

Effects of Trade Facilitation on Trade Performance in Africa: Implication for agri-food sector

by

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Abstract

International trade is now an embodiment of the new order of the global economy, as it ensures the movement of goods and services, and the factors involved in the production of these goods and services from one country to the other. In this paper, we analyze the effect of trade facilitation on trade performance in Africa with a focus on agri-food trade using a structural gravity model. For our first objective, we use the principal component analysis to construct four aggregate indicators of trade facilitation in African countries over the period 2007-2020. The second objective establishes the role of digital trade policies captured by the Regional Digital Trade Integration Index (RDTII) and the Digital Service Trade Restrictiveness Index (DSTRI) on trade in goods and services respectively in Africa. The results with Poisson Pseudo-Maximum Likelihood (PPML) method show that facilitating trade improves trade performance in Africa. Specifically, trade facilitation indicators such as physical infrastructure and Information Communication Technology (ICT) positively and significantly affect Africa's trade in goods, specifically in the agrifood sector. More interestingly, the results underscore that the better the level of trade facilitation, the larger the extent of trade flows. Findings also show that less conducive environment for digital trade assessed through RDTII and DSTRI negatively affect Africa's trade in goods and trade in services, respectively. These findings indicate that African governments should facilitate trade through the reduction of trade cost for better trade performance. Moreover, our findings underscore the importance of digital trade policies in boosting intra-African trade and therefore call for the adoption, domestication, and effective subsequent implementation of the AfCFTA Digital Trade Protocol.

Keywords: Trade facilitation, agrifood trade, structural gravity model, RDTII, DSTRI.

Jel Classification : F13 ; F14 ; Q17.

1- Introduction

International trade has been presented as one of the solutions to the development problems that developing countries in general, and those in Africa in particular, suffer from¹. It is now an embodiment of the new order of the global economy, as it ensures the movement of goods and services, and the factors involved in the production of these goods and services from one country to the other (Sakyi and Afesorgbor, 2019).

In 2018, African governments signed the Agreement establishing the African Continental Free Trade Area (AfCFTA)² which increased the political momentum for deepening regional integration. The AfCFTA has the potential to transform African economies and diversify the sources of growth and exports in a region where the expansion of cross-border trade has been undermined by tariff and Non-Tariff Barriers (NTBs) (ECA, 2018 ; Green et al., 2019 ; Fofack, 2020). Indeed, the AfCFTA agreement aims to harmonize customs procedures and to reduce tariffs and non-tariff measures (NTMs) among regional trade partners and bears great potential to redefine and improve Africa role in global and agricultural trade (ECA and CEPII, 2021; Fofack et al., 2021).

The current state of Africa in the world trade shows that African countries trade mostly with non-African partners, and the share of intra-African trade is about 15% of the African trade volumes (United Nations Economic Commission for Africa (ECA), 2021). At sectoral level, statistics show that intra-African agri-food trade still represents a small share of continental exports (~20 per cent) and imports (~15 per cent) (Bouët et al., 2021). In value terms, intra-African trade in agricultural products declined by 3.5 percent in 2020 compared to 2019 (Bouët et al., 2022).

Given the essential role that international trade and supply chains play in accessing essential supplies, many countries have renewed their efforts to simplify trade. In the narrow sense, Trade Facilitation (TF) is the simplification and harmonization of international trade procedures, with trade procedures being the activities, practices, and formalities involved in the collection, presentation, communication, and processing of data necessary for the movement of goods in international trade (WTO, 2015). More broadly, TF includes issues of transport infrastructures and transit, customs efficiency, institutional reforms, banking and

¹ The importance of international trade in the development process is proven by both theories and facts (see the international trade theories (Melitz, 2003).

² Note that the road to African integration began in 1991, when the African heads of state and government signed the Treaty Establishing the African Economic Community (Abuja Treaty), setting out the guiding principles and objectives to strengthen integration.

insurance (Spence and Karingi, 2011 ; Portugal-Perez and Wilson, 2012 ; Seck, 2016 ; Seck, 2017 ; Sakyi et al., 2018 ; Takpara et al., 2023). In this study, we based our analysis to the potential effect of trade facilitation using the broader aspect, specifically, the physical infrastructure, ICT, business environment as well as the border and transport efficiency variables. In the context of limited government budgets, choosing broader TF variables could help policymakers to prioritize among the various policy options.

Many reasons explain the focus of our study on the effects of trade facilitation on African trade flows. First, African countries implementation rate (sub Saharan Africa) (49.1%) of the World Trade Organization (WTO) Trade Facilitation Agreement (TFA) is low compared to other developing regions namely South-East and East Asia (75.3%), and Latin America and the Caribbean (72.1%) (United Nations, 2022). According to the World Bank, (2020) the maximization of the positive impacts of AfCFTA (greater integration) required significant efforts in terms of trade facilitation. Second, increased trade flows among African countries would result in greater gains for most African countries by spurring significant economic expansion. ECA, (2021) estimates that successful implementation of the AfCFTA would result in a major boost to intra-African trade. Moreover, the study also finds that the AfCFTA will help Africa to industrialize and reduce its dependence on energy and mining exports. Third, additional emphasis on agriculture trade is explained by the fact that it has a much greater impact on reducing poverty and improving food security than the other sectors of the economy (Irz et al., 2001 ; Majid, 2004; Pawlak and Kołodziejczak, 2020). Moreover, in 2022, the employment in agriculture sector in Africa is 52% of total employment compared to 37% and 11% in services and industry sectors respectively (World Development Indicators stat, 2023). An investigation of the economic literature on trade facilitation shows that there are a voluminous number of studies regarding its effects on trade flows in Africa. However, the existing literature suffers from two important and related defects. First, studies have mainly focused on the narrow aspect of trade facilitation (Wilson et al., 2003; Moïsé and Sorescu, 2013; Seck, 2016, 2017; Odebiyi and Alege, 2019; Sakyi and Afesorgbor, 2019). However, studies such as the one of Portugal-Perez and Wilson, (2012) and Seck, (2017) used the broader aspect of trade facilitation on trade flows in Africa with a limitation in terms of sample and coverage. Indeed, Seck, (2017) has analyzed TF effects on the trade of 41 sub-Saharan African (SSA) for only 2 years (2007 and 2012) and found that the quality of the trading environment would generate significant export gains. Portugal-Perez and Wilson, (2012) for their part have worked on 100 developing countries including a few SSA countries for the period 2004-2007. Second, the bulk of these empirical studies between trade facilitation and trade performance in

Africa do not provide a focus on agrifood trade in their analysis except studies from other regions (Duval et al., 2018 ; Fang and Shakur, 2018 ; Bueno Rezende de Castro and Kornher, 2023). In fact, the agricultural sector is at the core of African economy and could play a strategic role in improving the availability of food and achieving food security (Smutka et al., 2009; Wegren and Elvestad, 2018). Moreover, it offers great potential for low and middle-income countries to generate additional income and to diversify their export structures into non-traditional export sectors (Bueno Rezende de Castro and Kornher, 2023).

Considering the above related defects, the aim of this study is **to analyse the effects of trade facilitation on Africa's trade with a focus on agrifood trade.**

The study contributes to the literature in two ways. First, it focuses on the effect of trade facilitation on two dimensions of trade in Africa which are: i) bilateral trade in goods, and; ii) bilateral trade in agrifood. In fact, to our knowledge, this is the first study that investigates the role of trade facilitation on Africa's bilateral trade with a focus on agri-food trade using a panel regression. Second, we analyzed the effects of TF on Africa's trade by conducting a detailed structural gravity model based on PPML estimator to deal with heteroskedasticity and zero trade observations and a robust set of fixed-effects (bilateral country-pair, importer, exporter, and time) to mitigate endogeneity bias.

The rest of this paper is structured as follows: section 2 presents the literature review on the subject matter, while section 3 presents some facts related to trade facilitation in Africa. Section 4 outlines the data and methodology used for the analysis. Section 5 presents the results. Section 6 concludes with a set of policy recommendations provided.

