
Ln (GDP-exporting)	1.2 ***	3.1 ***
Ln (GDP-importing)	1.1 ***	0.8 ***
Ln (bilateral Distance)	-1.1 ***	-1.4 ***
Contiguity	0.35 *	0.34 *
Lagged Infrastructure index exporting	-	2.9 **
Interaction term between distance and infrastructure-exporting	-	0.12 *
Lagged Infrastructure index- importing	-	0.15 ***
Lagged Complementarity index	-	2***
Constant	-10,6***	-41.8***
Time varying exporting fixed- effect	Yes	Yes
Time varying importing fixed-effect	Yes	Yes
R^2	0.95	0.98
RESET *P*-value	0.0001	0.23

Standard errors in all estimations are clustered by trading pair in order to account for any intra-cluster correlations. The estimates of the time varying fixed effects for exporting or importing countries are omitted for brevity. ***,**,* significance at 1%, 5% and 10%. For the case of contiguity and the Interaction term, the significance is at 14 percent.

In the standard version of the model, all the elasticities are close to the unity, suggesting for example that an increase in the size of the exporting or the importing countries by 1 percent foster exports by the same scale. For the case of contiguity variable, sharing borders in fact increases trade by 4.1 percent.[7]

For the augmented version of the gravity model, except for the elasticity of the exporting GDP that has increased, the scale of the coefficients did not dramatically change after the addition of the infrastructure and complementary indexes. These explanatory variables have the expected economic sign showing how important is it to have an upgraded infrastructure whether for the exporting or the importing country in order to foster trade. Besides, when comparing the scale of the coefficients related to infrastructure, it is worth mentioning that what matters the most is the infrastructure qual-

7. The semi-elasticity exp (0.35)-1.

ity of the exporting country rather than that of the importing one.[8] This result is in line with the finding of Donaubauer, Glas & Nunnenkamp (2015). The role of infrastructure especially of the reporting country goes beyond. In fact, we have integrated an interaction term between the distance and the infrastructure variable and the coefficient reveals that the quality of infrastructure tends to attenuate the impact of the distance separating a pair of a country. In other words, the infrastructure base for the exporting country mitigate the role of distance and transportation cost and in fine broaden the international market for domestic suppliers. These results confirm the finding of Bougheas et al (1999) who showed that transportation cost depends not only on the distance but also on the stock of infrastructure. Regarding the significance of the infrastructure indicator in the importing country, our results might have some important implications for policy makers, at least in the ASEAN or in any REC. In fact, the availability and the quality of infrastructure could be considered as an *international public good* that serve foreign companies to penetrate domestic markets.

Regarding the complementarity index, it plays an important role in determining the intensity of bilateral trade with a statistically significant coefficient at the 1 percent level. Economies in which demand and supply seems to match, are expected to have higher bilateral trade, while those who do not enjoy this quality, could not leverage uniquely on their size or the infrastructure to foster their trade cooperation. The specification we choose, once infrastructure and complementarity are considered, passes the misspecification test. We could not reject the null hypothesis of the correct specification.

The next step is to "borrow the dynamics" observed in the ASEAN countries and try to replicate them over the ECOWAS region in order to predict the theoretical exports per country to the community itself. Then a ratio of actual exports to potential exports is calculated for the two version of the model. Given the coefficients estimated for the standard model, the potential for all countries is significantly above the actual level. As expected, the well-known regional integration in the ASEAN is translated into a higher potential in the ECOWAS region than the actual level.

However, the potential for the intra-trade is revised downward, given the structure of the production and the infrastructure. With no exception, the potential is lower for all the countries (see Table 4). In fact, the simu-

8. The *T*-test confirms that the coefficient related the exporting country is statistically higher than coefficient of the importing country.

