INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research

African J. of Economic and Sustainable Development

ISSN online: 2046-4789 - ISSN print: 2046-4770
https://www.inderscience.com/ajesd

The major determinants of the intra-ECOWAS market: do ICTs contribute significantly to the growth of intra-community trade?

Ferdinand Ouedraogo

DOI: 10.1504/AJESD.2024.10061577

Article History:

Received:	12 March 2023
Last revised:	19 September 2023
Accepted:	20 September 2023
Published online:	15 January 2024

The major determinants of the intra-ECOWAS market: do ICTs contribute significantly to the growth of intra-community trade?

Ferdinand Ouedraogo

University Thomas Sankara (former Université Ouaga 2),
P.O. Box 2, BP 5953, Ouagadougou 02, Burkina Faso
Email: ouedraogo.ferdinand@yahoo.fr

Abstract: The objective of this study is to identify and analyse the main determinants of intra-ECOWAS trade, to verify whether investments and the rapid penetration of ICT have a positive influence on the growth of intra-ECOWAS trade. Indeed, it emerges from this study that GDP, population and investments in ICT are variables which positively influence both exports and imports. Mobile phone subscriptions and customs duties only have a positive influence on exports. The hypothesis according to which ICT would have a positive influence on the growth of intra-ECOWAS trade is well and truly confirmed. Foreign direct investments do not have a favourable impact on intra-community trade. However, we see that their growth in volume over the last two decades is becoming increasingly important for all 15 ECOWAS countries.

Keywords: ECOWAS bilateral trade performances; major determinants; ICT impact; gravity model analysis.

Reference to this paper should be made as follows: Ouedraogo, F. (2024) 'The major determinants of the intra-ECOWAS market: do ICTs contribute significantly to the growth of intra-community trade?', *African J. Economic and Sustainable Development*, Vol. 9, No. 3, pp.239–254.

Biographical notes: Ferdinand Ouedraogo is an Assistant Professor in Economics at University Thomas Sankara (former Université Ouaga 2), Economics and Management department, Burkina Faso. He is also an associate member researcher of the CEDIMES Institute, State University of New York, Plattsburgh Campus, USA. He earned his PhD in economics at Grenoble Alpes University, France in 2009 and his research focuses on capacities building in developing countries, intelligence and efficiency of agricultural and renewable energy markets, agricultural and energy technological innovation, space markets, science and technology influence on Earth's environment and social well-being.

1 Introduction

With a population representing an intra-community market of over 350 million inhabitants generating a community GDP of more than 628 billion dollars, ECOWAS constitutes a regional trade bloc of West Africa composed of fifteen (15) member states.

The objectives targeted in terms of competitiveness and well-being give an important place to intra-regional trade. However, with regard to official statistics, intra-community trade (in the ECOWAS region) remains of a low magnitude because it represents only about 9.0% of the total exports of member countries and 10.5% of the total imports compared to certain regional organisations such as the European Union where most of the trade is concentrated within the community, i.e., around 70%.

Despite the efforts made by the heads of state in signing protocols and agreements for the development of intra-community trade and investment, the share of intra-regional exports in total ECOWAS exports, which was 10, 1% in 1980 (Osabuohien et al., 2017), could only increase by 0.6% between 1980 and 1998 and by 1.9% between 1980 and 2010, i.e., an increase of around 2% in 30 years of implementation of these agreements and protocols.

It is therefore important to know why intra-community trade remains very low (less than 15% in the ECOWAS region) despite its 45 years of existence and how to do to increase intra-community trade in the future?

The answer to this question goes through the precise identification of the factors which negatively and positively influence intra-community trade.

So, with the penetration and rapid growth of ICT in West Africa, it is important to know its impact on the development of intra-regional trade.

In 2017, the 15 ECOWAS member states had 176 million unique mobile subscribers with an overall subscriber penetration rate of 47% compared to 19% in the early 2000s (GSMA, 2018). Between 2010 and 2017, the number of mobile telephone subscribers doubled in the ECOWAS zone (GSMA, 2018). The same source which estimates the level of Internet penetration at 37.5% in the ECOWAS zone in 2017 indicated that the number of mobile Internet subscribers has doubled in the last four years, reaching 78 million, or close to the half of the total number of mobile subscribers in 2017.

The objectives of this study are therefore to identify and analyse the major determinants of intra-ECOWAS trade, to confirm or invalidate whether the use of ICT and related investments have a positive influence on intra-regional trade.

In terms of scope, our study in addition to covering all 15 ECOWAS member countries, analyses a larger database (19 years) covering the period from 2000 to 2018 unlike those of Ackah et al. (2012) and Osabuohien et al. (2017, 2019) who covered older and smaller databases (8 years).

A good knowledge and mastery of these major determinants would allow ECOWAS to put in place policies favourable to the good development of intra-regional trade in order to tend towards the achievement of its objectives.

2 Literature review and analysis models

This section is devoted to the presentation of the literature review, the methodology and the model retained for the analysis of the study database.

2.1 Literature review

In the identification and analysis of the major determinants of bilateral or intra-trade community, the review of the literature makes it possible to distinguish economic determinants from non-economic determinants.

