Trade Between Waemu And Eu Countries Ante-Brexit : Lessons From A Gravity Model

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Trade Between Waemu And Eu Countries Ante-Brexit : Lessons From A Gravity Model.

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Abstract

The aim of this study is to analyse trade between the member countries of the West African Economic and Monetary Union (WAEMU) and those of the European Union (EU) pre-Brexit over the period 2014-2019. It estimates a gravity model based on panel data. Three econometric estimation techniques are used : the WITHIN method, the Generalised Least Squares (GLS) method and the Hausman and Taylor (HT) method. These different estimation techniques are then compared to determine which is the most appropriate. The data used are secondary data from several sources : the International Monetary Fund (World Economic Outlook), the World Bank (World Development Indicators), the United Nations (UN Comtrade) and the *ephemeride* website. The results show that trade between these two groups of countries is positively and significantly influenced by income in WAEMU countries, infrastructure in WAEMU countries and population in EU countries. They also show that when an EU country is landlocked, its trade flows with WAEMU countries are reduced, while at the same time, the landlocked status of a WAEMU country does not affect its trade with EU countries. Variables such as the bilateral real exchange rate, distance, language and colonial links were found to be insignificant.

Keywords : Trade, trade flows, gravity model, EU, WAEMU and Brexit

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Introduction

The role of trade in economic and social development is beyond doubt (ENDA CACID, 2012). Both economic theory and history show that the growth of international trade is generally favourable to progress (Merle & Porcher, 2014). A whole body of empirical literature also indicates, with solid evidence to back it up, that increased participation in international trade can stimulate economic growth that is essential for development in general (CNUCED, 2014). For Bhagwati (2004), for example, trade is an important instrument for achieving autonomous growth and often a powerful weapon in the fight against poverty. International trade in goods and services, and more specifically imports of capital and production goods, is an important instrument for technology transfer (Verdier, 2013). The development trajectory of certain countries in East Asia and South-East Asia (Hong Kong, Singapore, Taiwan, Thailand, Malaysia, Indonesia, etc.) in the recent past clearly confirms this (CNUCED, op. cit.).

The countries of the West African Economic and Monetary Union (WAEMU) maintain trade relations with a large number of countries (Europe, Africa, America, etc.), and trade with Asia (particularly China) is becoming increasingly important. At the same time, trade with the European Union (EU) is tending to decline, both in terms of exports and imports. Whereas the EU accounted for around half of WAEMU trade in the 1990s, it now accounts for only 22.4% of WAEMU exports and 34.8% of its total imports (Madariaga, 2010 ; BCEAO, 2022).

Despite this decline, the European Union has remained one of the WAEMU's most important partners. In 2020, for example, it was its biggest supplier, accounting for 34.8% of imports, ahead of Asia (33.5%), Africa (14.9%) and America (7.7%). In the same year, with 22.4% of WAEMU exports, it was the region's second largest customer, behind Africa (24.3%), and ahead of Asia (18.5%) and America (5.4%) (BCEAO, 2022). Have factors such as colonial ties, language, distance, etc. played an important role in maintaining trade relations between WAEMU and EU countries ? In other words, what factors have governed trade between the two zones ?

This study, entitled "Trade between WAEMU and EU Countries ante-Brexit : Lessons from a Gravity Model", therefore has the general objective of analysing trade between the member countries of the West African Economic and Monetary Union (WAEMU) and those of the European Union (EU) before Brexit. Specifically, the aim is to examine the factors that stimulate trade between the two geographical entities and to identify the factors that hinder it. This work does not take into account the post-Brexit period, as the number of years after Brexit does not currently allow consistent econometric estimates to be made.

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It should also be noted that the structure of WAEMU exports is dominated mainly by mining products (oil, gold and uranium), whose share is estimated at 38.9% of exports in 2021, and by agricultural products, whose share is estimated at 32.6%, also in 2021. Imports of goods from the region are mainly made up of everyday consumer goods (33.7%), capital goods (22.4%), intermediate goods (17.9%) and energy products (15.1%) (BCEAO, 2022).

The interest of this subject is twofold. On the one hand, the pre-Brexit EU has supplied a significant share of the equipment contributing to the sub-region's economic growth and development, and has long been its main export market. In 2014, for example, it delivered 39.8% of its capital goods to the WAEMU, compared with just 17.6% for China (BCEAO, 2016). Secondly, the "substitution" of certain Asian countries such as China for the EU in the supply of capital goods to the WAEMU has not been a perfect substitution, insofar as this supply has only been limited to the implementation of a few mining and oil projects by these countries.