Table 4. Intra-trade potential in the ECOWAS*

Countries	Standard	Ratio of Actual trade to Potential in (%) Augmented version	Intra- trade 2015 (%)	Nominal GDP billions of current $ (2015)
Sierra Leone	Below 1%	<500	8.9	4
Liberia	Below 1%	<500	1.7	2
Guinea	Below 1%	<500	4.7	9
Gambia	Below 1%	<500	36.1	1
Burkina Faso	Below 1%	<500	11.9	8
Benin	Below 1%	[200-300]	44.2	10
Senegal	Below 1%	[100-200]	38.3	14
Cabo Verde	Below 1%	[50 - 100]	3.0	2
Mali	Below 1%	[20 - 50]	8.7	13
Côte D'Ivoire	Below 1%	[0 - 5]	24.8	33
Ghana	Below 1%	[0 - 5]	10.0	38
Nigeria	Below 1%	[0 - 5]	4.0	481

*Calculated ratios are presented in Annex 2.

lations show that actual trade is largely above the potential especially for Sierra Leone, Liberia and Guinea and it happens to be that these economies are small and their intra-trade is relatively low and below the 10 percent average. The prospects for furthering their integration in the economy is conditional on the effectiveness of policy actions aimed to stimulate economic diversification and large-scale infrastructure investments. In the opposite way, large economies as Ghana and Nigeria still seem to enjoy a scope for improvement in their integration rate, as the actual trade is significantly below the estimated potential. For the largest economy in the ECOWAS and in Africa, Nigeria have greater policy leeway in terms of promoting its integration and reaping the benefits of the trade liberalization process in the REC, as it has the lowest ratio of actual trade to theoretical exports. However, this result needs to be interpreted with caution. The simulation analysis has been conducted over nominal variables (GDP and Trade) and this period witnessed a surge in Oil prices amplified by the rebasing of Nigerian GDP in 2013 that leads to over 70 percent increase. The simulation analysis is likely to translate this expansion in the economic size as an unseized opportunity to export. In fact, the ratio of actual trade to potential

Table 5. Intra-trade potential in the ECOWAS by economic partner

Exporter/ Importer	Benin	Burkina Faso	Côte D'Ivoire	Cabo Verde	Ghana	Guinea	Gambia	Liberia	Mali	Nigeria	Senegal	Sierra Leone	Total Opportunities per exporter
Benin		■	■	■	▲	▲	▲	■	■	▲	■	■	4/11
Burkina Faso	■		■	▲	■	■	■	■	■	▲	■	▲	3/11
Côte D'Ivoire	▲	▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	11/11
Cabo Verde	■	▲	■		■	■	▲	▲	▲	▲	▲	▲	7/11
Ghana	▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	▲	11/11
Guinea	■	■	■	■	■		■	■	■	■	■	■	0/11
Gambia	▲	▲	▲	■	▲	■		■	■	▲	■	■	5/11
Liberia	■	■	■	■	■	▲	■		■	■	▲	■	2/11
Mali	▲	▲	▲	▲	▲	▲	▲	▲		▲	■	▲	10/11
Nigeria	▲	▲	▲	■	▲	▲	▲	▲	▲		▲	▲	10/11
Senegal	■		■	▲	▲	▲		■	■	▲		▲	7/11
Sierra Leone	■	■	■	■	■	■	■	■	▲	■	■		1/11
Total Opportunities per market	5/11	7/11	4/11	5/11	6/11	8/11	6/11	5/11	5/11	8/11	5/11	7/11	

*Not Concerned. ■ = Above; ▲ = Below potential.

is slowing down over time. For Cote d'Ivoire, despite the importance of ECOWAS market as it represents 25 percent of total exports, the room for improvement is still important.

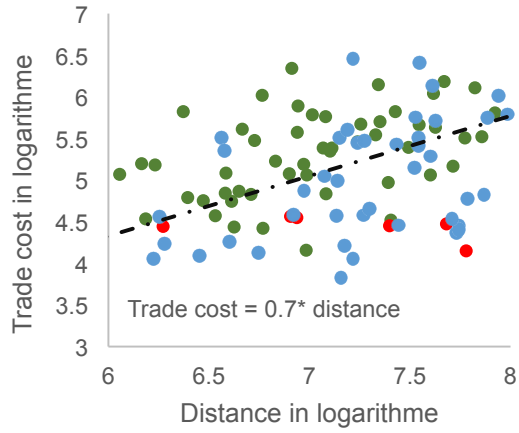
The simulation exercise per partner shows significant divergence across economies. It appears that most of the untapped potential for each of the ECOWAS members is related to their bilateral trade with the Nigerian economy. As explained above, the increased size of the Nigerian Economy opened great opportunities for domestic economies to expand their supply. In addition, potential intra-trade expansion is in favour of large economies or is likely to occur within major economies, namely Nigeria, Ghana, Cote d'Ivoire and Senegal. However, the scope for regional integration is likely to be constrained within smaller economies. For example, Côte d'Ivoire, Ghana and Nigeria could witness an expansion of their trade with almost all the ECOWAS members.