2- Background and literature review

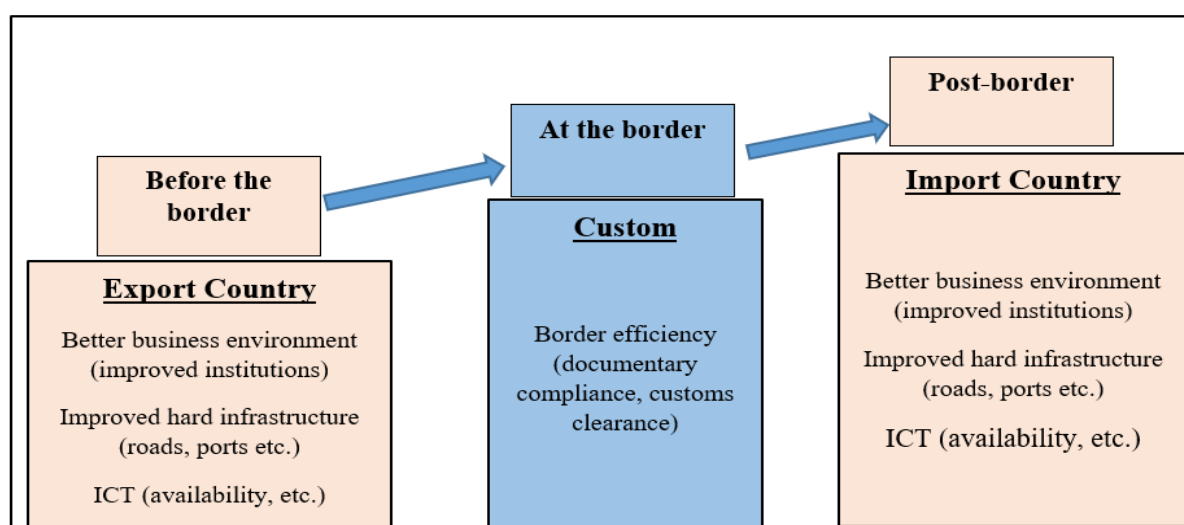
Trade facilitation is both a policy objective and a process to reduce trade costs. As a country's trade costs increase, its ability to trade according to international trade theories decreases according to various trade theories, including about comparative advantage, theory of intra-industry trade, heterogeneous firms' theory. In 1817, David Ricardo introduced the theory of comparative advantage to explain trade between two countries. Ricardo's work is at the heart of all trade models to explain that trade emerges between countries according to their ability to produce goods differently. Krugman (1980) in the theory of intra-industry trade notes that inefficient trade procedures lead to higher trade costs; increase the price of foreign varieties and thus reduce trade. For the author, the reduction of these trade costs through trade facilitation measures promotes intra-industry trade (WTO, 2015). Melitz (2003) in the theory of heterogeneous firms have added that reducing trade costs through trade facilitation will increase a country's exports at the intensive margin (existing exporters increase the volume of

their exports) and extensive margin (increase in exports resulting from the entry of new firms into the export market).

As trade liberalization has resulted in economic gains from tariff reductions between nations worldwide, the cost of the actual movement of goods across borders has become increasingly important (Martinez-Zarzoso and Márquez-Ramos, 2008; Portugal-Perez and Wilson, 2012; Bonuedi et al., 2020). There will always be trade costs when goods have to move between or within countries, and there is always a desire to keep them as low as possible in order to facilitate movement along a supply chain. Efforts designed to reduce the cost and time to export and import goods are the key metrics in trade facilitation. These metrics should consider the entire supply chains. According to Rippel (2011), a more comprehensive approach to trade facilitation should examine the costs that traders and producers face; from producer's door in the exporting country until the delivery of their goods and services to the overseas buyer (consumer) in the importing country. Ideally, such costs should include all the direct and indirect transaction fees associated with the trading process.

Figure 1 below show how trade facilitation process can help movement of products from the exporter country to the importer country. Facilitating trade broadly (reduction of border costs, better business environment, improved infrastructure) has the potential to increase trade by accelerating the movement of agrifood products across borders. The process can be decomposed in 3 steps: i) before crossing the border with costs incurred within the country of origin; ii) at the border with customs/clearance related costs, and iii) post-border with costs incurred in the country of destination. Facilitating trade through reduction of these costs will also ensure timely delivery of goods to international markets.

Figure 1: main trade facilitation steps based on the nature of barriers.



Source: Author based on the literature.

Empirically, there are two categories of studies on trade facilitation (those using the narrow definition and those using the broad definition by integrating infrastructure in their analysis). Firstly, the empirical works on the effects of trade facilitation on expanding trade have used more the narrow aspect of TF (see: Hendy and Zaki, 2021; Töngür and al, 2020; Odebiyi and Alege, 2019; Bourdet and Persson, 2014; Marti et al., 2014; Tosevska-Trpcevska and Tevdovski, 2014). Indeed, Töngür and al. (2020) in their study have examined the effects of logistics infrastructure on export variety, as measured by the extensive margin using gravity model. Their estimates suggest that logistics infrastructure positively influences export values and has a greater impact on the extensive margin than the intensive margin. However, using a gravity model, Odebiyi and Alege (2019) analyze the effects of trade facilitation on trade in ECOWAS. They show that the TF indicators used in the model such as administrative procedures in exporting and importing countries do not have a significant influence on bilateral trade in ECOWAS. In another approach, Hendy and Zaki (2021) have investigated the impact of administrative barriers to trade on firms' exports using Egypt firm-level data for the period 2005–2016 in a gravity model. They found that at the sectoral level that while agriculture and manufacturing are affected by time delays, fuel is not. Also, their results confirms that perishable and seasonal products are found to be more sensitive to time to trade than other products. Secondly, few empirical studies integrate the infrastructure aspect, (see: Wilson et al., 2003; Portugal-Perez and Wilson, 2012; Seck, 2017 ; Noureen and Mahmood, 2022). Noureen and Mahmood (2022) examined the effects of different trade cost components on bilateral export flows via the dynamic panel gravity model. The results show that overall trade costs tend to decline overtime. Additionally, they found that the costs associated with non-tariff barriers in emerging countries have a greater role in the continuation of higher trade costs, in comparison to tariffs.

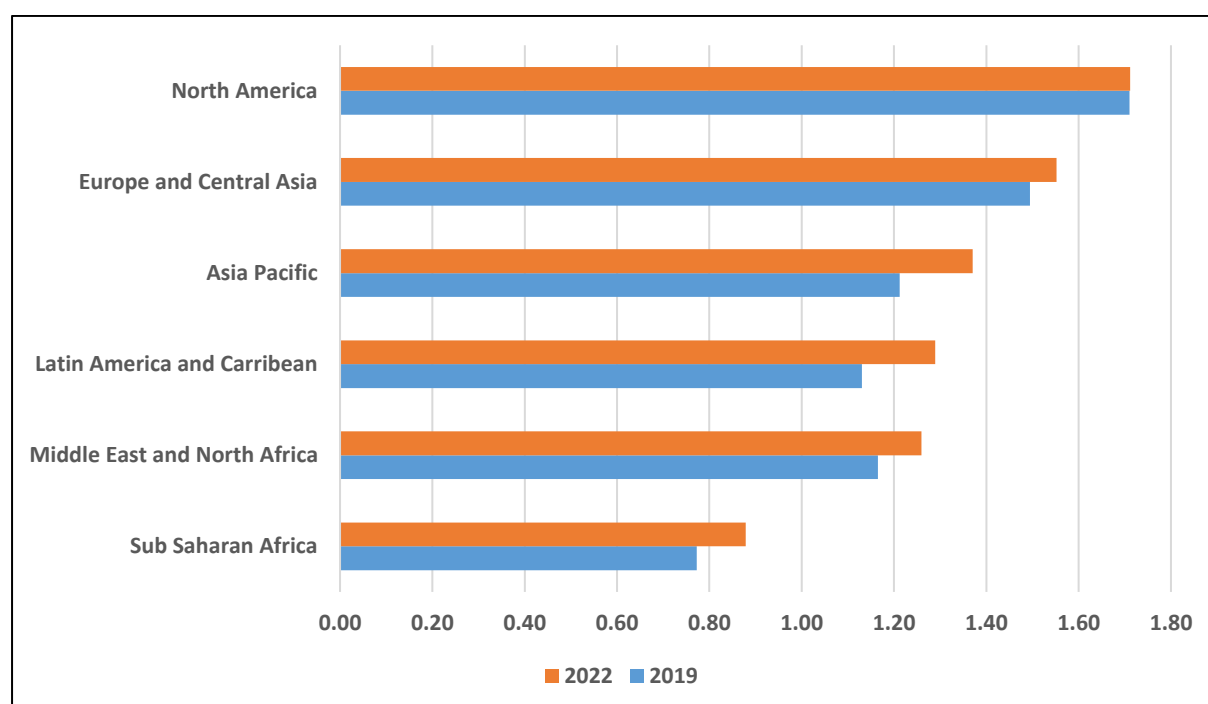
Some authors have also used trade facilitation variables to analyse their effect on agri-food trade in their studies (Duval et al., 2018 ; Fang and Shakur, 2018 ; Ibrahim et al. 2022 ; Bueno Rezende de Castro and Kornher, 2023). Indeed, Duval et al. (2018) in their study have shown that full implementation of both binding and non-binding measures in the WTO TFA is associated with an average 15% trade cost reduction in Asia-Pacific. Additionally, full implementation of binding and non-binding WTO TFA measures together with other paperless and cross-border trade facilitation measures is projected to decrease trade costs by more than 26%. Finally, Bueno Rezende de Castro and Kornher, (2023) for their part analyzed the effect of trade and customs digitalization on agrifood trade in Asian and sub-Saharan African countries. Using a cross-country data on a gravity model with fixed effects, they found that a

one-standard deviation improvement in e-trade facilitation at the exporter level and in non-tariff measures digitalization at the importer level increase agrifood exports by 9.7 per cent and 1.3 per cent, respectively for SSA and Asian countries.