2.1.1 Economic determinants

The economic determinants identified essentially consist of income, customs duties, the exchange rate and the supply of credit.

An empirical analysis by the IMF (Palomba et al., 2019) based on African countries shows that tariff reductions can stimulate intraregional trade, even if the estimated elasticity of trade flows to tariffs in Africa is relatively limited. The overall effect of a very significant reduction in customs duties of 90% of trade flows within the framework of the AfCFTA would increase the value of trade or intra-regional trade by around $16 billion, or nearly 16%.

The results of the study by Osabuohien et al. (2017) which showed that consumers in ECOWAS member countries tend to consume more imports from other member countries as their income increases, contradict the conclusions of Ackah et al. (2012) who showed a negative relationship between intra-regional trade and the income of ECOWAS countries and thus allowing us to infer that with an increase in income, domestic consumers of member countries tend to prefer foreign substitutes. The study by Evans S. Osabuohien et al. (2017), using databases from the 15 ECOWAS member countries, showed that bilateral trade flows increase with the size of the economy (GDP).

Osabuohien et al. (2017) thus examined the importance of formal financial development in facilitating intra-regional trade, which corresponds to the ideas of Babatunde and Odularu (2017) who argue that the productive capacity of member states should be strengthened to stimulate intra-regional trade.

Gbetnkom (2013) showed in his study a positive relationship between the GDP of exporting States and trade flows, a positive relationship between the GDP of importing States and these trade flows. On the other hand, the same study indicated a negative relationship between the exchange rate and trade flows in the CEMAC zone, a negative relationship between the population of the country of origin (exporter) and trade flows.

The work of this author also revealed a negative coefficient of the exchange rate in the CEMAC zone, thus indicating that greater volatility of the bilateral exchange rate reduces trade flows between the two countries concerned. This result is entirely consistent with the expectations of theory which generally predicts a negative relationship between the exchange rate and trade flows.

2.1.2 Non-economic determinants: the growing use of information and communication technologies

The non-economic determinants that have been identified are essentially made up of variables such as population, distance, homogeneity of products, concentration of trade, free movement of goods and people, size of countries, geographical and cultural proximity, the quality of infrastructure, education, working language and information and communication technologies represent a variable of very important interest in the context of this study.

According to trade theory, trade flows increase with the size of countries (population, GDP) and their level of development.

The study by Osabuohien et al. (2017), using the databases of the 15 ECOWAS member countries, showed that bilateral trade flows increase with the size of the countries' populations, the size of their GDP but decrease with the distances between countries.

Authors like Ackah et al. (2012), Eveslage (2015), Ukaoha and Ukpe (2013), Anyanwu (2014), justified the low level of increase in these exchanges by the homogeneity of exchangeable products, the concentration of exchanges in certain sectors of production thus limits the capacity for diversification, the difficulties of free movement of goods and people despite the agreements and protocols in force.

Ackah et al. (2012) focused their work on infrastructure development, particularly logistics infrastructure which should be improved for intra-community trade of member states.

The IMF (Palomba et al., 2019), within the framework of the AfCFTA, carried out a study on trade flows based on the augmented gravity model for the analysis of the determining factors with the quality of infrastructure and logistics,). This study showed the significant influence of the quality of infrastructure on intra-African trade.

Gbetnkom (2013) as for this author was able to show that countries having English or French in common tend to trade and develop exchanges between them.

New theories of international trade have shown that ICT can modify trade flows and therefore the terms of trade through an increase in productivity, a reduction in costs and an increase in human capital endowment.

For Xing (2017), high-speed internet and secure servers would be a crucial step in unlocking the potential of e-commerce for developing countries.

Nzepang and Anya (2022), a follower of this new theory, showed that the growing adoption of information and communication technologies (ICT) is a factor that improves the terms of trade in sub-Saharan African economies. According to his study, the evolution of the terms of trade index is positively affected by the evolution of the number of Internet users as a percentage of mobile telephone subscribers, a shock which would increase the number of internet users. Internet of 10% of mobile telephone subscribers would lead to an increase in the terms of trade index of more than 5%.

Dadegnon and Igué (2022) showed in West African Economic and Monetary Union zone (WAEMU) that ICT increases trade by 0.06%, and that mobile phone and Internet subscriptions as well as investments in ICT would respectively increase trade by 0.03%; 0.02% and 0.02%; and according to the work of these same authors, the use of the TIC variable would considerably reduce the negative influence of distance from 0.13% to 0.01%.

The works of these authors (Xing, 2017, Nzepang and Anya, 2022; Dadegnon and Igué, 2022) who uses the gravity model to study the impacts of ICT on bilateral trade in developing countries and particularly in sub-Saharan Africa and the WAEMU zone, are what will inspire us to analyse the major determinants of ECOWAS intra-market with ICT as a variable of major interest.

2.2 Analysis models

2.2.1 Source and sampling of databases

In this study, we chose to use the WTO and UNCTAD databases on intra-African trade flows and specifically the ECOWAS zone. As panel data, we have statistics concerning the 15 ECOWAS countries over a period of 19 years from 2000 to 2018 largely covering our variables of interest.