The rest of the article is organised as follows. Section 1 presents the WAEMU and the EU ante-Brexit. Section 2 reviews the literature, while the methodological approach is presented in Section 3. Section 4 presents and discusses the results of the study. Finally, a conclusion is offered.

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1. Presentation of the WAEMU and the ante-Brexit EU

Here, the WAEMU will be presented first. Then it will be the turn of the pre-Brexit European Union. Finally, the question of export destinations and import sources will be addressed.

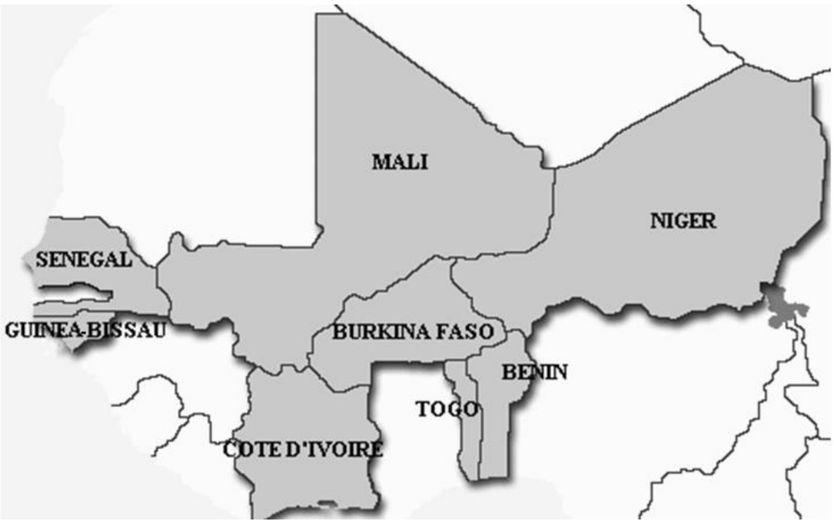
1.1 Presentation of the WAEMU

The West African Economic and Monetary Union (WAEMU) is an international sub-regional organisation. It was created by a treaty[1] signed in Dakar on 10 January 1994 by the seven West African countries that use the CFA franc in common. These are : Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Togo. These countries were joined on 2nd May 1997 by Guinea-Bissau. The headquarters of the WAEMU are in Ouagadougou, Burkina Faso. Today, the West African Economic and Monetary Union has a total of eight Member States :

- Benin
- Burkina Faso
- Côte d'Ivoire
- Guinea-Bissau
- Mali
- Niger
- Senegal
- Togo

These different countries are represented on the map below :

Figure 1 : Map of WAEMU Member States



Source : WAEMU

[1] The treaty establishing the WAEMU, it should be recalled, came into force on 1st August 1994 after ratification by the Member States.

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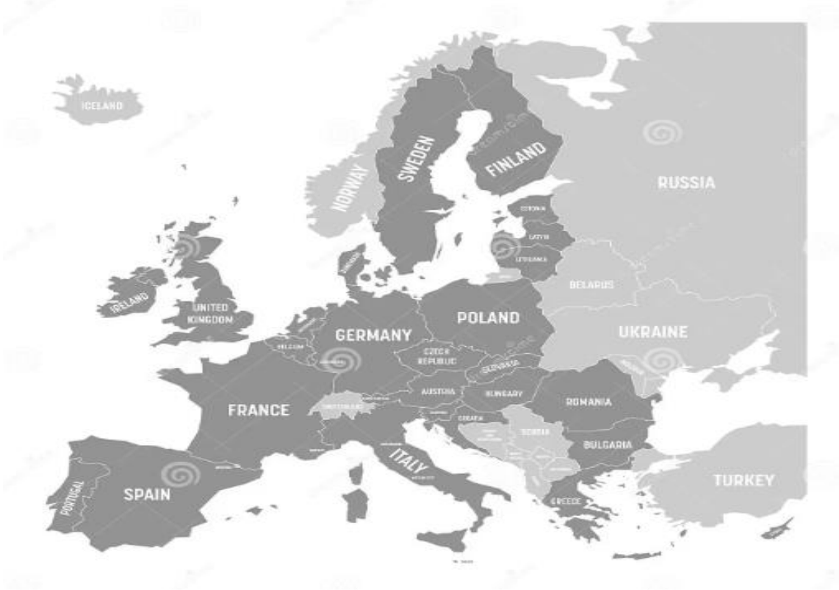
1.2 Presentation of the ante-Brexit EU

The pre-Brexit European Union (EU) was a *sui generis* association of twenty-eight European states that delegated or transferred by treaty the exercise of certain competences to common bodies. It covered an area of 4,493,712 km2, had a population of 505.7 million and was the world's leading economic power. Its member countries were: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Three of these countries (Bulgaria, Croatia and Romania) were not included in the empirical study due to their late accession to the EU.