3- Stylized facts

Figure 2 below shows the comparative analysis of the average trade facilitation performance in different regions of the world. Based on 11 trade facilitation indicators³ of OECD which capture the WTO-TFA, the figure shows that, Africa (SSA and North Africa) has the lowest scores of all the regions. The scores range from 0 (low) to 2 (high). Indeed, SSA has scored 0.77 in 2019 and 0.88 in 2022, while scores are 1.21 and 1.37 in Asia Pacific for the same years, respectively. We can see that the continent has progressed between 2019 and 2022 but remain low compared to other. The region with the highest trade facilitation performance is North America with a score of 1.71 in 2022.

Figure 2: Average trade facilitation performance



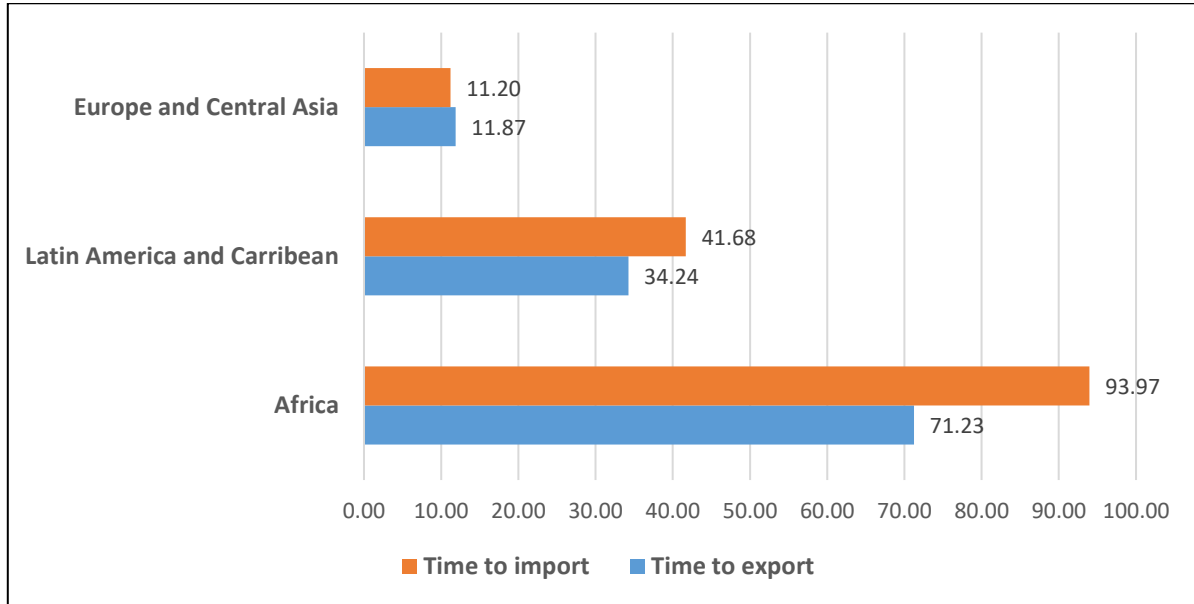
Source: Author construction based on OECD data (2023).

Figure 3 below shows the average number of days/hours required to export/import a product in the world. As with the OECD data, the doing business (world bank data) also shows that, Africa has relatively inefficient trade procedures compared to other regions. Indeed, for Africa

³ The OECD TF data includes: A-Information availability; B-Involvement of the trade community; C-Advance rulings; D-Appeal procedures; E-Fees and charges; F-Documents; G-Automation; H-Procedures; I-Internal border agency co-operation; J-External border agency co-operation; K-Governance and impartiality.

it takes on average over 71 hours to export and nearly 94 hours to import a good, whereas it only takes on average around 11 hours to export or import a good in Europe and Central Asia. This situation shows how inefficient are trade procedures in Africa.

Figure 3: Average number of hours to export/import a good



Source: Author calculation based on Doing Business data (2023).

4- Methodology

In this section we describe our methodology to achieve the objective. The empirical specification is first provided, followed by the estimation strategy and the description of data used.

4-1 Theoretical foundation and econometric specification

4-1-1 Theoretical foundation of structural gravity model

The econometric analysis for the effect of trade facilitation on Africa's trade is based on a structural gravity model. This model theoretical works under the assumptions that goods are differentiated⁴ by place of origin (Armington, 1969) and that consumer preferences are homothetic, identical across countries, and approximated by a constant elasticity of substitution (CES) utility function. We use a generic structural gravity model described by the following standard system of equations (Anderson and van Wincoop, 2003 ; Head and Mayer, 2014 ; Yotov et al., 2016 ; Anderson et al., 2018).

$$X_{ij} = \left(\frac{T_{ij}}{\Pi_i P_j} \right)^{1-\sigma} Y_i E_j \quad (1)$$

⁴ Note that, gravity model still works even the product are not differentiated.

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{T_{ij}}{P_j} \right)^{1-\sigma} E_j \quad (2)$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{T_{ij}}{P_j} \right)^{1-\sigma} Y_i \quad (3)$$

where X_{ij} denotes bilateral trade flows between country i and country j ; Y_i is the production in country i and equals its total sales to all countries $Y_i = \sum_j X_{ij}$; E_j represents the expenditure in country j and equals the sum over all imports $E_j = \sum_i X_{ij}$; T_{ij} is a function of bilateral trade costs between i and j while Π_i and P_j are outward and inward multilateral resistance terms. According to Fally (2015), these multilateral resistance terms can be interpreted as a measure of the exporter's access to foreign markets and the degree of competition in the importer's market.

4-1-2 Econometric specification

The economic theory implies the following structural gravity equation with fixed effects when the static system of equations (1)– (3) holds for all periods (Heid et al., 2021):

$$X_{ijt} = \exp[\beta T_{ij} + \pi_{it} + \mu_{jt} + \varepsilon_{ijt}] \quad (4)$$

The dependent variable X_{ijt} represents the value of trade between country i and country j at time t ; T_{ij} is a vector of all bilateral trade costs between i and j . Finally, π_{it} is the exporter $\times$ year fixed effects, which will control the time-varying observable and unobservable variables. It's a proxy of outward multilateral resistances and by nature will absorb any other country-specific trade determinants on the exporter side. Similarly, μ_{jt} is the set of importer $\times$ year fixed effects, which will control for inward multilateral resistances and will absorb any other country-specific trade determinants on the importer side. ε_{ijt} is the error term. The vector of bilateral trade costs (T_{ij}) in equation 4 include both time invariant and time-varying components of bilateral trade costs. Among the time-invariant components, in our specification we use the usual cultural and geographical variables (common language, distance, common border, and colonial relationship, etc.) as well as a series of non-tariffs measures captured by trade facilitation indicators. For time-varying components, we consider regional trade

agreement indicator which measures the semi-elasticity of bilateral trade flows with respect to the presence of a trade agreement.

Based on the following, we rewrite equation 4 with all the control variables:

$$\begin{aligned} \ln X_{ijt} = & \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POP_{it} + \alpha_4 \ln POP_{jt} + \\ & \alpha_5 \ln DIST_{ijt} + \alpha_6 Lang_{ij} + \alpha_7 Border_{ij} + \alpha_8 Landlocked_{ij} + \\ & \alpha_9 ComCol_{ij} + \alpha_{10} RTA_{ij} + \alpha_{11} TFI_{it} + \alpha_{12} TFI_{jt} + \varphi_{it} + \mu_{jt} + \varepsilon_{ijt} \end{aligned} \quad (5)$$

where, X_{ijt} represents the export value from exporter i to importer j at time t . GDP_{it} , GDP_{jt} represent respectively the gross domestic products of the exporting and importing countries; POP_{it} and POP_{jt} are the populations of the exporting and importing countries respectively; $DIST_{ijt}$ is the distance between trading partners; $Lang_{ij}$; $Border_{ij}$; $ComCol_{ij}$ are dummy variables which take the value 1 when the partners share a common language, a common border and a common colonizer respectively and 0 otherwise. $Landlocked_{ij}$ is a dummy variable which takes the value 1 if country $i(j)$ is landlocked and 0 otherwise; RTA is a dummy variable that accounts for the presence of a regional trade agreement between trading partners i and j . This variable takes the value 1 when the two countries are members of the same RTA, and it is equal to zero otherwise. TFI_{it} ; TFI_{jt} represent the vector of trade facilitation of country i and country j in period t respectively.