The analysis of trade between countries amounts to considering bilateral flows from an exporting country to an importing country. These countries have their own

particularities in geo-economic terms which more or less determine their levels of trade. Such a problem is based on the foundations of Newton's gravitational model and on the application of graph theory (Berge, 1958), models whose complementarity has also been mentioned in similar contexts (Bonnefoy et al., 1996).

Thus, the sample covered by our analysis is made up of the 15 ECOWAS member countries.

We have 3,990 (=15 × 14 × 19) observations. With 15 as the number of ECOWAS countries, 14 as the number of function variables and 19 as the number of years.

The appropriate estimation method is then that of panel data. Given that there are different patterns of parameter variation that justify several methods of estimating panel data (fixed effects model, random effects model and model without fixed effects and without random effects), a reasoned choice is necessary as to the appropriate estimation method among these three methods.

Before proceeding with the estimation of the model, a descriptive analysis of some variables of interest is necessary.

2.2.2 Graphs at the service of flow analysis

The analysis of trade between countries in a given space involves a complex system of geoeconomic entities and their relationships. Geoeconomic entities are the countries of origin and destination of flows.

We can therefore assimilate the studied system to a graph, where the nodes are the countries of origin and destination. These nodes are described by explanatory variables which are specific to them. The edges are oriented according to the relationships between these nodes and are evaluated according to different variables.

The trade flow to be explained, or any explanatory variable, is associated with two nodes (for example: the distance separating two countries). The global structure is therefore presented in the form of a directed graph potentially complete and connected (except for the cases of absence of exchange) and not planar. All edges of the graph can potentially be duplicated.

Thus, from the point of view of trade, we can associate pairs of countries with two flows of opposite directions and specific values, depending on the level of trade. An import (vs. an export) is only representative of one and the same flow. The whole difficulty lies in integrating these levels, which can in turn become relevant decision scales.

The flows for the analysis of the exchange balances of the countries, the blocks of countries (current and future) for the apprehension of the effects of integration or eviction, and the evaluation of the export potential of one country to another, which is the subject of our analysis.

Gravity models constitute the main theoretical basis for the development of our model.

2.2.3 Gravity models applied to trade

The gravity model is based on quantitative models developed by astronomer Stewart in 1940 based on Newton's theory. According to Evenett and Keller (2002), this model has enjoyed great empirical success since the 1960s, but despite everything, it suffered for several years from an absence of theoretical foundations in the field of economics.

Despite the challenges, it is recognised that the theoretical foundations of the gravity model are justified in microeconomics (Anderson, 1979), international trade theory (Bergstrand, 1985; Deardorff, 1998) and, finally, in the new geographic economy (Steward, 1941; Krugman, 1980).

An illustration of this model was made by Bergstrand (1985) who succeeded in deriving the gravitational equations for differentiated products based implicitly on Ricardian, Heckscher-Ohlin (1991) structural models and increasing returns to scale.

In Africa, the IMF used the gravitational model (Palomba et al., 2019) and in particular the CGE modelling of international relations in applied general equilibrium – MIRAGE – model (Berthelot, 2016) to estimate the impact of the AfCFTA after the decisions on its creation by African heads of state in 2012.

Literature teaches us that the gravity model was first used by Tinbergen (1962) in work on international trade. This model was inspired by Newton's universal gravitational law which states that two bodies separated by a distance *D*, exert on each other attractive forces of the same value:

$$F_{ij} = G \cdot \frac{M_i \cdot M_j}{D_{ij}^2}$$

2.2.3.1 Simple gravity model

The theoretical bases of gravity models have been widely developed and are based on Newton's law, used by both geographers and economists.

Gross domestic products (GDP), the economic mass, acts as the attractor of trade between two trading partners and has a positive effect on trade. In contrast, distance, a measure of transportation cost used by most studies, serves as a drag factor and plays a negative role on trade.

From an economic point of view, the use of gravity models in the analysis of international trade is based on the logic according to which the flows of trade between two countries depend positively on their 'economic masses' as measured by their gross domestic products (GDP) and depend negatively on the distance between them. In other words, a country's ability to export to its economic partners depends on its own economic size as measured by GDP, while the demand of partner countries depends on the income of the latter. The role of distance becomes obvious as we are in front of a given GDP pair. So, the simple gravity model looks like this:

$$Flow_{ij} = \alpha \cdot GDP_i^{\beta_1} \cdot GDP_j^{\beta_2} \cdot Dist_{ij}^{\beta_3}$$

where

- $Flow_{ij}$ represents the value of bilateral trade (export) from country *i* to country *j*
- GDP_i (GDP_j) is the gross domestic product of exporting country *i* (importing country *j*)
- $Dist_{ij}$ measure the distance between exporting country *i* and importing country *j*
- α, β_1, β_2 and β_3 the coefficients.

β_3 is assumed to be negative while β_1 and β_2 are assumed to be positive.

Expressed in logarithmic form, the preceding equation can be reformulated as follows:

$$\log\left(Flows_{ij}\right) = \beta_0 + \beta_1 \log\left(GDP_i\right) + \beta_2 \log\left(GDP_j\right) + \beta_3 \log\left(Dist_{ij}\right) + \varepsilon_{ij}$$

where

- ε_{ij} is the bilateral trade (export) error term from country *i* to country *j*
- β_0 a constant defined by $\beta_0 = \log(\alpha)$.