Figure 2 : Map of pre-Brexit EU Member States



Source : Dreamstime website

1.3 Destinations of WAEMU exports and origins of imports

Here, the main destinations of the WAEMU's exports of goods will be presented before the main origins of its imports of goods are determined.

1.3.1 Destinations of WAEMU goods exports

In 2019, almost half of WAEMU exports of goods (46% of total exports) are destined for Europe, of which 26.3% for the European Union and 19.7% for other European countries. Africa outside the WAEMU is the second largest destination for WAEMU exports.

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Table 1 : Geographical breakdown of WAEMU exports between 2016 and 2019 (%)

	2016	2017	2018	2019
EUROPE	43.6	43.3	42.9	46.0
European Union	*27.9*	*26.8*	*24.5*	*26.3*
Euro zone	*24.8*	*23.9*	*21.8*	*23.2*
Other of which Switzerland	*14.5*	*14.8*	*17.2*	*18.5*
AFRICA	28.3	27.4	25.9	22.9
ECOWAS	15.8	16.1	16.0	12.9
AMERICA	8.2	7.8	7.0	6.4
ASIA	18.9	20.1	22.5	23.1
OTHER COUNTRIES	1.0	1.4	1.7	1.6
TOTAL EXCHANGES	100.0	100.0	100.0	100.0

Source : BCEAO (2022)

1.3.2 Origin of WAEMU goods imports

WAEMU imports come mainly from Europe (particularly the European Union), Asia, Africa and America. Europe remains WAEMU's leading supplier, with an estimated share of 41.9% in 2019. WAEMU purchases on this continent are made mainly in European Union countries (33.4% in 2019).

Table 2 : Geographical breakdown of imports from WAEMU countries (in %) between 2016 and 2019

	2016	2017	2018	2019
EUROPE	39.4	41.7	41.1	41.9
European Union	*34.7*	*36.1*	*33.5*	*33.4*
of which Euro zone	*31.1*	*32.5*	*30.2*	*29.8*
AFRICA	15.1	14.3	15.7	15.0
AMERICA	8.0	6.5	6.9	7.8
ASIA	36.2	36.4	35.4	34.1
OTHER COUNTRIES	1.3	1.1	0.8	1.2

Source : BCEAO (2022)

2. Literature review

The literature on gravity models is abundant. An impressive number of works have been published on the subject. But before presenting a few of them, it is important to note that gravity models were introduced into economics by Tinbergen (1962), by analogy with Newton's gravitational law in physics. This being the case, it is important to begin this review with a presentation of the studies relating to the West African Economic and Monetary Union (WAEMU). While the literature on gravity models is rich, there is very little work on trade