4-2 Estimation strategy

The various empirical studies on the gravity model type generally use the Ordinary Least Squares (OLS) estimator, the Tobit estimator, the Poisson Pseudo-Maximum Likelihood (PPML) estimator (Eaton and Akiko, 1994; Lee and Yu, 2010; Santos Silva and Tenreyro, 2006). In the literature, some studies have highlighted various biases in the estimated coefficients resulting from the application of traditional estimation methods, particularly OLS. These biases can be explained by the failure to consider the specificities of countries as well as the heteroscedasticity issue. Thus, the particularity of trade in African countries is that there is a total absence of trade for many bilateral relations. Consequently, the value of trade between two countries may be zero. With a logarithmic specification, such an observation will become indeterminate. To solve this problem, we follow the approach of Santos Silva and Tenreyro, (2006) by using the Poisson Pseudo-Maximum Likelihood (PPML) estimator. The use of the PPML estimator allows us to estimate the model in equation (5) in level with a multiplicative error term (ε_{ijt}). This estimator has two advantages: it helps to deal with heteroskedasticity and zero trade values in the dependent variable (Santos Silva and Tenreyro, 2006; Hendy and Zaki, 2021; Bozzola et al., 2023).

4-3 Data source and definition of variables

This study is based on trade data (goods and agri-food), trade facilitation and other control variables for African countries over the period 2007-2020. The sample and study period are dictated by the availability of data.

4-3-1 Trade data

We compiled data on bilateral trade (exports and imports) from the International Monetary Funds' Direction of Trade Statistics (DOTS) expressed in millions of US\$. Bilateral agri-food trade is from the UN Comtrade database. Agri-food trade data are aggregated at the one-digit level of the classification by Broad Economic Categories (BEC) and consider the category 'Food and beverages' (BEC 1996: 01).

4-3-2 Trade facilitation data

The trade facilitation indicators (physical infrastructure, ICT, business environment, and border and transport efficiency) are aggregate indicators constructed from several primary indices extracted from the World Economic Forum and Doing Business databases (Portugal-Perez and Wilson, 2012). In fact, *physical infrastructure* measures the level of development and quality of road, port, and airport infrastructures. *Information and Communication Technology* is interpreted as the extent to which an economy uses ICT to improve efficiency and productivity, as well as to reduce transaction costs. It contains indicators on the availability, use, absorption, and priority given by the government to ICT. *Business and regulatory environment* measures the level of development of regulations and transparency. It is based on indicators of irregular payments, government transparency, and anti-corruption measures. The indicator *border and transport efficiency* aim to quantify the level of customs and inland transport efficiency reflected in the time and number of documents required for export and import procedures. The construction of the four aggregate indicators is based on Principal Component Analysis (PCA). The use of PCA is now established in the literature on index construction (African Development Bank (AfDB) et al., 2019). It is a way to reduce the multidimensionality of the data, by transforming the data into a new coordinate system such that the largest variance by any projection of the data is in the first coordinate or principal component, the second largest variance in the second coordinate, and so on. We expect trade facilitation to positively affect Africa's trade.

The results of the PCA are reported in table 1. For the four aggregate indicators of TF in the exporting and importing side as well on bilateral side, only the first principal component is retained as the composite index except for border efficiency indicator in the exporting side where two components are retained (see table 1).

4-3-3 Control variables

The control variables in model 5 include the Gross Domestic Product (GDP) at current prices and country population extracted from the World Bank World Development Indicators (WDI, 2023) database. *GDP and population* are indicators of the potential market size. The greater these variables are, the more trade opportunities are available to both partners. Based on the literature, both GDP and Population variables should positively influence trade. We also include the bilateral geographical and cultural variables (distance, common border, common language, common colonizer) extracted from the database of the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII). These geographical variables include:

- (i) *Distance* as a proxy for transaction costs. In the literature, distance generates transport costs that are higher the further apart two partners are. These transport costs are usually captured by the distance between the co-traders (Gbetnkom and Avom, 2005);
- (ii) The *Landlocked* variable which estimates the effect on trade of countries that do not have an opening onto the sea. Both distance and landlocked variables should negatively affect trade.
- (iii) *Common colonizer and common language* variables capture the colonial past between partners and studies have shown that the common colonial past between partners influences bilateral trade. Both variables should positively affect trade. *RTA* is a dummy variable that accounts for the presence of a regional trade agreement between trading partners *i* and *j*. This variable captures the trade creation or trade diversion. Appendix 1 provides a summary of the variables used in model 5.

Table 1: PCA for TF variables

TF index	Eigenvalue	Proportion explained	Primary variables	Eigenvectors	Correlation Coefficients	Bartlett (p-value)
Physical Infrastructure i	1.714	0.571	Quality of airport	0.698	0.908	0.000
			Quality of port	0.700	0.917	
			Quality of road	0.168	0.219	
ICT index i	2.287	0.762	Availability of ICT	0.631	0.955	0.000
			Level of ICT absorption	0.617	0.933	
			Use of ICT	0.470	0.710	
Business Environment i	3.160	0.790	Transparency	0.475	0.844	0.000
			Trust in government	0.511	0.909	
			Irregular payments	0.505	0.898	
			Government favouritism	0.508	0.903	
Border Efficiency i	2.716	0.679	Days to export	0.479	0.917	0.000
	1.168	0.971	Days to import	0.502	0.938	
			Document to export	0.502	0.648	
			Document to import	0.516	0.680	
Physical Infrastructure j	1.725	0.575	Quality of airport	0.694	0.912	0.000
			Quality of port	0.700	0.920	
			Quality of road	0.165	0.217	
ICT j	2.248	0.749	Availability of ICT	0.637	0.955	0.000
			Level of ICT absorption	0.620	0.930	
			Use of ICT	0.457	0.686	
Business Environment j	3.178	0.794	Transparency	0.475	0.847	0.000
			Trust in government	0.512	0.913	
			Irregular payments	0.506	0.902	
			Government favouritism	0.506	0.902	
Border Efficiency j	2.635	0.659	Days to export	0.531	0.861	0.000
			Days to import	0.535	0.868	
			Document to export	-0.456	-0.740	
			Document to import	-0.474	-0.769	
Physical Infrastructure ij	2.034	0.678	Quality of airport	0.692	0.188	0.000
			Quality of port	0.693	0.165	
			Quality of road	0.205	0.044	
ICT ij	2.754	0.918	Availability of ICT	0.593	0.983	0.000
			Level of ICT absorption	0.586	0.967	
			Use of ICT	0.552	0.879	
Business Environment ij	3.755	0.939	Transparency	0.507	0.983	0.000
			Trust in government	0.511	0.991	
			Irregular payments	0.469	0.910	
			Government favouritism	0.510	0.989	
Border Efficiency ij	3.588	0.897	Days to export	0.505	0.956	0.000
			Days to import	0.503	0.952	
			Document to export	0.490	0.928	
			Document to import	0.503	0.952	

Note: The correlation coefficients show the degree of correlation between the constructed index and the corresponding primary variables used. The number of principal components was selected by the Kaiser criterion of eigenvalue greater than one. The null hypothesis of the Bartlett test of sphericity is that the variables are not intercorrelated.

5- Estimation results and analysis

In this section, the estimates of the coefficients of the gravity models are reported and interpreted.

5-1 Results using trade facilitation indicators for the origin and destination countries

The results of the estimation with PPML are presented for both total trade in goods and agrifood trade at the origin and destination countries in table 2 without fixed effects and in table 3 with the exporter and importer's fixed effects. In each table, the results in columns 1 through 4 concerned the total trade in goods, while columns 5 through 8 are for the agrifood trade specifically. While the results in table 2 give some insights on TF and trade performance nexus, we based our analysis on table 3 where we controlled the multilateral resistances with the inclusion of the countries fixed effects⁵.

The results in table 3 show that our variables of interest have the expected signs for both trade in goods and in agrifood at the country of origin. From an economic and policy perspective, our results show that trade facilitation in origin country increases intra Africa trade.