Overall, translating the observed dynamics in the ASEAN on the ECOWAS does not end up systematically with higher opportunities of regional integration, once the stock of infrastructure and the matching system between supply and demand is considered. International organizations, such as ADB (2017) and World Bank, pointed out the high level of transaction cost between African countries that challenge policy makers' ambition to further their integration. The regional integration does not respond mechanically to tariffs eliminations. Issues ranging from complex administrative procedures to regulatory barriers raise transaction costs and depress trade integration. The quality of -infrastructure poses also serious issues on the capacity of African economies to meet the challenge. Indeed, the infrastructure index as computed by the World Economic Forum shown Table 6 highlights the weak state of overall infrastructure in countries of the ECOWAS in particular. The necessity to scale up intra-trade-oriented infrastructure investment is imperative to contribute to trade facilitation. According to ADB assessment, the estimated financing requirement to close Africa's infrastructure deficit amounts around 100 billion annually until 2020. ADB (2017) indicated that transportation and communication infrastructure for intra-African trade is less developed than those that connect Africa to the rest of the world.

Referring to the trade cost indicator provided by the World Bank[9], a simple comparison of the average trade cost between the ECOWAS, the

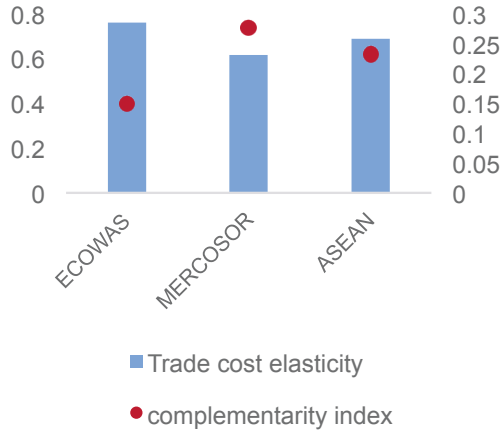
9. "This indicator provides estimates of bilateral trade costs. It is built on trade and production data collected in 178 countries. Symmetric bilateral trade costs are computed

Figure 6. Trade costs (2006-2015 average) and distance in Complementarity index.



Green, blue and red marks relate to ECOWAS, ASEAN and MER COSUL members respectively.

Figure 7: Trade cost elasticity to distance and the ECOWAS, ASEAN and MERCOSUL.



The latest data available are for 2013.

using the Inverse Gravity Framework (Novy 2009), which estimates trade costs for each country pair using bilateral trade and gross national output". (World Bank)

Table 6. Infrastructure Index for ECOWAS member countries

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Benin	2.3	2.2	2.3	_	2.4	2.6	2.7	2.7	2.6	2.6	2.4
Burkina Faso	_	_	_	2.0	2.1	2.2	2.1	2.1	2.6	2.6	2.4
Côte D'Ivoire	3.5	3.4	3.3	3.1	2.8	2.8	2.9	2.8	_	_	_
Cabo Verde	_	3.6	3.6	3.4	3.1	3.1	3.0	3.1	3.5	3.3	_
Ghana	3.6	3.4	3.3	3.3	3.4	3.6	3.7	3.8	4.0	3.7	3.1
Guinea	3.3	2.9	2.7	3.0	3.0	2.9	2.8	2.9	3.1	3.0	_
Gambia	2.4	_	1.8	1.8	1.7	1.9	_	_	_	_	_
Liberia	2.4	2.6	2.6		2.4	2.8	_	_	_	_	_
Mali	2.8	2.9	3.1	3.2	3.0	3.0	2.8	2.6	2.7	2.6	2.6
Nigeria	2.0	2.1	2.1	2.1	2.3	2.3	2.2	2.0	2.3	2.2	2.2
Senegal	3.1	3.0	3.0	2.9	2.8	2.5	2.6	2.7	3.3	3.0	2.6
Sierra Leone	2.6	2.3	2.1	2.1	2.1	2.1	_	_	_	_	_

Source: World Economic Forum

1 = extremely underdeveloped, among the worst in the world; 7 = extensive and efficient, among the best in the world.