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involving the countries of the West African Economic and Monetary Union (WAEMU) and using a gravity approach. Three studies are mentioned here : Gbetnkom and Avom (2005), Agbodji (2007) and Diop (2007). Gbetnkom and Avom (2005) used a gravity model to estimate the determinants of intra-WAEMU trade, focusing on the impact of the economic reforms of the 1980s and 1990s. They apply the model for the periods 1990-1994 and 1996-2000 on a sample of 25 exporting states and 31 partner states. Their results indicate that regional integration substantially increases trade between member states in the WAEMU after economic reforms. They also show the existence of significant trade potential between the economies of the sub-region. Agbodji (op. cit.) used a dynamic gravity model to study, in the presence of significant unrecorded cross-border trade, the isolated impacts of monetary and economic union on intra-WAEMU trade. His model includes an indicator variable for fraud incentives in cross-border trade. Its results showed that membership of the common monetary area and the implementation of economic reforms had significant effects in terms of diversion of imports and exports. Diop (2007) estimated a gravity model based on bilateral trade data between member countries of the Economic Community of West African States (ECOWAS) for the period 1997-2004. The results of his analyses indicated that geographical and structural factors, as well as membership of a monetary union, in this case the WAEMU, determine the intensity of bilateral trade flows in West Africa. He also found that the impact of the common currency is reflected in net trade creation. In addition to studies on the WAEMU, other studies are worth mentioning. Glick and Rose (2002) sought to verify whether a country leaving a monetary union resulted in a reduction in international trade. To carry out their analysis, these authors used a large panel database covering 217 countries over the period 1948-1997. Glick and Rose (op. cit.) observed that during this period, a significant number of countries had left currency unions and experienced a decline in bilateral trade. They also noted that a pair of countries that began to use a common currency saw their bilateral trade almost double. Carrère (2006) used a gravity model to evaluate regional trade agreements ex-post. Her model includes 130 countries and is estimated with panel data covering the period 1962-1996. She adopts a methodology that allows her to control for Vinerian trade creation and trade diversion effects, while her estimation method takes into account the unobservable characteristics of each pair of trading partner countries, the endogeneity of some explanatory variables as well as a possible selection bias. Her results show that regional agreements have led to an increase in trade between members, often at the expense of the rest of the world. Duc (2007) set himself the objective of verifying whether countries involved in trade preference agreements with democratic constraints trade more with each other. To do this, he uses a panel data gravity model derived from the model of

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Anderson and van Wincoop (2003) and differentiates the types of agreement according to the democratic clauses they contain. His results show that the inclusion of a democratic clause tends to increase trade, particularly when it involves Southern countries. Trotignon (2007) used a panel data gravity model with 3 regional indicator variables to assess the impact of the new free trade agreements signed between Latin American countries in the 1990s. More specifically, he investigated whether the groupings stimulated trade not only between member countries but also with all the sub-continent's partners. His results show that all the selected groupings (Mercosur, Andean Community, Group of 3, Bolivia-Mexico and Chile-Mexico Free Trade Areas) generate intra-regional trade. They also show that, with the exception of the Chile-Mexico agreement, the impact on imports and exports with the rest of Latin America is also positive. The author therefore concludes that the new groups represent building blocks (net creators of trade) for the Latin American region. He also adds that the revival of the regionalisation process in the 1990s is having a knock-on effect across the sub-continent as a whole. Grigoriou (2007) assessed the impact of internal infrastructure and landlockedness on Central Asian trade using a panel gravity equation estimated on a large sample of countries (167 countries over the period 1992-2004). The panel structure of his database allows him to control for specific bilateral effects. His results lead to practical recommendations. Trotignon (2010) estimated the effects on exports of controlling a country's CO_2 emissions relative to its partners using a panel data gravity model. The model specified introduces *dummy* variables corresponding to the internal and external trade flows of regional groups. The results indicate that the reduction in CO_2 emissions is beneficial to the external performance of companies (1986-2003). The author therefore concludes that international climate agreements provide an opportunity to shift national economies towards fossil fuel-efficient technologies and products.

3. Methodology

This section will begin by presenting the theoretical model. It will then specify the empirical model. Finally, it will describe the econometric estimation procedure for the empirical model.µ

3.1 The theoretical model

The model presented here is based on the work of Baier and Bergstrand (2002), Carrère (2002), Anderson and van Wincoop (2003) and Carrère (2006). As Baier and Bergstrand (2002) have shown, when firms in country j set prices for products delivered to the market in country i at $p_{ij} = p_j \theta_{ij}$, an equilibrium trade flow results. The expression for this equilibrium flow is :

$$M_{ij} = \left[\frac{\gamma}{\varphi(1-\sigma)}\right]\frac{Y_j}{p_j} Y_i \left[\frac{p_j \theta_{ij}}{P_i}\right]^{1-\sigma} \left[s_j(1+t_i)(1+t_{ij})^{-\sigma}\right] \quad (1)$$

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with

M_{ij} : the CIF value of the total flow of goods imported by country i from country j ;

σ : the elasticity of substitution between goods ;

γ : a preference parameter for goods ;

φ : the fixed cost faced by each firm ;

$Y_{i(j)}$: the Gross Domestic Product of country i (j) ;

p_j : the price level of the good representative of the exporting country (country j) ;

The price level of this good in country i (CIF price) is given by :

$$p_{ij} = p_j \theta_{ij} \tag{2}$$

where θ_{ij} is a function of the barriers to trade between i and j.