Specifically, the hard infrastructures indicators namely physical infrastructure, ICT affect positively and significantly the volume of trade in goods and in agrifood in African countries at 1%. This implies that a 1-point improvement in the quality of road, ports and airports increases the volume of Africa's goods trade by 0.17 point and Africa's agrifood trade by 0.49 point.

Furthermore, an improvement in the utilization of ICT of 1-point increases Africa's trade in goods by 0.15 point and Africa's agrifood trade by 0.34 point. These results are in line with those of Portugal-Perez and Wilson (2012) and Noreen and Mahmood, (2022). The latter found that the physical infrastructure and uncertainty in time delay are major hurdles in the sustainable growth of exports and indeed have rendered the exports.

Concerning the soft infrastructures (business environment and border efficiency), they have the expected and statistically significant signs. For example, a 1-point reduction in border procedures increases the Africa's Agri-food trade by 0.13 point. In other words, the simplification of border procedures, particularly the number of days and documents, has a positive impact on the volume of trade in Africa. This result is in line with those in the literature (Moïse and Sorescu, 2013 ; Hendy and Zaki, 2021). Moïse and Sorescu (2013) for example,

⁵ To account for MRT the use of exporter-time and importer-time fixed effects is recommended (Olivero and Yotov, 2012). These authors demonstrate that the MR terms should be accounted for by exporter-time and importer-time fixed effects in a dynamic gravity estimation framework with panel data.

found that TF indicators related to the availability of trade-related information, simplification and harmonization of documents, rationalization of procedures and the use of automated processes seem to have the greatest impact on trade volume and trade costs.

Among the four trade facilitation indicators, physical infrastructure effects on trade flows appear to be the TF variable with the most impactful effect on Africa's trade, followed by ICT indicator.

The results in table 3 show also that trade facilitation in the importing countries does not necessarily increase trade from the country of origin to the destination country. In fact, we can see that only two out of four trade facilitation indicators in the importing countries affect positively and significantly Africa's trade. According to Sakyi and Afesorgbor (2019), this could be explained by the fact that in terms of trade facilitation measures, most African countries are more focused on promoting exports rather than imports. This can be seen through exports promotion strategies in many African countries.

Table 2: PPML results (without countries fixed effect)

VARIABLES	Trade in Good				Trade in Agri Food			
	1	2	3	4	5	6	7	8
lnGDP_i	0.786*** (0.044)	0.837*** (0.060)	0.964*** (0.046)	0.921*** (0.035)	0.747*** (0.047)	0.741*** (0.066)	1.073*** (0.055)	1.117*** (0.055)
lnGDP_j	0.530*** (0.029)	0.449*** (0.031)	0.675*** (0.038)	0.743*** (0.043)	0.307*** (0.034)	0.334*** (0.046)	0.361*** (0.042)	0.483*** (0.050)
lnPopulation_i	0.130*** (0.046)	0.066 (0.062)	-0.140** (0.058)	0.016 (0.048)	-0.093** (0.043)	-0.102* (0.057)	-0.247*** (0.054)	-0.238*** (0.057)
lnPopulation_j	0.078*** (0.028)	0.133*** (0.032)	-0.081* (0.042)	-0.087** (0.042)	-0.099*** (0.038)	-0.106** (0.049)	-0.205*** (0.044)	-0.186*** (0.046)
Indistance_ij	-0.683*** (0.049)	-0.473*** (0.050)	-0.492*** (0.070)	-0.282*** (0.061)	-0.729*** (0.054)	-0.659*** (0.054)	-0.740*** (0.063)	-0.607*** (0.067)
Border_ij	0.812*** (0.089)	1.088*** (0.089)	0.919*** (0.124)	1.237*** (0.098)	1.069*** (0.090)	1.114*** (0.092)	1.097*** (0.114)	1.274*** (0.111)
Language_ij	0.567*** (0.078)	0.485*** (0.081)	0.757*** (0.095)	0.613*** (0.094)	0.159* (0.094)	0.217** (0.097)	0.416*** (0.109)	0.083 (0.118)
Colony_ij	-0.318*** (0.072)	-0.281*** (0.078)	-0.583*** (0.080)	-0.587*** (0.073)	0.277*** (0.107)	-0.059 (0.115)	-0.291** (0.122)	0.348** (0.142)
FTAIj	1.089*** (0.088)	1.243*** (0.090)	1.384*** (0.095)	1.262*** (0.084)	0.968*** (0.089)	1.185*** (0.102)	1.084*** (0.098)	1.296*** (0.106)
Physical_Infrastructure_i	0.211*** (0.031)				0.508*** (0.033)			
Technologt_ICT_i		0.194*** (0.031)				0.368*** (0.033)		
Business_Environment_i			-0.123*** (0.031)				0.207*** (0.030)	
Border_efficiency_i				0.010 (0.032)				-0.165*** (0.037)
Physical_Infrastructure_j	0.294*** (0.030)				0.180*** (0.025)			
Technologt_ICT_j		0.340*** (0.026)				0.152*** (0.038)		
Business_Environment_j			0.021 (0.017)				-0.022 (0.021)	
Border_efficiency_j				0.092*** (0.027)				-0.059 (0.043)
Constant	-9.937*** (0.818)	-10.834*** (0.843)	-12.570*** (1.012)	-15.644*** (0.975)	-9.853*** (1.024)	-9.984*** (1.067)	-13.535*** (1.126)	-19.405*** (1.006)

Observations	8,390	7,074	7,100	9,160	6,203	5,091	5,164	5,697
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	No	No	No	No	No	No	No	No
Importer fixed effects	No	No	No	No	No	No	No	No
R-squared	0.636	0.698	0.581	0.615	0.772	0.775	0.660	0.740

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Author

The traditional variables of the gravity model present in most cases the expected signs. For example, the value of bilateral trade increases with market size and decreases with distance. Geographical characteristics such as relative distance hinder bilateral trade. Our results underline the positive role played by membership to a regional trade agreement. Regarding the geographical and structural factors, our results confirm those in the literature (Carrère, 2004 ; Geda and Seid, 2015).

Table 3: PPML results (with countries' fixed effects)

VARIABLES	Trade in Good				Trade in Agri Food			
	1	2	3	4	5	6	7	8
lnGDP_i	0.820*** (0.043)	0.881*** (0.061)	1.003*** (0.038)	0.945*** (0.032)	0.605*** (0.055)	0.700*** (0.072)	0.776*** (0.059)	0.907*** (0.078)
lnGDP_j	0.598*** (0.031)	0.491*** (0.036)	0.767*** (0.033)	0.787*** (0.042)	0.298*** (0.040)	0.320*** (0.051)	0.374*** (0.042)	0.448*** (0.056)
lnPopulation_i	0.087** (0.044)	0.012 (0.061)	-0.177*** (0.050)	0.018 (0.051)	0.065 (0.053)	-0.047 (0.066)	0.138* (0.073)	-0.049 (0.087)
lnPopulation_j	-0.010 (0.032)	0.083** (0.038)	-0.200*** (0.039)	-0.199*** (0.044)	-0.070 (0.045)	-0.088 (0.056)	-0.179*** (0.045)	-0.166*** (0.049)
lnDistance_ij	-0.768*** (0.048)	-0.532*** (0.054)	-0.644*** (0.060)	-0.351*** (0.064)	-0.655*** (0.054)	-0.610*** (0.057)	-0.607*** (0.061)	-0.581*** (0.081)
Border_ij	0.741*** (0.080)	1.027*** (0.088)	0.837*** (0.098)	1.193*** (0.096)	0.993*** (0.091)	1.088*** (0.096)	0.967*** (0.101)	1.258*** (0.112)
Language_ij	0.446*** (0.074)	0.433*** (0.078)	0.515*** (0.083)	0.398*** (0.099)	0.167* (0.090)	0.236** (0.096)	0.383*** (0.101)	0.137 (0.124)
Colony_ij	-0.283*** (0.070)	-0.270*** (0.076)	-0.459*** (0.076)	-0.437*** (0.075)	0.229** (0.110)	-0.077 (0.119)	-0.328** (0.128)	0.384** (0.154)
FTAi_j	0.910*** (0.095)	1.156*** (0.099)	1.096*** (0.101)	1.058*** (0.091)	1.142*** (0.087)	1.276*** (0.097)	1.390*** (0.098)	1.337*** (0.106)
Physical_Infrastructure_i	0.176*** (0.030)				0.494*** (0.034)			
Technologt_ICT_i		0.154*** (0.033)				0.335*** (0.033)		
Business_Environment_i			-0.132*** (0.027)				0.247*** (0.031)	
Border_efficiency_i				-0.001 (0.033)				-0.129*** (0.037)
Physical_Infrastructure_j	0.250*** (0.028)				0.193*** (0.028)			
Technologt_ICT_j		0.310*** (0.025)				0.149*** (0.040)		
Business_Environment_j			0.012 (0.017)				-0.022 (0.022)	
Border_efficiency_j				0.105*** (0.026)				-0.070 (0.044)
Constant	-10.303*** (0.773)	-11.094*** (0.847)	-12.884*** (0.809)	-15.528*** (0.936)	-9.177*** (1.042)	-9.547*** (1.114)	-14.189*** (1.142)	-17.113*** (1.189)
Observations	8,390	7,074	7,100	9,160	6,203	5,091	5,164	5,697
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.684	0.719	0.687	0.616	0.737	0.757	0.688	0.695

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Author

5-2 Results with bilateral trade facilitation indicators

A country's trade flows can be impacted through its own reforms but also the reforms of its trading partners. Therefore, we follow Moïsé and Sorescu, (2013) with a specification that includes the geometric average of the importer and exporter countries trade facilitation indicators. The geometric average is employed because it will also smooth accuracy issues, when for instance an index for country i will be based on several missing variables opposed to an index for country j computed without missing variables (Moïsé et al., 2011).