The previous log-linear form makes it possible to interpret the coefficients as elasticities of trade flows with respect to the explanatory variables.

The success of the gravity model with only GDP and distance as explanatory variables is remarkable in empirical studies. But foreign trade is not influenced only by these two factors. Some other characteristics of partners also matter.

2.2.3.2 Augmented gravitational model

Consider the simple model (see the previous equation) to which we add other potential determinants in order to broaden the scope of the model. This extension is inspired by the model used by Luo (2001) which will improve the gravity model by limiting the risk of bias in the estimates of the coefficients which would result from the omission of relevant variables.

The extended model is then written:

$$\log\left(Flow_{ij}\right) = \beta_0 + \sum_{k=1}^{n} \beta_{1.k} \log\left(X_{i.k}\right) + \sum_{k=1}^{n} \beta_{2.k} \log\left(X_{j.k}\right) + \sum_{k=1}^{n} \beta_{3.k} \log\left(C_{ij.k}\right) + \varepsilon_{ij}$$

2.2.3.3 Definition of variables

- Exports (Export_ijt) – exports relate to the annual trade of goods by partner and by product. Values are in thousands of US dollars.
- Populations (Population_it: population of exporting country i at date t; Population_jt: population of exporting country j at date t) – these are the total populations of each country at each moment of the period considered (2000 to 2018) expressed in thousands.
- Gross domestic products GDP (GDP_it for country i at date t; GDP_jt for country j at date t) – total GDP at current price is expressed in millions of US dollars.
- Foreign direct investments (ForeignDirectInvest_it for country i; ForeignDirectInvest_jt for country j, at time t).
- ICT (ICT_it of country i, ICT_jt of country j) – ICT investments represents here investment expenditure in ICT.
- Customs duties (CustomsDuties_ijt) – these are the average duties applied to the import of the main categories of non-agricultural and non-petroleum products, by country (markets) and by economic grouping (origins). It is the simple arithmetic

mean of the rates, for a given group of products, calculated at the level of the tariff heading. For the calculation, all products are taken into account regardless of trade.

- Mobile telephone subscribers (MobilePhoneSubscribers_it of country i, MobilePhoneSubscribers jt of country j).
- Exchange rate (ExchangeRate_ijt).
- Distances (Distance_ijt).

3 Results

This section aims to assess and analyse the performance of intra-ECOWAS trade.

Economic series are not stationary a priori by nature, and since non-stationarity has fundamental consequences on the econometric level, it will therefore be appropriate for us to carry out stationarity tests of the different series to be studied.

For this, several detection methods are possible one has among others the graphical method (graph of the series and of the auto correction function) and the tests of specific stationarity (the unit root tests). As far as our work is concerned, we will only be interested here in the specific stationarity test, because the graphs only provide an indication as to the stationarity or not of a series.

Once the stationarity tests have been carried out, there will then remain the problem of choosing the estimation method.

If the tests indicate non-stationarity for all series and when differentiating them once, they become stationary, cointegration techniques will be applied. Otherwise, the estimate will be made using the OLS/MCG method.

3.1 The tests

3.1.1 Unit root tests

Before proceeding with the estimation of the model, it is advisable to make sure of the stationarity of the observed series, because when the variables are not stationary, the estimation of the coefficients by the OLS method (where MCG) and the usual tests t-students and f-Fisher are not valid. That said, the estimated coefficients will not converge to their true value. We will say that the regressions are fallacious.

As the graphic methods of detecting the stationarity or not of the series are not reliable, we use more rigorous tests: the unit root tests.

The main unit root tests on panel data are those of Levin et al. (1992) and Im et al. (2003). The test of Im et al. is similar to the ADF test of Dickey and Fuller (1979). This test is stable and efficient and remains applicable to panel data models.

$$\text{The unit root test is:} \begin{cases} H_0: & \text{the variable is not stationary} \\ H_a: & \text{the variable is stationary} \end{cases}$$

For the unit root test of Levin et al., we reject the unit root Hypothesis H_0 if the prob value is less than 1%, 5% and 10% respectively.

The EViews software gives the stationarity test results obtained for the present variables. See Table 1.

Table 1 Stationarity test results

Variables	*Levin et al.*		*Im et al.*	
Log(Export_ijt)	–186.069	0.0000	–33.9454	0.0000
Log(Population_it)	–55.7146	0.0000	–14.5226	0.0000
Log(Population_jt	–55.7146	0.0000	–14.5226	0.0000
Log(GDP_it)	–24.377	0.0000	–4.844	0.0000
Log(GDP_jt	–24.377	0.0000	–4.844	0.0000
Log(ForeignDirect Invest_it)	–12.531	0.0000	0.4054	0.6574
Log(ForeignDirect Invest _jt)	–12.531	0.0000	0.4054	0.6574
Log(ExchangeRate_ijt)	–10.6428	0.0000	–5.3014	0.0000
Log(ICT_jt)	–7.6153	0.0000	–9.2895	0.0000
Log(ICT_jt)	–198.976	0.0000	–215.867	0.0000
Log(MobilePhoneSubscribers _it)	–43.6149	0.0000	–34.6672	0.0000
Log(MobilePhoneSubscribers _jt)	–43.6149	0.0000	–34.6672	0.0000
Log(CustomsDuties it)	–9.32474	0.0000	–7.191	0.0000
Log(CustomsDuties jt)	–10.8623	0.0000	–7.229	0.0000

Source: Author's calculations

According to Table 1, we have that the majority of the variables are stationary, even highly stationary because the P-value is less than 0.001% except for the variable Log(ForeignDirectInvest).