P_i denotes the multilateral resistance of country i and is expressed as follows :

$$P_i = \left[\sum_{k=1}^{N} n_k \left[p_k \theta_{ik} (1 + t_{ik}) \right]^{1-\sigma} \right]^{1/1-\sigma} \tag{3}$$

where :

n_j is the number of varieties of goods produced in country j ;

t_{ij} represents the Ad Valorem tariff applied by country i on the good produced in country j ;

s_j is the share of goods produced in the national product of j ;

t_i indicates the share of tariff revenue in total revenue.

Assuming $t_{ij} = t_{ji}$ and $\theta_{ij} = \theta_{ji}$, Anderson and van Wincoop (2003) show that the solution to equations (1) and (3) is as follows:

$$p_j^* = \left(\frac{s_j Y_j}{n_j Y_w} \right)^{1/1-\sigma} P_j^{-1} \tag{4}$$

Substituting p_j^* into equation (1) and assuming $t_i = 0$ [2] gives :

$$M_{ij} = \left[\frac{\gamma}{\varphi(1-\sigma)} \right] \frac{1}{Y_w} s_j Y_i Y_j \theta_{ij}^{1-\sigma} (1 + t_{ij})^{-\sigma} \left[P_i P_j \right]^{\sigma-1} \tag{5}$$

[2] Because in most countries, tariff revenue represents an insignificant proportion of Gross Domestic Product.

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where Y_w is world production of goods.

This last equation is very close to the gravity equations used in the empirical literature. It suggests that a correct specification should include :

- the logarithm of the product of the GDPs of countries i (Y_i) and j (Y_j) ;
- the GDP per capita or population of the exporting country, N_j, as a proxy for the capital endowment ratio (which determines s_j) ;
- a proxy for the term θ_{ij} ;
- the product of the multilateral resistance terms of the countries making up each pair of partner countries.

Following Carrère (2006), with a slight modification, the function of barriers to trade between country i and country j can be modelled as follows :

$$\theta_{ij} = (D_{ij})^{\delta_1} (IN_i)^{\delta_2} (IN_j)^{\delta_3} \left[e^{\delta_4 L_{ij} + \delta_5 E_i + \delta_6 E_j + \delta_7 C_{ij}} \right] \qquad (6)$$

with

D_{ij} : the distance between country i and country j ;

$IN_{i\,(j)}$: the infrastructure index of country i (j) constructed from four variables (the total number of kilometres of road, the number of kilometres of paved roads, the number of kilometres of rail and the number of fixed telephone lines per person) using the approach followed by Limão and Venables (2001), Carrère (2002), and Carrère (2006) ;

L_{ij} : the binary variable for sharing an official language. It takes the value 1 if country i and country j share the same official language, and 0 otherwise ;

$E_{i\,(j)}$: the landlocked variable for country i (j). This is a binary variable which takes the value 1 if country i (j) has no access to the sea, and 0 otherwise ;

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C_{ij} : the binary colonial link variable, which is equal to 1 if country i and country j have colonial links, and 0 otherwise.

There are three methods for determining the multilateral resistance factors P_i and P_j. The first is to use non-linear estimation techniques. The second involves country fixed effects.
The third involves the use of proxies called "remoteness" instead of multilateral resistance terms. Carrère (2006) has identified certain weaknesses associated with the use of the first two methods.

The third method will be used here. The multilateral resistance terms P_i and P_j will therefore be replaced by *remoteness* indices denoted R_i and R_j. The expressions for these indices will be given later in the article.

Taking into account the various modifications mentioned above and using logarithms, we obtain the following expression :

$$\begin{aligned} \ln M_{ij} = {} & \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_j + \beta_4 \ln R_i + \beta_5 \ln R_j + \beta_6 \ln IN_i + \beta_7 \ln IN_j \\ & + \beta_8 \ln D_{ij} + \beta_9 L_{ij} + \beta_{10} E_i + \beta_{11} E_j + \beta_{12} C_{ij} + \omega_{ij} \end{aligned} \quad (7)$$

where $[\gamma/\varphi(1-\sigma)]1/Y_w$ is in the constant term and ω_{ij} is the error term.