Equation (5) presented earlier becomes:

$$\begin{aligned} \ln X_{ijt} = & \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POP_{it} + \alpha_4 \ln POP_{jt} + \\ & \alpha_5 \ln DIST_{ijt} + \alpha_6 Lang_{ij} + \alpha_7 Border_{ij} + \alpha_8 Landlocked_{ij} + \\ & \alpha_9 ComCol_{ij} + \alpha_{10} RTA_{ij} + \alpha_{11} TFI_{ijt} + \varphi_{it} + \mu_{jt} + \varepsilon_{ijt} \end{aligned} \quad (6)$$

With TFI_{ijt} the trade facilitation indicators of country i and j

$$TFI_{ijt} = \sqrt{TFI_{it} * TFI_{jt}}$$

The results of the regression of equation 6 are presented in tables 4 and 5. Table 4 presents the results without countries fixed effects, while table 5 shows results with the countries' fixed effects. We can see from table 5 that both exporter and importer countries TF positively affect Africa' trade in goods as well as in agrifood. Specifically, the quality of infrastructures of both the county of origin and the country of destination matters in boosting intra African trade. The same applies for the indicators ICT and business environment. Indeed, the utilization of ICT in the exporter and importer countries in the trade process contributes to an increase in intra Africa's trade flows. Moreover, a better business environment in both countries also increases trade in goods and in agrifood. This confirms the finding that a better business environment which is also associated with the quality of institution improves trade flows (Bah et al., 2021).

Table 4 PPML results (without country fixed effects)

VARIABLES	Trade in Good				Trade in Agri Food			
	1	2	3	4	5	6	7	8
lnGDP_i	0.768*** (0.060)	0.857*** (0.030)	0.857*** (0.030)	0.900*** (0.028)	1.030*** (0.042)	1.045*** (0.043)	1.053*** (0.043)	1.148*** (0.043)
lnGDP_j	0.665*** (0.035)	0.672*** (0.030)	0.672*** (0.030)	0.714*** (0.030)	0.256*** (0.033)	0.263*** (0.033)	0.265*** (0.033)	0.347*** (0.035)
lnPopulation_i	0.026 (0.058)	-0.002 (0.038)	-0.002 (0.038)	-0.025 (0.037)	-0.277*** (0.037)	-0.285*** (0.038)	-0.273*** (0.038)	-0.317*** (0.038)
lnPopulation_j	-0.029 (0.032)	-0.080*** (0.028)	-0.080*** (0.028)	-0.080*** (0.027)	-0.103*** (0.033)	-0.100*** (0.034)	-0.103*** (0.035)	-0.128*** (0.035)
lnDistance_ij	-0.497*** (0.064)	-0.471*** (0.036)	-0.471*** (0.036)	-0.458*** (0.036)	-0.660*** (0.047)	-0.652*** (0.048)	-0.643*** (0.048)	-0.655*** (0.047)
Border_ij	0.983*** (0.105)	0.960*** (0.075)	0.960*** (0.075)	0.974*** (0.072)	1.030*** (0.092)	1.039*** (0.093)	1.052*** (0.095)	0.991*** (0.091)
Language_ij	0.638*** (0.089)	0.499*** (0.068)	0.499*** (0.068)	0.526*** (0.068)	0.427*** (0.085)	0.451*** (0.086)	0.455*** (0.086)	0.454*** (0.085)
Colony_ij	-0.504*** (0.083)	-0.401*** (0.058)	-0.401*** (0.058)	-0.390*** (0.057)	-0.107 (0.094)	-0.144 (0.095)	-0.135 (0.095)	-0.041 (0.094)
FTAi_j	1.275*** (0.083)	1.239*** (0.056)	1.239*** (0.056)	1.201*** (0.055)	1.137*** (0.075)	1.155*** (0.075)	1.151*** (0.075)	1.173*** (0.075)
Physical_Infrastructure_ij	0.162*** (0.034)				0.255*** (0.035)			
Technologt ICT_ij		0.013 (0.014)				0.154*** (0.025)		
Business_Environment_ij			0.013 (0.014)				0.115*** (0.027)	
Border_efficiency_ij				0.136*** (0.015)				0.148*** (0.020)
Constant	-10.912*** (1.131)	-11.938*** (0.578)	-11.938*** (0.578)	-13.500*** (0.599)	-12.233*** (0.901)	-12.617*** (0.881)	-13.310*** (0.881)	-16.091*** (0.919)
Observations	9,187	21,213	21,213	21,275	10,919	10,919	10,919	10,919
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	No	No	No	No	No	No	No	No
Importer fixed effects	No	No	No	No	No	No	No	No
R-squared	0.586	0.457	0.457	0.490	0.545	0.507	0.503	0.505

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source : Author

Table 5 PPML results (with country fixed effects)

VARIABLES	Trade in Good				Trade in Agri Food			
	1	2	3	4	5	6	7	8
Indistance_ij	-0.354*** (0.059)	-0.185*** (0.035)	-0.185*** (0.035)	-0.151*** (0.035)	-0.089* (0.052)	-0.469*** (0.051)	-0.446*** (0.052)	-0.280*** (0.054)
Border_ij	1.202*** (0.126)	1.338*** (0.087)	1.338*** (0.087)	1.366*** (0.085)	1.974*** (0.109)	1.381*** (0.103)	1.415*** (0.106)	1.276*** (0.093)
Language_ij	0.705*** (0.100)	0.803*** (0.073)	0.803*** (0.073)	0.854*** (0.076)	1.079*** (0.111)	0.902*** (0.109)	0.937*** (0.109)	0.263*** (0.078)
Colony_ij	-1.188*** (0.101)	-1.313*** (0.067)	-1.313*** (0.067)	-1.345*** (0.070)	-1.004*** (0.094)	-0.851*** (0.099)	-0.876*** (0.099)	0.324*** (0.099)
FTAij	0.857*** (0.121)	0.858*** (0.081)	0.858*** (0.081)	0.964*** (0.079)	1.476*** (0.081)	1.421*** (0.081)	1.446*** (0.081)	1.404*** (0.089)
Physical_Infrastructure_ij	0.406*** (0.029)				0.304*** (0.030)			
Technologt ICT_ij		0.092*** (0.014)				0.208*** (0.024)		
Business_Environment_ij			0.092*** (0.014)				0.141*** (0.020)	
Border_efficiency_ij				-0.062*** (0.019)				-0.143*** (0.028)
Constant	12.164*** (0.495)	10.272*** (0.297)	10.272*** (0.297)	10.167*** (0.293)	7.654*** (0.430)	11.543*** (0.443)	11.409*** (0.453)	9.402*** (0.407)
Observations	9,469	21,962	21,962	22,072	10,597	10,597	10,597	10,919
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.359	0.159	0.159	0.150	0.510	0.493	0.476	0.581