By considering a risk of 5% (to be larger), we see that the variables are stationary, which allows us to favour estimation by the method of ordinary least squares or generalised. Thus, in the following our analysis we will consider a threshold $\alpha = 5\%$.

Model specification test (homogeneity): specification tests for individual effects.

When considering panel data, the very first thing to check is the homogeneous or heterogeneous specification of the process generating the data. Econometrically, this amounts to testing the equality of the coefficients of the model studied in the individual dimension.

From an economic standpoint, the specification tests amount to determining whether we are entitled to assume that the theoretical model studied is perfectly identical for all countries or, on the contrary, whether there are specificities specific to each country.

3.1.2 Fisher's test

$$\text{The hypothesis test is written: } \begin{cases} H_0 & \text{Absence of fixed effects} \\ H_a & \text{Presence of fixed effects} \end{cases}$$

The result is performed automatically after the estimation of the fixed effects model on R is: F-statistic: 37.4577 on 11 and 3,769 DF, p-value < 2.22e-16.

The p-value associated with the test is worth 0 therefore less than α, we reject H_0 for the absence of fixed effects.

3.1.3 Breusch-Pagan test

This test allows the detection of heteroskedasticity.

$$\text{The hypothesis test is written:} \begin{cases} H_0 & \text{Absence of random effects} \\ H_a & \text{Presence of random effects} \end{cases}$$

The test result is shown below:

- Lagrange multiplier test – (Honda) for balanced panels
- data: log(Export_ijt_1) ~ log(GDP_it) + log(GDP_jt) + log(POP_it) + …
- normal = 106.93, p-value < 2.2e-16
- alternative hypothesis: significant effects.

We find that the p-value is below the 5% threshold. Therefore, we reject the hypothesis that there is no random effect. The test is then significant. The model has random effects.

3.1.4 Hausman test

This test, generally used in panel econometrics, is used to discriminate between fixed and random effects.

$$\text{The hypothesis test is written:} \begin{cases} H_0 & \text{Presence of random effects} \\ H_a & \text{Presence of fixed effects} \end{cases}$$

- result: Hausman test
- data: log(Export_ijt_1) ~ log(GDP_it) + log(GDP_jt) + log(POP_it) + …
- chisq = 112.7, df = 11, p-value < 2.2e-16
- alternative hypothesis: one model is inconsistent.

The critical statistic associated with the threshold α is 15.50, it can be seen that the statistic of the test is greater than the critical statistic. In addition, the probability of the Hausman test is zero, therefore less than α, so, we reject Hypothesis H_0 of the presence of random effects. Therefore, the adoption of a fixed effect model should be preferred.

3.1.5 Residue test

3.1.5.1 Heteroscedasticity tests

The error heteroskedasticity test is designed to test the specific hypothesis of error homoscedasticity. Under the null hypothesis, the test assumes that the variance of errors is the same for all individuals.

3.1.5.2 Inter-individual heteroskedasticity test

This test is designed to test the specific hypothesis of inter-individual homoscedasticity. STATA uses a modified Wald test, which is essentially an F test. Under the null

hypothesis, the test assumes that the variance of errors is the same for all individuals and the statistic follows a χ^2 distribution of degree of freedom N = 52.

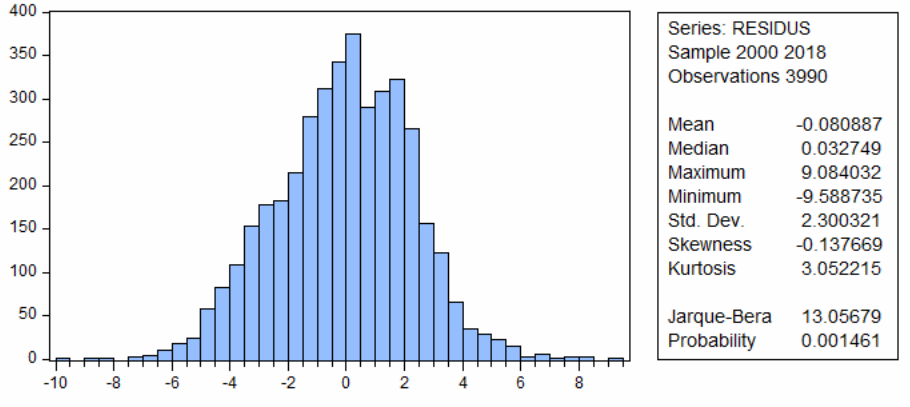
3.1.5.3 Autocorrelation test

We try to check if the errors are auto-correlated

3.1.5.4 Error normality test

The hypothesis test is written: $\begin{cases} H_0 & \text{errors are normally distributed} \\ H_a & \text{errors are not normally distributed} \end{cases}$

Figure 1 Error normality test (see online version for colours)



The result of the test is as follows: JB = 12.799 and P-value = 0.0016.