ASEAN and the MERCOSUL, shows how far is it higher in Africa compared to the other regions. It is 2.7 and 1.3 times higher in the ECOWAS, than MERCUSOR and ASEAN. Figure 7 presents how elastic is the cost of trade, as it is provided by the World Bank, to the distance separating a pair of countries. While the average elasticity is around 0.7, suggesting that any increases in the distance by 1 percent would rise trade cost by 0.7 percent. However, 74 percent of the ECOWAS of each pair of ECOWAS members are located above the fitted trend curve, while this number is around 40 percent for ASEAN members. Regarding the matching issue between supply and demand in each of these RECs, the prevailing fact is that ECOWAS is lacking considerably complementarity between the structures of production and demand of each of its members, with an index around 15 percent. For the MERCOSUL and ASEAN, the index is well above that level.

Supply Side Constraints: the Revealed Comparative Advantage index analysis

The analysis of trade potential within the ECOWAS, once controlling for the quality of infrastructure and the production structure has shown

how observed trade is close to its theoretical level, especially for small economies unlike what was widely accepted regarding the huge potential. Having said that, trade dynamics are much more complicated and depend on several factors ranging from short-term variables, such as macroeconomic policy or structural aspects dealing with trade facilitation initiatives or doing business climate in general. In addition, expanding trade between ECOWAS members is expected to come at the expense, at least in the short term, of classic suppliers of these countries, such as China or the US. The competitiveness of local products is a central element that determines how far ECOWAS's products can substitute for foreign products. That is why we are referring in the next section of what might be a proxy for competitiveness in ECOWAS' export fabric, such as Revealed Comparative Advantage index.

This indicator "illustrates whether a country is in the process of extending the products in which it has a trade potential, as opposed to situations in which the number of products that can be competitively exported is static. It can also provide useful information about potential trade prospects with new partners" (WITS, Trade Indicators). Therefore, countries displaying comparable RCA within the same category of product tend to trade less, whereas countries with different RCA tend to trade more. Within a regional economic community such as the ECOWAS, a country with a RCA similar to the world average will benefit more from integration in the sense that it can become the supplier of these goods instead of the world market. However, there is a risk of trade diversion since these goods are likely to be more expensive that those exported by the world market since they are not expected to be produced as efficiently as in the world market (Venables, 1998). RCA is calculated as follows:

$$RCAi,j = (Xi,j/Xi,t)/(Xw,j/Xw,t)$$

Where $X_{i,}$ and $X_{w,}$ represents the values of export of country i of product j and values of export the world of the same product, and where $X_{i,}$ and $X_{w,}$ refer to the total exports of country i and the world. A value greater than one indicates that the country i displays a revealed comparative advantage in the product j, while a value less than one entails that the country i has a revealed comparative disadvantage in the product j.

Table 7 shows that revealed comparative advantages remain clustered among Food and Animal products and commodity exports (Minerals and Fuels), with the exception of Textiles and Clothing and Stone and Glass. The range of comparative advantages is relatively less concentrated for

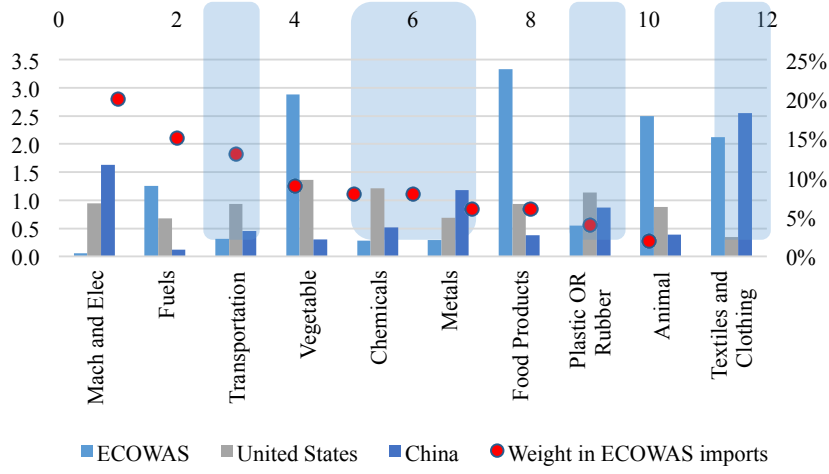
Table 7. Revealed Comparative Advantage of ECOWAS members China and the United States with the world, 2015[a]