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source : Author

6- Additional analysis

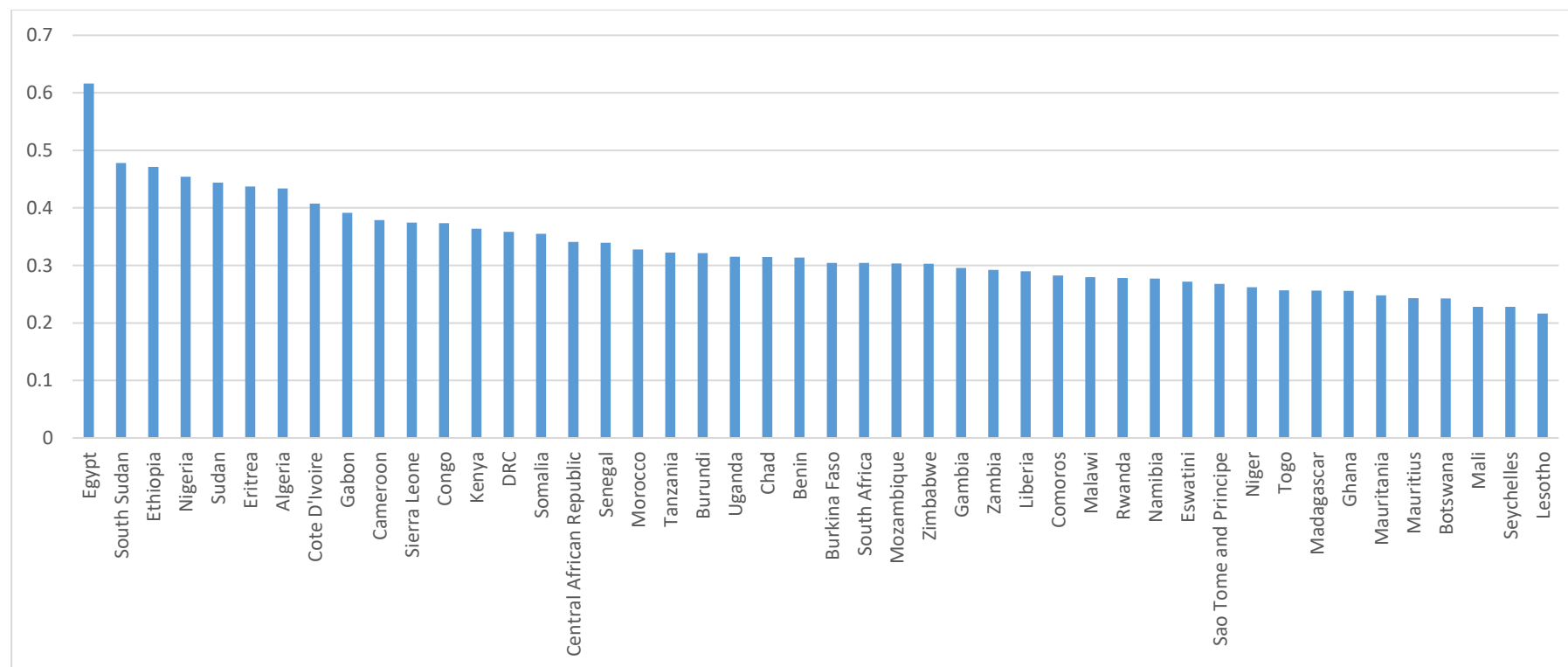
In this section, the focus of the analysis shifts from the four trade facilitation indicators investigated so far to digital trade environment to assess the effect of digital trade regulations and policies on trade performance. Here, the digital trade policies are measured by the Regional Digital Trade Integration Index (RDTII) jointly developed by ECA, ECLAC, ESCAP and EUI⁶ and the Digital Service Trade Restrictiveness Index (DSTRI) developed by the OECD⁷. The RDTII measures the level of restrictiveness and can be classified in 12 pillars (ECA, 2023). It assesses targeted countries' readiness to engage effectively in digital trade and e-commerce. The DSTRI covers restrictions to trade in digitally-enabled services only and these restrictions are in five pillars: infrastructure and connectivity, electronic transactions, payment systems, IPRs and other barriers affecting trade in digitally-enabled services (Ferencz, 2019). It should be noted that some authors in the literature have used the DSTRI as an alternative measure of soft indicators for trade facilitation (Majune et al., 2023).

⁶ Economic Commission for Africa (ECA), Economic Commission for Latin America and Caribbean (ECLAC), Economic and Social Commission of Asia and Pacific (ESCAP), and the European Union Institute (EUI).

⁷ Note that the data for African countries was collected by the United Nations Economic Commission for Africa (UNECA). <https://dtri.uneca.org/eca/home#home>

Figure 4 below shows the RDTII scores by African countries covered so far. The index goes from 0 for a policy environment fully open to digital trade integration, to 1, for one fully closed to digital trade. We can see that based on overall RDTII scores the top five restrictive African countries are Egypt, South Sudan, Nigeria, Ethiopian, and Sudan. Those countries are the one that have significantly higher score in restrictiveness meaning that they have a policy environment less supportive of digital trade integration. Conversely, some countries such as Lesotho, Seychelles, Mali, Botswana, and Mauritius obtained a low RDTII score around 0.2 putting them as the best performing countries for their policy environment for digital trade integration.

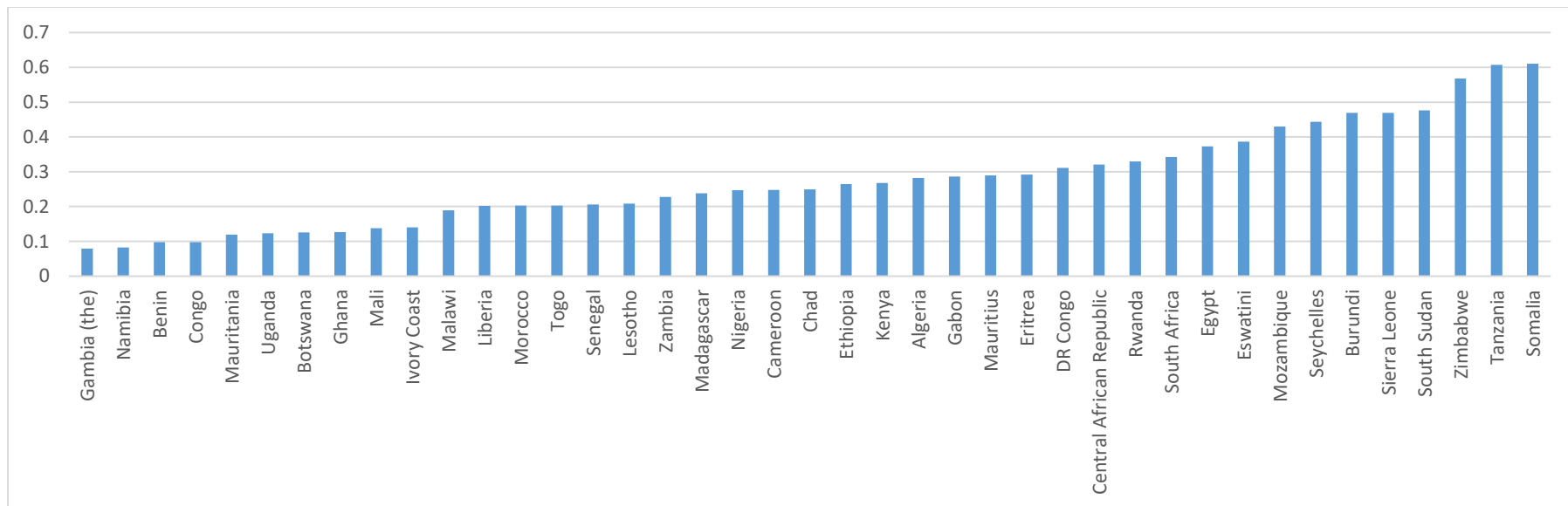
Figure 4: Regional Digital Trade Integration Index for African countries (score by country in 2023)



Source: ECA's RDTII 2023

Figure 5 presents the score for the OECD's DSTRI for the year 2022. For the digital services trade restrictions, countries like Somalia, Tanzania and Zimbabwe are the worst performer with a relatively high DSTRI scores compared to Gambia, Namibia, or Benin the best performer countries with lowest DSTRI scores. The latter are more open in terms of policy when it comes to digital services trade.

Figure 5: OECD's Digital Services Trade Restrictiveness Index for African countries (score by country in 2022)



Source: OECD, DSTRI database 2023

In the econometric analysis, we applied a cross sectional analysis using RDTII with intra Africa trade in goods data in 2020 due the fact that RDTII index is only available for one year for 46 African countries while for DSTRI we use the services trade data for the period 2014-2021 for 41 African countries. In the structural gravity model, RDTII and DSTRI measures are used on the importers' side. The expected result from the regressions is that a higher level of restrictiveness as measured by the RDTII applied by African countries is associated with a lower level of trade in goods from any other partner country in Africa. Table 6 results show that the RDTII is negative and highly significant. In fact, a 1-point increase in the level of restrictiveness reduces trade in goods by 10.55 points. Regarding the specific pillars, we can see that nine (09) out of the twelve are negative and significant confirming the negative effects of RDTII indicators on trade in goods. Pillar 10 (Quantitative trade restrictions) and 3 (Foreign direct investment in sectors relevant to digital trade) have the most notable negative effect on trade in goods in Africa with -6.42 and -4.59 respectively. Considering the cross-country nature of the regression, the economic importance of the results must be taken with cautious.