The P-value of the Jasque and Bera test is 0.0016 which is less than α, we reject the Hypothesis H_a.

So in summary, the presence of individual effects, heteroskedasticity and the normality of the residuals leads us to favour the method of generalised least squares (GLS).

Finally, in our case, we use variants of the EGLS [method: panel EGLS (cross-section)] function of the EViews software. This function estimates the model by GCM and makes it possible to combine the various conclusions with the previous tests. It suffices to specify one of the three choices of panel variance structure.

3.2 Model estimation

The results of the various previous tests make it possible to estimate the model by the GCM method.

The estimate was made from panel data made up of data from the fifteen ECOWAS countries on a 19-year chronological basis (2000 to 2018). This estimate generated 3,990 observations due to the use of bilateral intra-community trade in space. The results of the unit root, Hausman and heteroskedasticity tests are presented in Table 2.

Table 2 Results of estimation

Dependent variable: LOG_Export				
Method: panel EGLS (cross-section weights)				
Date: 07/15/20 Time: 22:19				
Sample: 2000–2018				
Periods included: 19				
Cross-sections included: 210				
Total panel (balanced) observations: 3,990				
Linear estimation after one-step weighting matrix				
Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob.*
C	–3.711793	0.888851	–4.175947	0.0000
LOG_GDP_I	0.968451	0.060360	16.04461	0.0000
LOG_GDP_J	0.114933	0.047616	2.413728	0.0158
LOG_Distance	–1.922783	0.030383	–63.28453	0.0000
LOG_MobilePhoneSubscribers_I	0.046521	0.012724	3.656007	0.0003
LOG_MobilePhoneSubscribers_J	–0.025733	0.012634	–2.036872	0.0417
LOG_CustomsDuties_I	0.838335	0.231527	3.620888	0.0003
LOG_CustomsDuties_J	–0.395547	0.165418	–2.391190	0.0168
LOG_ForeignDirectInvest_I	–0.172759	0.025199	–6.855811	0.0000
LOG_ForeignDirectInvest_J	–0.108503	0.019319	–5.616262	0.0000
LOG_Population_I	0.604357	0.052864	11.43235	0.0000
LOG_Population_J	1.063275	0.055702	19.08880	0.0000
LOG_ExchangeRate	–0.142814	0.012740	–11.20960	0.0000
LOG_ICT_I	0.460747	0.076245	6.042957	0.0000
LOG_ICT_J	0.209394	0.071916	2.911646	0.0036
Weighted statistics				
R-squared	0.798638	Mean dependent var	10.41753	
Adjusted R-squared	0.797928	S.D. dependent var	10.47251	
S.E. of regression	2.282874	Sum squared resid	20,715.76	
F-statistic	1,126.109	Durbin-Watson stat	0.476252	
Prob (F-statistic)	0.000000			
Unweighted statistics				
R-squared	0.581948	Mean dependent var	6.741674	
Sum squared resid	21,133.81	Durbin-Watson stat	0.356171	

Source: Author's calculations

4 Discussion and involvement of economic policies

The probability associated with the Fisher statistic is zero, which reflects a good fit for the whole model.

The variables retained therefore generally explain the evolution of bilateral intra-ECOWAS trade.

In addition, R-squares adjusted equal to 0.7979 is acceptable. This means that on average 79.79% of the variability of exports is explained by the variability of the variables used for the analysis.

The coefficients of the main variables of the model (GDP and distance, population, foreign direct investments and exchange rate) are highly significant at the 1% level. However, the number of telephone subscribers is only significant at the 5% level.

We note that variables such as GDP, populations, investments in ICTs are those that positively influence both exports and imports. Also, variables like GDP, populations, ICT investments, mobile phone subscribers and customs duties are those that positively influence exports.

However, mobile phone subscriptions and customs duties in importing countries have a negative influence on merchandise imports. And variables such as distance, exchange rate and foreign direct investments are variables that negatively influence both exports and export between countries in the ECOWAS zone.

The negative coefficient of distance is an expected result, indicating it as a barrier to ECOWAS intra-trade development. The study of Osabuohien et al. (2017) in ECOWAS zone led to the same results.

The negative coefficient of the exchange rate is an expected result, indicating a negative relationship between the exchange rate of currencies in circulation on the community market and intra-ECOWAS trade flows. This negative relationship between the exchange rate and the intra-ECOWAS trade flows conforms to the result obtained by Gbetnkom in his study in 2013 on the determinants of intra-community trade in the CEMAC zone using the gravity model.

The positive relationship between GDP and intra-ECOWAS trade flows is a theoretically expected relationship that shows that companies tend to export more as their incomes increase and consumers in ECOWAS member countries increase tendency to consume more products imported from other member countries as their incomes increase. The same positive relationship was found Gbetnkom in his study using the gravity model for the CEMAC zone in Central Africa in 2013 and by Osabuohien et al. in their study in ECOWAS zone in 2017.