HS Classification	BEN	BFA	CPV	CIV	GMB	GHA	GIN	MLI	NER	NGA	SEN	TGO	Total	USA	CHN
Animal	0.4	0.2	0.1	11.9	0.2	0.4	6.3	2.0	0.5	0.2	5.9	1.9	5/11	0.9	0.4
Vegetable	6.0	4.8	3.2	0.1	0.6	0.8	10.5	0.5	2.6	0.5	2.6	2.6	7/11	1.4	0.3
Food Products	0.6	0.2	14.6	5.1	6.8	0.4	3.5	0.2	1.4	0.6	3.6	3.1	7/11	0.9	0.4
Minerals	5.1	0.2	0.2	0.0	1.3	31.4	0.0	0.0	43.6	0.0	11.9	18.4	6/11	0.5	0.1
Fuels	0.4	0.0	1.7	3.6	0.0	0.0	0.3	0.1	1.8	5.8	1.4	0.1	5/11	0.7	0.1
Chemicals	0.1	0.1	0.3	0.0	0.1	0.0	0.4	0.2	0.0	0.1	1.1	1.1	2/11	1.2	0.5
Plastic or Rubber	0.1	0.0	1.3	0.1	0.5	0.6	0.5	0.1	0.0	0.3	0.4	2.9	2/11	1.1	0.9
Hides And Skins	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	5.9	1.0	0.1	1/11	0.5	2.2
Wood	0.9	0.0	0.9	0.0	1.7	3.3	1.4	0.1	0.0	0.1	0.4	1.1	4/11	1.1	0.8
Textiles and Clothing	9.3	3.0	0.6	0.6	0.1	0.1	6.2	2.0	0.6	0.2	0.4	2.6	5/11	0.4	2.6
Footwear	0.0	0.0	0.5	1.8	0.0	0.0	0.3	0.0	0.0	0.5	1.6	3.5	3/11	0.1	3.1
Stone and Glass	0.5	12.7	1.3	0.0	17.2	8.3	0.0	21.2	1.1	0.0	2.1	0.8	7/11	1.0	0.8
Metals	1.0	0.5	0.1	0.1	0.4	0.0	0.2	0.1	0.0	0.1	0.5	0.6	0/11	0.7	1.2
Machinery &Electrics	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0/11	0.9	1.6
Transportation	0.8	0.1	0.2	1.1	0.0	0.6	0.1	0.0	0.6	0.1	0.1	0.3	1/11	0.9	0.5

Source: World Integrated Trade Solution (WITS).

a. Latest data for Gambia is 2014, for Ghana and Mali is 2012 and for Nigeria is 2010. No data available for Guinea-Bissau, Liberia and Sierra Leone.

Figure 8. Revealed Comparative Advantages of top 10 products imported by the ECOWAS



Source: World Integrated Trade Solution (WITS).

Togo and Senegal, who display RCAs for nine and eight group of products respectively, ranging from Vegetable, Food Products, and Chemicals to Textile and Clothing. Regarding, Guinea and Niger, they have the strongest RCAs for Minerals with indexes ranging from 31.4 to 43.6. None of ECOWAS members has RCAs in Metals and Machinery and Electrics and only one country (Côte d'Ivoire) has a RCA in Transportation. As a result, aside from fuel products and other primary commodities like vegetables, ECOWAS's main imports such as Machinery and Electrics, Transportation, Chemicals and Metals (as shown in Table 1) originate from other countries of the world such as China and the United States. In fact, 60 percent of the top 10 products imported by the ECOWAS during the considered period come from countries outside the region who display stronger RCAs for these products.