Concerning the DSTRI results reported in table 7, the average DSTRI score is negative and significant at 1%. This result indicates that a 1-point reduction in services restrictiveness could increase trade in services by 1.49 point. The results of the specifics pillars of DSTRI confirm the result of the average index except pillar 3 (FDI). Indeed, the regression analysis under pillar 1 (Infrastructure and connectivity), pillar 2 (Electronic transactions), pillar 4 (Intellectual Property Rights (IPRs)) and pillar 5 (Other barriers affecting trade in digitally enabled services) had a statistically significant negative effect on the services trade. Our results on RDTII as well as on DSTRI are in line with those obtained by ECA, (2023).

Table 6: PPML results using the RDTII

VARIABLES	(1) Total RDTII	(2) Pillar 1	(3) Pillar 2	(4) Pillar 3	(5) Pillar 4	(6) Pillar 5	(7) Pillar6	(8) Pillar7	(9) Pillar 8	(10) Pillar 9	(11) Pillar 10	(12) Pillar 11	(13) Pillar 12
Indistance_ij	-0.352 (0.240)	-0.003 (0.132)	-0.067 (0.138)	-0.067 (0.138)	-0.067 (0.138)	-0.067 (0.138)	-0.430* (0.227)	-0.444** (0.217)	-0.436* (0.255)	-0.498** (0.212)	-0.458** (0.220)	-0.344* (0.191)	-0.426* (0.236)
Border_ij	1.310*** (0.353)	1.567*** (0.300)	1.479*** (0.255)	1.479*** (0.255)	1.479*** (0.255)	1.479*** (0.255)	1.152*** (0.349)	1.105*** (0.345)	1.087*** (0.334)	1.091*** (0.367)	1.132*** (0.345)	1.209*** (0.349)	1.132*** (0.330)
Language_ij	0.982*** (0.374)	0.487* (0.262)	0.359 (0.280)	0.359 (0.280)	0.359 (0.280)	0.359 (0.280)	0.716* (0.401)	0.625* (0.365)	0.701* (0.403)	0.662* (0.361)	0.718** (0.361)	0.747** (0.370)	0.690* (0.364)
Colony_ij	-1.066*** (0.349)	0.247 (0.217)	0.296 (0.214)	0.296 (0.214)	0.296 (0.214)	0.296 (0.214)	-1.001*** (0.361)	-0.895*** (0.320)	-0.897** (0.362)	-0.926*** (0.294)	-0.934*** (0.299)	-0.997*** (0.309)	-0.888*** (0.330)
FTA	0.664* (0.350)	1.195*** (0.285)	1.260*** (0.282)	1.260*** (0.282)	1.260*** (0.282)	1.260*** (0.282)	0.568 (0.387)	0.696* (0.379)	0.678* (0.410)	0.479 (0.394)	0.503 (0.402)	0.642 (0.399)	0.658* (0.396)
RDTII	-10.550** (5.092)	-0.863** (0.436)	4.670*** (1.401)	-4.592*** (1.377)	-4.203*** (1.261)	-3.849*** (1.155)	0.384 (1.006)	2.466* (1.436)	-1.303** (0.563)	-1.595* (0.964)	-6.421*** (2.146)	-3.059** (1.425)	-1.814* (1.081)
Constant	15.981*** (2.744)	7.948*** (1.179)	7.185*** (1.528)	9.738*** (1.285)	10.711*** (1.303)	10.361*** (1.289)	13.422*** (1.826)	12.772*** (1.675)	13.937*** (2.204)	14.674*** (1.890)	14.182*** (1.870)	13.270*** (1.729)	14.017*** (2.098)
Observations	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230	1,230
Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.392	0.778	0.799	0.799	0.799	0.799	0.263	0.279	0.266	0.309	0.305	0.283	0.285

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0

Source: Author

Table 7: PPML results using the OECD's DSTRI index

VARIABLES	Services Trade : final values					
	1	2	3	4	5	6
Indistance_ij	-0.166*** (0.044)	-0.166*** (0.043)	-0.198*** (0.044)	-0.203*** (0.042)	-0.181*** (0.045)	-0.189*** (0.043)
Border_ij	0.920*** (0.068)	0.911*** (0.068)	0.880*** (0.070)	0.801*** (0.067)	0.851*** (0.066)	0.884*** (0.068)
Language_ij	0.362*** (0.055)	0.342*** (0.055)	0.344*** (0.056)	0.282*** (0.055)	0.327*** (0.056)	0.364*** (0.057)
Colony_ij	0.053 (0.057)	0.080 (0.057)	0.067 (0.057)	0.127** (0.056)	0.068 (0.056)	0.046 (0.058)
FTA	0.378*** (0.067)	0.393*** (0.067)	0.353*** (0.069)	0.422*** (0.070)	0.393*** (0.068)	0.358*** (0.069)
DSTRI_score	-1.487*** (0.183)					
Pillar 1		-2.019*** (0.257)				
Pillar 2			-3.697*** (1.150)			
Pillar 3				13.600*** (2.519)		
Pillar 4					-12.811*** (1.589)	
Pillar 5						-2.252*** (0.645)
Constant	1.324*** (0.353)	1.190*** (0.345)	1.427*** (0.336)	0.881** (0.347)	1.122*** (0.364)	1.243*** (0.347)
Observations	13,120	13,120	13,120	13,120	13,120	13,120
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Importer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.683	0.684	0.689	0.705	0.685	0.690

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source : Author

7- Conclusion and policy implications

The primary aim of this study was to analyze the effects of trade facilitation on trade performance (trade in goods and the agrifood trade) in Africa. The analysis is based on a structural gravity model using panel data on African countries between 2007-2020. The results show that trade facilitation indicators related to hard infrastructure positively and significantly affect Africa's trade in both total goods and agri-food products. Trade facilitation indicators related to soft infrastructure, especially border efficiency affect negatively and significantly intra African trade in both total goods and agrifood. To confirm our results, we use additional measure of digital trade policies such as the Regional Digital Trade Integration Index as well as the Digital Services Trade Restrictiveness Index which confirm the negative effects of digital trade restrictions on trade performance. The main lesson of the study is that, notwithstanding the low level of intra-African trade, the elimination of non-tariff barriers through the implementation of trade facilitation measures increases trade flows. However, greater emphasis should be placed on conducting specific reforms. Thus, some major implications can be drawn from the findings of this study. First, among the trade facilitation indicators that positively affect exports, hard infrastructure is very critical. To this end, Africa should give priority to a regional approach to infrastructure development in terms of building transnational roads to connect countries in the continent. Second, soft infrastructure, especially border efficiency, plays a crucial role in the development of trade within the continent. Consequently, to create a suitable environment for activities within the continent in the current context of AfCFTA, efforts should be made by policymakers to reduce the administrative factors by simplifying and harmonizing the trading procedures in Africa. Moreover, our results underscore the importance of digital trade policies in boosting intra-African trade and therefore call for the domestication and effective implementation of the AfCFTA Digital Trade Protocol.

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Appendix

1- Summary of model variables, sources and expected signs.

Variables	Measure	Sources	Expected signs
Trade	It represents the bilateral trade for i) goods ii) agrifood (Broad Economic Categories (BEC) Food and beverages' (BEC 1996: 01) in country i and j	IMF and COMTRADE	N/A
Physical Infrastructure	Level and quality of road, port, and airport infrastructure (1= extremely underdeveloped, to 7 = well developed)	WEF	+
ICT	Use of ICT to improve efficiency and productivity and to reduce transaction costs (1 to 7 = best)	WEF	+
Business Environment	Level of development of regulations and transparency (1=low to 7=high).	WEF	+
Border and transport Efficiency	Customs and inland transport efficiency reflected in the time and number of documents	DB	-
GDPs (i, j)	Gross Domestic Product (\$ current)	WDI	+
POP (i, j)	Population in millions	WDI	+
Distance	Distance between the two partners (km)	CEPII	-
Lang	Dummy variable = 1 if the i and j have a common language and 0 otherwise.	CEPII	+
Border	Dummy variable = 1 if the i and j have a common border and 0 otherwise.	CEPII	+
Landlocked	Dummy variable = 1 if one of the two partners is a landlocked country	CEPII	-
Common_colonizer	Dummy variable = 1 if i and j have the same colonizer and 0 otherwise.	CEPII	+
RTA	Dummy variable = 1 if i and j are part of a regional trade agreement and 0 otherwise.	WTO	+

Source: Author.