We expect : $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 < 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_6 = (1-\sigma)\delta_2 > 0$, $\beta_7 = (1-\sigma)\delta_3 > 0$, $\beta_8 = (1-\sigma)\delta_1 < 0$, $\beta_9 = (1-\sigma)\delta_4 > 0$, $\beta_{10} = (1-\sigma)\delta_5 < 0$, $\beta_{11} = (1-\sigma)\delta_6 < 0$, $\beta_{12} = (1-\sigma)\delta_7 > 0$

3.2 The empirical model

Specifying equation (7) as a panel and taking account of the competitiveness of economies through the real exchange rate gives the following model :

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_0 + \alpha_t + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{jt} + \beta_4 \ln R_{it} + \beta_5 \ln R_{jt} + \beta_6 \ln IN_{it} \\ & + \beta_7 \ln IN_{jt} + \beta_8 \ln D_{ij} + \beta_9 L_{ij} + \beta_{10} E_i + \beta_{11} E_j + \beta_{12} C_{ij} + \beta_{13} \ln RER_{ijt} + \mu_{ij} + \nu_{ijt} \end{aligned} \quad (8)$$

with

α_0 : an effect common to all years and all country pairs ;

α_t : an effect specific to each year and common to all country pairs ;

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μ_{ij} : an effect specific to each pair of countries and common to all years ;

ν_{ijt} : the error term

RER_{ijt} : the real exchange rate, which is calculated as follows :

$$RER_{ijt} = (CPI_{jt})/(CPI_{it}).(NER_{it/\$t}/NER_{jt/\$t})$$

with

$NER_{i\,(j)\,t/\$t}$: the conversion rate of 1 US dollar into the currency of country i (j) at date t ;

$CPI_{i\,(j)\,t}$: the consumer price index for country i (j) in period t.

R_{it} : the remoteness index for country i. It is calculated as follows[3] :

$$R_{it} = \sum_j w_{jt} D_{ij} \text{ for } i \neq j \text{ and with } w_{jt} = \frac{Y_{jt}}{\sum_j Y_{jt}} \text{ for all } i$$

R_{jt} : the remoteness index for country j. Its expression is :

$$R_{jt} = \sum_i w_{it} D_{ij} \text{ for } i \neq j \text{ and with } w_{it} = \frac{Y_{it}}{\sum_i Y_{it}} \text{ for all } j$$

The other variables in the model have already been defined.

3.3 The estimation procedure

It starts with two tests : the two-tailed effects test and the time effects test. In the first case, a Fisher test will be used to check the joint nullity of the two-sided effects. In the second case, the Fisher test will again be used to examine the joint nullity of the time effects. Turning to the estimation aspect proper, it should be noted that the two classic techniques for estimating panel data models are the fixed-effects method and the random-effects method. However, these estimation techniques have a number of limitations. The fixed-effects method does not allow the coefficients of time-invariant variables to be estimated. Such variables are of proven importance for gravity models such as the one studied here (distance, common language, isolation, colonial ties, etc.). The random effects method, for its part, makes it possible to remedy this weakness of the fixed effects method, while also having its own limitations. For

[3] See Grigoriou (2007)

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example, it does not take into account individual fixed effects (or bilateral fixed effects, as is the case here) which are likely to be present when we have a heterogeneous sample of individuals (or pairs of countries, as is the case here). To overcome the weaknesses of the two classic techniques mentioned above, another estimation method has been developed : the *Hausman and Taylor (1981) method*. It is based on the instrumental variables procedure and allows both time-varying and time-invariant explanatory variables to be taken into account, while correcting for the endogeneity of variables correlated with bilateral effects (Duc, 2007). Egger (2005) shows that the Hausman and Taylor (op. cit.) estimator is consistent and that its performance is at least equal to that of the random effects estimator and the fixed effects estimator. From the above, it is clear that the best method for estimating model (8) is that of Hausman and Taylor (op. cit.). Although the Hausman and Taylor (op. cit.) method is clearly the most appropriate here, the other methods will also be used and the Hausman (1978) test will be used to compare the results of the different techniques. It will also be used to identify endogenous variables.

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The data used in this study come from several sources, which are presented in the table below:

Table 3 : Data sources

Variables	**Descriptions**	**Sources**
M	Imports	http://comtrade.un.org/data/
Y	Gross Domestic Product	IMF World Economic Outlook (WEO) 2021
N	Population	IMF World Economic Outlook (WEO) 2021
R	Multilateral resistance	Calculated from WEO 2021 data and data from the *ephemeride* website
RER	Real exchange rate	Calculated from WEO 2021 and World Development Indicators (WDI) 2021 data
IN	Infrastructure	Calculated from WDI 2021 and WEO 2021 data
D	Distance	http://www.ephemeride.com
L	Language	Binary variable which takes the value 1 if the partner countries share the same official language, and 0 otherwise
E	Enclavement	Binary variable which takes the value 1 if the country has no access to the sea, and 0 otherwise
C	Colonial link	Binary variable which takes the value 1 if the partner countries have colonial links, and 0 otherwise

Source : author

The statistical processing of the various data and the econometric estimations were carried out using STATA 12.0 software.