Conclusion

The process of regional economic integration in the ECOWAS has not reached its full potential yet, as intra-regional trade remains low compared to other developing regions of the world. Stemming from empirical litera-

ture, this chapter aims to analyse the potential for intra-regional trade in the ECOWAS. Two gravity models have been estimated using the PPML approach and controlling for multilateral resistance term through time-varying exporter and importer dummies. The estimation has been conducted over the ASEAN community, which display high trade integration across its members.

Using the coefficients of these models, a simulation has been performed on the ECOWAS region in order to predict the theoretical intra-regional exports per country and hence calculate the trade potential of these countries. Although the results imply the existence of a potential for intraregional trade in the ECOWAS, it remains unlike what is widely agreed. Moreover, achieving this potential in order to eventually foster regional integration is confronted to several obstacles, which lie, as demonstrated, in the deficit in infrastructure stock and the lack of complementarity between ECOWAS members.

Policy measures to advance regional economic integration of the ECOWAS through intra-regional trade should hence focus on the challenges regarding the lack of infrastructure on one hand and the lack of diversification and competitiveness of ECOWAS exports on the other hand. Therefore, improving and investing in adequate infrastructure between member countries of the ECOWAS is crucial, since improved stock of infrastructure can mitigate the distance and the high transportation costs between two partners, which leads to a greater level of not only intra-regional but also international integration, through increased levels of trade.

Furthermore, developing trade complementarities between members of the ECOWAS is found to play a crucial role in determining the intensity of bilateral trade. Indeed, economies in which demand and supply seem to match are likely to increase their trade. In addition, supply side factors related to the extent to which ECOWAS economies are likely to substitute for already foreign products pose serious challenges to the capacity of these countries to increase their integration. Revealed comparative advantage indexes display how specialized and concentrated are ECOWAS countries.

References

Adekunle, B. and Gitau, M., 2011. "Illusion or Reality: Understanding the Trade Flow between China and Sub-Saharan Africa".

African Development Bank, (2017) "Trade policies and regional integration in Africa" *African Economic Outlook*.

Akpan, U. S., 2014. "Impact of Regional Road Infrastructure Improvement on Intraregional Trade in ECOWAS". *African Development Review.*

Alemayehu G. and Haile K., 2008. "Regional Economic Integration in Africa: A Review of Problems and Prospects with a Case Study of COMESA". *Journal of African Economies*.

Alemayehu, G., and Edris, H-S., 2015. "The potential for internal trade and regional integration in Africa". *Journal of African Trade*.

Anderson, J. E., and Wincoop E. V., (2003). "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review*.

Armington, P.S., (1969). "A Theory of Demand for Products Distinguished by Place of Production." *International Monetary Fund*.

Baldwin, R.E., and Taglioni D. (2006). "Gravity for Dummies and Dummies for Gravity Equations." NBER Working Paper No. 12516.

Bougheas S. et al. (1999). "Infrastructure, Transport Costs and Trade" *Journal of International Economics*.

Cardamone, P., 2006. "A Survey of Assessments of the Effectiveness of Preferential Trade Arrangements Using Gravity Models"; Working Paper University of Calabria, Italy Trade Preference.

Cassim, R., 2001. "The determinants of intra-regional trade in Southern Africa with Specific reference to Southern Africa and the rest of the Region". DPRU Working Paper, University of Cape Town.

Deen-Swarray, M., Adekunle, B., Odularu, G., 2011. "The Impact of Infrastructural Development on Intra-Regional Trade: The Case of the Economic Community of West African States (ECOWAS)".

Donaubauer J., Glas A., Nunnenkamp P., (2016) "Infrastructure and Trade: A Gravity Analysis for Major Trade Categories Using a New Index of Infrastructure" Kiel Institute for the World Economy.

Ebaidalla M. and Yahia A. M., (2015), "Performance of Intra-COMESA Trade Integration: A Comparative Study with ASEAN's Trade Integration", *African Development Review*.