The positive relationship between population and intra-ECOWAS flows is proof that an increase in population leads to an increase in trade flows. An increase in the population of the exporting country by 1% results in an increase in its current exports of 0.604%. Regarding imports, we see that an increase in the population of the importing country by 1% increases its current imports by 1.06%.

As population contributes to the size of the economy through consumption and the production of wealth, this positive relationship between population and trade flows is a result consistent with that obtained by Osabuohien et al. in 2017 in the same study area.

The positive coefficient of ICT shows that investments in ICT have a positive influence on intra-ECOWAS trade flows. A 1% increase in current ICT investments by exporting countries results in a 0.46% increase in exports. A 1% increase in current ICT investments in importing countries leads to an increase in imports of 0.209%.

The positive and negative relationship between the number of mobile telephone subscribers shows that the number of mobile telephone subscribers has a positive and negative influence on intra-ECOWAS trade flows even if this influence remains weak.

The 1% increase in the number of current mobile phone subscribers in the exporting country leads to an increase in exports of 0.046%. As for imports, we see that a 1% increase in the number of current mobile phone subscribers leads to a decrease of 0.025%.

With regard to customs duties, its positive and negative coefficient shows that this factor has a positive influence on exports but negative on imports.

A 1% increase in the current customs duties of the exporting country leads to an increase in exports of 0.838%. A 1% increase in the current customs duties of the importing country leads to a decrease in imports of 0.395%.

The negative relationship between distances and intra-ECOWAS trade flows is an expected result showing that an increase in distances of 1% leads to a decrease in trade flows of 1.9% of trade flows.

The negative coefficient of foreign direct investment shows that there is a negative relationship between foreign direct investment and trade flows.

An increase in current foreign direct investment of 1% in the exporting country decreases its exports by 0.172%. In terms of imports, it is currently observed that an increase in foreign direct investment of 1% reduces imports by 0.108%.

We could thus retain that an increase in the GDP and investments in ICTs leads to both an increase in exports and imports but an increase in exports more than proportional to that of imports. This could result in an improvement in the trade balance of the trading countries. An increase in foreign direct investment leads to both drop-in exports and imports, but a drop-in export more than proportional to that of imports. This could lead to deterioration in the balance of the trade balance.

The increase in customs duties and mobile phone subscriptions lead to an increase in exports and a decrease in imports, but an increase in exports more than proportional to the decrease in imports. This would result in an improvement in the balance of the trade balance. Distances and exchange rates reduce the volume of exports and imports and in this sense constitute significant barriers to the development of intra-community trade.

Since distances represent barriers to the development of intra-community trade, ICTs remain the only effective means of member states rapprochement, the surest means for the development of their trade. Thus, regional policies should weigh in favour of investments in ICT:

1 by setting up optical fibre to increase the penetration rate and improve internet speeds (passage from 3G to 5G)

2 by increasing the penetration rate of mobile telephony by relaxing equipment import taxes, creating local industries for manufacturing smartphones or mobile telephony devices affordable for users.

The positive influence of the population on intra-community trade is proof that population growth and the free movement of people represent a potential intra-community market for the production and distribution of goods and services. In doing so, community policies favourable to the free movement of people and goods in the ECOWAS region are to be encouraged.

Foreign direct investment does not act favourably on intra-community trade. They are much more profitable for multinationals for the export of raw materials to Europe and Asia, in particular China, and the import of cheaper food and manufacturing products

(dumping), destabilising local production and processing units and stifling thus production and internal trade.

The implementation of such investments deserves to be well studied.

5 Conclusions

The objectives of this study are therefore to identify and analyse the major determinants of intra-ECOWAS trade, to confirm or invalidate whether the use of ICT and related investments have a positive influence on intra-regional trade.

It thus emerged in its conclusions that all the variables targeted at the outset clearly explain the performance of the regional market. The coefficients of the main variables of the model (GDP and distance, population, foreign direct investments and exchange rate) are highly significant.

We note that variables such as GDP, populations, investments in ICTs are those that positively influence both exports and imports.

Also, variables like GDP, populations, ICT investments, mobile phone subscribers and customs duties are those that positively influence exports.

However, mobile phone subscriptions and customs duties in importing countries have a negative influence on merchandise imports. And variables such as distance, exchange rate and foreign direct investments are variables that negatively influence both exports and export between countries in the ECOWAS zone.

The finding that ICTs (use and investment) have a positive influence on the growth of intra-ECOWAS trade is a confirmation of our research hypothesis.

Foreign direct investment does not act favourably on intra-community trade. Yet we note that their growth in volume during the last two decades is becoming increasingly important for all 15 ECOWAS countries. So, the implementation of such investments deserves to be well studied.

The literature review showed that the low quality of infrastructure and the supply of credit homogeneity of products, concentration of trade, free movement of goods and people, size of countries, geographical and cultural proximity, education, working language represent important determinants in intra-community commercial exchanges. Unfortunately, these types of statistical data are not available and are absent from WTO and UNCTAD databases used in this study.