4. Results and discussion

The results will first be presented and then discussed.

4.1 Results

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The results of the estimates are shown in the table below :

Table 4 : Estimation results for the gravity model

(dependent variable: logarithm of imports (in US dollars) of country i from country j at date t)

Variables	WITHIN		GLS		HT	
	(1)	(2)	(3)	(4)	(5)	(6)
LnYi	2.546	0.486	4.720	1.628	2.811	0.694
	(1.70)*	(0.72)	(9.24)***	(5.97)***	(2.34)**	(2.14)**
LnYj	0.519	0.076	0.516	-0.728	0.418	-0.098
	(1.02)	(0.15)	(1.31)	(2.51)**	(1.00)	(0.31)
lnNj	1.660	0.879	1.213	2.480	1.360	1.890
	(0.57)	(0.31)	(2.30)**	(5.39)***	(2.29)**	(3.63)***
lnRi	-64.639	-3.697	7.071	27.590	11.929	13.975
	(1.01)	(0.13)	(0.41)	(1.87)*	(0.57)	(0.86)
lnRj	63.297	-14.804	16.393	29.607	14.198	9.534
	(0.74)	(0.35)	(1.33)	(2.54)**	(0.93)	(0.69)
lnRERij	-0.831	-0.986	0.066	0.241	-0.072	-0.059
	(0.76)	(0.98)	(0.21)	(0.77)	(0.19)	(0.16)
lnINi	0.620	2.034	1.053	2.080	1.705	2.967
	(0.49)	(1.97)**	(1.34)	(2.67)***	(1.72)*	(3.64)***
lnINj	-1.053	-1.058	0.300	0.328	-0.077	0.023
	(1.09)	(1.09)	(0.52)	(0.55)	(0.12)	(0.04)
lnDij			-19.539	-31.278	-18.042	-13.579
			(1.67)*	(2.83)***	(1.24)	(1.04)
Lij			0.248	2.131	1.451	2.479
			(0.12)	(1.06)	(0.58)	(1.05)
Ei			1.242	4.855	3.605	7.094
			(0.54)	(2.20)**	(1.11)	(2.77)***
Ej			-4.934	-4.922	-5.327	-5.480
			(3.52)***	(3.45)***	(3.02)***	(3.26)***
Cij			2.597	0.959	1.427	0.396
			(0.92)	(0.33)	(0.40)	(0.12)
B.Effect	Yes	Yes	Yes	Yes	Yes	Yes
T.Effect	Yes	No	Yes	No	Yes	No
Obervat.	1200	1200	1200	1200	1200	1200
Pairs	200	200	200	200	200	200
H. GLS vs W.			17.45**	-7.32		
H. HT vs GLS					-9.70	-11.33
H. HT vs W.	9.70	9.65				

* p<0,1; ** p<0,05; *** p<0,01

WITHIN= Within method, GLS= Generalised Least Squares method, HT= Hausman and Taylor method, B. Effect= bilateral effect, T. Effect= time effect, Obervat.= number of observations, Pairs= number of country pairs, H. GLS vs W.= Hausman test GLS versus WITHIN, H. HT vs GLS= Hausman test HT versus GLS, H. HT vs W.= Hausman test HT versus WITHIN. Estimates using the HT method were made using Y_i and Y_j as endogenous variables[4].

Source : our estimates

[4] These two variables are the ones most often suspected of endogeneity in gravity models.