Eichengreen, B., Irwin, D. A., 1995. "Trade blocs, currency blocs and the reorientation of world trade in the 1930s". *Journal of International Economics*.

European Centre for Development Policy Management (ECDPM), 2016. "Overview of trade barriers to trade in West Africa: Insights in political economy dynamics, with particular focus on agricultural and food trade". Discussion Paper.

Foroutan, F. and Pritchett, L., 1993. "Intra-Sub-Saharan African Trade: is it too little?" *Journal of African Economies*.

Geda, A., Kibret, H., 2008. "Regional integration in Africa: a review of problems and prospects with a case study of COMESA". *J. Afr. Econ*.

Hacker, R.S and Einarsson, H., 2003. "The Pattern, Pull and Potential of Baltic Sea Trade", *Annals of Regional Science*.

International Monetary Fund (IMF). 2017. "Fiscal Adjustment and Economic Diversification". *Sub-Saharan Africa Regional Economic Outlook*, October.

Longo, R., Sekkat, K., (2001). "Obstacles to expanding intra-African trade. OECD Technical Paper.

Luqman A. O., Bakar N. A. A., Izraf A. A. M., (2016). "The Gravity Model Approach: An Application of the ECOWAS Trade Bloc". *South East European Journal of Economics and Business*.

Martinez-Zarzoro I, Nowak-Lehmann F., (2003). "Augmented Gravity Model: An Empirical Application to MERCOSUL-European Union Trade Flow". *Journal of Applied Economics*.

Piermartini, R. and Yotov Y. V. (2016). "Estimating Trade Policy Effects with Structural Gravity", World Trade Organization, Working Paper.

Santos Silva, J.M.C., and Silvana Tenreyro, (2006). "The Log of Gravity." *Review of Economics and Statistics*, 88(4): 641–658.

Santos Silva, J.M.C., and S. Tenreyro, (2011). "Further Simulation Evidence on the Performance of the Poisson Pseudo-Maximum Likelihood Estimator." *Economics Letters*.

Tinbergen, J., (1962). "Shaping the World Economy: Suggestions for an International Economic Policy". *The Economic Journal*.

United Nations Conference on Trade and Development, (2013) "Economic Development in Africa Intra-African trade: Unlocking private sector dynamism".

United States Agency International Development, (2015). "EADS Analytical Brief on Trade in West Africa".

Venables, A. J. (1999). "Regional Integration Agreements: A force for convergence or divergence?" Annual Bank Conference on Development Economics, The World Bank.

Annex: Data Description

The bilateral trade data, just as the bilateral complementarity index are taken from the UNCTAD database, while nominal GDP is extracted from the World Bank Database (World Development Indicators). The infrastructure index refers to the infrastructure quality index published by the World Economic Forum (WEF) within The Global Competitiveness Report. It contains assessment of the quality and availability of transport, electricity and communication infrastructures. In fact, a survey is conducted among business leaders around the world to captures their opinions on the quality and availability of infrastructure, from which an aggregated indicator is constructed (WEF). A higher indicator means higher quality of infrastructure. The contiguity and the distance are taken from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

The countries used in the gravity estimation as well as the simulation:

Table A-1. Member countries of ASEAN and ECOWAS used in the gravity model and simulation

ASEAN members (model estimation)	ECOWAS members (simulation)
Brunei Darussalam	Benin
Cambodia	Burkina Faso
Indonesia	Cabo Verde
Laos	Côte D'Ivoire
Malaysia	Gambia
Myanmar	Ghana
Philippines	Guinea
Singapore	Liberia
Thailand	Mali
Vietnam	Nigeria
	Senegal
	Sierra Leone

For a detailed description of the data, see CEPII website. Infrastructure data are not available for Guinea Bissau, Niger and Togo. They were excluded out of the simulation analysis.

Table A-2. Annex 2- Intra-trade potential in the ECOWAS

Country	Potential/Observed Trade in (%)
Benin	204.6
Burkina Faso	586.2
Côte D'Ivoire	5.1
Cabo Verde	75.8
Ghana	1.7
Guinea	2118.1
Gambia	743.2
Liberia	2415.9
Mali	29.5
Nigeria	0.5
Senegal	140.8
Sierra Leone	12169.9