Future research on the major determinants of intra-ECOWAS trade could take this into account.

References

Ackah, C., Turkson, F.E. and Opoku, K. (2012) 'Trade cost and intra-regional trade flows in ECOWAS', *Journal of West African Integration*, Vol. 1, No. 1, pp.1–43.

Anderson, J.E. (1979) 'A theoretical foundation for the gravity equation', *American Economic Review*, Vol. 69, No. 1 pp.106–116.

Anyanwu, J.C. (2014) 'Does Intra-African trade reduce youth unemployment in Africa?', *African Development Review*, Vol. 26, No. 2, pp.286–309.

Association Internationale des Opérateurs de Téléphonie Mobile (GSMA) (2018) *Economie mobile en Afrique de l'Ouest*, Rapport édition 2018.

Babatunde, A.M. and Odularu, G. (2017) 'Understanding bilateral trade flows and negotiating south-south RTAs: lessons and policy directions for the Tripartite Free Trade Area Agreement (TFTA)', in Odularu, G. and Adekunle, B. (Eds.): *Negotiating South-South Regional Trade Agreements: Economic Opportunities and Policy Directions for Africa*, Springer [online] https://link.springer.com/book/10.1007/978-3-319-45569-3#toc.

Berge, C. (1958) *The Theory of Graphs and Its Applications*, 101 editions published between 1958 and 2003.

Bergstrand, J.H. (1985) 'The gravity equation in international trade: some microeconomic foundations and empirical evidence', *The Review of Economics and Statistics*, Vol. 67.

Berthelot J. (2016) 'la folie suicidaire de la zone de libre-échange continentale', *SOL Alternatives Agroécologiques et Solidaires* [online] https://www.sol-asso.fr/wp-content/uploads/2016/06/.

Bonnefoy, J., Pumain, D. abd Rozenblat, C. (1996) 'Théorie des graphes et interactions non gravitaires', in Bocquet-Appel, D., Courgeau, D. and Pumain, D. (Eds.): *Analyse spatiale des données biodémographiques*, pp.171–186, John Libbey/Collection Ined, 367p.

Dadegnon, A.K. and Igué, C.B. (2022) 'TIC et échanges commerciaux dans les pays de l'UEMOA: les résistances multilatérales tiennent-elles toujours?', *Actes de la troisième Conférence internationale sur la Francophonie économique VERS UNE ÉCONOMIE RÉSILIENTE, VERTE ET INCLUSIVE*, 16–18 March, Université Cheikh Anta Diop de Dakar – Sénégal.

Deardorff, A. (1998) 'Determinants of bilateral trade: does gravity work in a classical world?', in Frankel, J. (Ed.): *The Regionalization of the World Economy*, University of Chicago Press, Chicago.

Dickey, D.A. and Fuller, W.A. (1979) 'Distribution of the estimators for autoregressive time series with a unit root', *Journal of the American Statistical Association*, Vol. 74, No. 366, pp.427–431.

Egger, P. and Pfaffermayr, M. (2004) 'Distance, trade and FDI: a Hausman-Taylor SUR approach', *Journal of Applied Econometrics*, Vol. 19, No. 2, pp.227–246.

Evenett, J.S. and Keller, W. (2002) 'On theories explaining the success of the gravity equation', *Journal of Political Economy*, Vol. 110, No. 2.

Eveslage, B. (2015) 'What is the impact of regional trade agreements on economic growth in Sub-Saharan Africa? Case study on the ECOWAS', *TIPS Annual Forum on Regional Industrialisation and Regional Integration*, Johannesburg.

Gbetnkom, D. (2013) 'Intégration régionale et potentialité commerciale dans la CEMAC : une évaluation par le modèle de gravité', *Techniques Financières et Développement 2013/2*, No. 111, p.89.

Osabuohien, E., Efobi, U., Odebiyi, J. and Fayomi, O. (2017) 'Financial development, trade costs and bilateral trade flows: connecting the nexus in ECOWAS', in Seck, D. (Ed.): *Investment and Competitiveness in Africa*, pp.153–176, Springer International Publishing, Geneva.

Osabuohien, E., Okorie, U. and Osabohien, R. (2018) 'Rice production and processing in Ogun State, Nigeria: qualitative insights from farmers association', in Obayelu, E. (Ed.): *Food Systems Sustainability and Environmental Policies in Modern Economics*, pp.188–216, IGI Global, Hershey, PA.

Osabuohien, E.S. et al. (2019) 'Bilateral trade performance in West Africa: a gravity model estimation', *African Development Review*, Vol. 31, No. 1, pp.1–14.

Palomba et al. (2019) 'La zone de libre-échange continentale changera-t-elle la donne en Afrique?', *FMI 2019*.

Steward, J.Q. (1941) 'In inverse distance variation for certain social influences', *Science*, Vol. 93, pp.89–90.

Tinbergen, J. (1962) 'An analysis of world trade flows', *Shaping the World Economy*.

Ukaoha, K. and Ukpe, A. (2013) 'The ECOWAS trade liberalisation scheme: genesis, conditions and appraisal', *ECOWAS Vanguard*, Vol. 2, No. 3, pp.1–12.