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4.2 Discussion

Although the literature indicates that the Hausman and Taylor (1981) method is the most appropriate for estimating a gravity model with time-invariant variables, other estimation techniques (WITHIN and GLS[5]) have also been used, mainly for comparison purposes. The Hausman test (1978) was used to make these various comparisons. It was also used to identify the endogenous variables. If the estimates were made with and without a time effect, only the results without a time effect will be discussed, since the null hypothesis of joint nullity of the time effects could not be rejected. The p-value associated with this test is 0.1193. The test for the bilateral effect gives a probability equal to 0. The null hypothesis of joint nullity of the bilateral effects was therefore rejected, which justifies the inclusion of this effect in all the equations in table 2. The chi2 statistic for the Hausman GLS versus WITHIN test is negative (-7.32). This can be interpreted as evidence that the null hypothesis that the GLS estimator is efficient and convergent is not rejected. In this case, the GLS estimator is preferred to the WITHIN estimator. The Hausman HT versus GLS test also provides a negative chi2 statistic (-11.33). This can also be interpreted as evidence that the null hypothesis that the HT estimator is less biased than the GLS estimator is not rejected. The HT estimator is therefore preferred to the GLS estimator. The p-value of the Hausman HT versus WITHIN test is 0.1403. The null hypothesis that the HT estimator is unbiased cannot be rejected. In these circumstances, the HT estimator is preferred to the WITHIN estimator, thus revealing the endogenous variables of the model, which are Y_i and Y_j . This result was to be expected, since the number of time-varying exogenous variables (6, N_j, R_i, R_j, RER_{ij}, IN_i, IN_j) is greater than the number of invariant endogenous variables (0) (Baltagi, 2005). The latest developments clearly show that the results obtained from estimates using the Hausman and Taylor method are better than the others. These results indicate that trade between WAEMU countries and those of the ante-Brexit European Union is positively and significantly influenced by the income and infrastructure of WAEMU countries and by the population of European countries. In fact, a 1% increase in the income of WAEMU countries translates into an increase in trade flows between these countries and those of the pre-Brexit EU of around 0.69%. Similarly, a 1% increase in the level of infrastructure in WAEMU countries leads to an increase in trade flows between these countries and those of the pre-Brexit EU of around 2.97%. A demographic growth rate of 1% in pre-Brexit EU countries leads to an increase in trade flows between these countries and those of the WAEMU of around 1.89%. The coefficient on the landlockedness variable for WAEMU countries is positive and

[5] Generalized Least Squares

significant (7.09). It does not have the expected sign. It could be said that this indicates that the fact that a WAEMU country is landlocked does not affect its trade with the pre-Brexit EU countries. The landlockedness variable for pre-Brexit EU countries has a negative and significant coefficient. This means that when a pre-Brexit EU country is landlocked, its trade flows with WAEMU countries are reduced. The sign of the coefficient on the *income* variable for ante-Brexit EU countries is opposite to the expected sign, but insignificant. The other variables in the model (terms of multilateral resistance for WAEMU countries and pre-Brexit EU countries, bilateral real exchange rate, infrastructure in EU countries, distance, language and colonial ties) have coefficients that have the expected signs, but are insignificant.

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Conclusion

The aim of this study was to analyse trade between the member countries of the West African Economic and Monetary Union (WAEMU) and those of the European Union (EU) ante-Brexit over the period 2014-2019 using a gravity model. The data used have a panel structure. The results indicate that trade between WAEMU countries and the European Union is positively and significantly influenced by income and infrastructure in WAEMU countries and by the population of pre-Brexit EU countries. They have also shown that when a pre-Brexit EU country is landlocked, its trade flows with WAEMU countries are reduced, while at the same time being landlocked for a WAEMU country in no way affects its trade with EU countries. They also revealed that variables such as EU countries' income, WAEMU countries' multilateral resistance term, EU countries' multilateral resistance term, bilateral real exchange rate, EU countries' infrastructure, distance, language and colonial link are non-significant variables.

In view of the results obtained, the study recommends :

- ✓ WAEMU Member States to step up investment in infrastructure, in particular; this will enable them to further develop trade with EU countries, thus benefiting from a significant transfer of technology (given the structure of their imports on the one hand, and the lessons of Verdier on the other), achieve autonomous growth and combat poverty (in line with Bhagwati's deductions) ;

- ✓ the landlocked countries of the post-Brexit EU to strengthen cooperation with maritime countries in order to facilitate the transport of goods; this will give the WAEMU countries access to a much larger and more diversified volume of goods from the EU, and will certainly also help to sell commodities.

The United Kingdom's exit from the EU should not significantly affect trade between the WAEMU and the EU, since the political variable (colonial link) and the cultural variable (language) are insignificant in the model. This is all the more true given that the WAEMU countries have neither political proximity (colonial ties) nor cultural proximity (language) with the United Kingdom. In terms of future prospects, the Brexit issue could be the subject of a more in-depth and extensive study in another paper.

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