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Why is African Trade so Limited?

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Abstract: This paper studies the determinants of the low participation of African countries in international trade. We point out the under-trading status of Africa, and then we estimate a gravity equation in order to identify the determinants of trade in general. As we characterize the level of these explanatory variables in Africa as compared to the rest of the world, we identify the main variables behind the low participation of Africa in trade in general. Usual gravity factors play an important role, but we show that non-tariff measures and the quality of infrastructure and institutions are important. Import duties do not significantly impede African exports.

Keywords: Africa, international trade, gravity equation.

1. Introduction

This paper studies the determinants of the low participation of African countries in international trade. We first point out the under-trading status of Africa, then we estimate a gravity equation in order to identify the determinants of trade in general. As we characterize the level of these explanatory variables in Africa as compared to the rest of the world, we identify the main variables behind the low participation of Africa in trade in general during the study period of 2001-2013.

The issue of under-trading by Africa has remained highly debated in the literature. The literature focuses on two aspects of this topic: first, the participation of African countries in global trade; second, the level of regional (within-Africa) trade.

Concerning the first issue, opinions diverge. For some authors, Africa's participation in world trade is low. For Sachs and Warner [1], Africa

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has missed out on globalization. For the World Bank [2], Africa's loss in world trade has cost it almost $70 billion a year. This reflects a failure to diversify into new products as well as a falling market share for traditional goods. From a gravity equation, Subramanian and Tamirisa [3] conclude that Africa "has been disintegrating from the world economy" and that this trend has been particularly strong for Francophone Africa. Starting with a complete review of available indicators and methodologies, Bouët, Cosnard, and Laborde [4] develop a methodological toolbox for better evaluation of the actual level of trade integration and find that Africa is characterized by weak trade integration, particularly with the rest of the world.

However, relatively well-developed literature argues that Africa has been trading in line with predicted trade or even overtrading. Coe and Hoffmaister [5] estimate a gravity model of bilateral trade between developing and industrial countries and conclude that in the early 1990s Africa actually overtraded compared with developing countries in other regions. They also point to a trend decline in African North-South trade over the past 25 years in marked contrast to the trend increase in Latin America and the broadly stable pattern in Asia. Rodrik [6] shows that African trade is in line with country size, income, and average distance from the world.

Concerning regional trade (that is, trade within Africa), here also points of view differ. On one side, many international institutions agree on Africa's relatively low level of regional trade. For the United Nations Economic Commission for Africa, the African Union Commission, and the African Development Bank [7], "more than 80 percent of African countries' exports are still destined for markets outside the continent, with the EU (European Union) and the United States accounting for more than 50 percent of this total. On average, over the past decades, only about 10 to 12 percent of African trade takes place among other African nations. About 40 percent of North American trade occurs with other North American countries. Similarly, about 63 percent of western European trade takes place with other western European nations." For Brenton and Isik [8] Africa's level of intraregional trade is low. Barka [9] confirms this conclusion, pointing out that in 2009, "intra-African trade (that is, trade among African countries) accounted for about 10 percent of the continent's total trade." Brenton, Portugal-Perez, and Regolo [10] study market integration in Central and Eastern Africa for three food staples: maize, rice, and sorghum, based on a large database of monthly consumer prices for 150 towns in 13 African countries and detailed data on the length and quality of roads linking the towns. They conclude there are significant distance and border effects.

However, the academic literature comes to a different conclusion. For example, Foroutan and Pritchett [11] concluded that flows of trade within Sub-Saharan Africa (SSA) are not differentially low, either because of policy or infrastructural weakness and they observed that trade tallied with predicted levels. Yang and Gupta [12] concluded that even if intraregional trade in Africa is lower than that in other regions, trade intensity is substantially higher among African countries than between African countries and the rest of the world. Along the same lines, Iapadre and Luchetti [13] and Bouët, Cosnard, and Laborde [4] support the conclusion that Africa's regional trade is relatively high.

In this paper, our main focus is to understand why Africa trades so little. This allows us to emphasize a few important conclusions. From a general point of view, the low participation of this continent in world trade is explained by the low quality of institutions and infrastructure in Africa. In particular, we point out the important positive role of trade infrastructure in exporting countries and the negative role of non-tariff measures in importing countries. Besides, the level of import duties is not a significant impediment to African exports. Our study contributes to a large literature related to African trade by determining that apart from usual gravity factors, the quality of not only

infrastructure but also of institutions and non-tariff measures are significant determinants of African nations' trade.

The rest of the paper is organized as follows. Section 2 points out the under-trading status of Africa. Section 3 compares the level of the determinants of trade in Africa to that outside Africa. Section 4 conducts an econometric test of world trade based on a gravity equation. Section 5 concludes the paper.

2. The trading status of Africa

Figure 1 shows the share of Africa and Sub-Saharan Africa in world trade[1] of goods and services from 1960 to 2016. The trend is decreasing. This share was around 5.5% in 1960; it is around 2.5% in 2016. The trend equation indicates that every decade, Africa's share in world trade of goods and services has declined by approximately 0.5%.

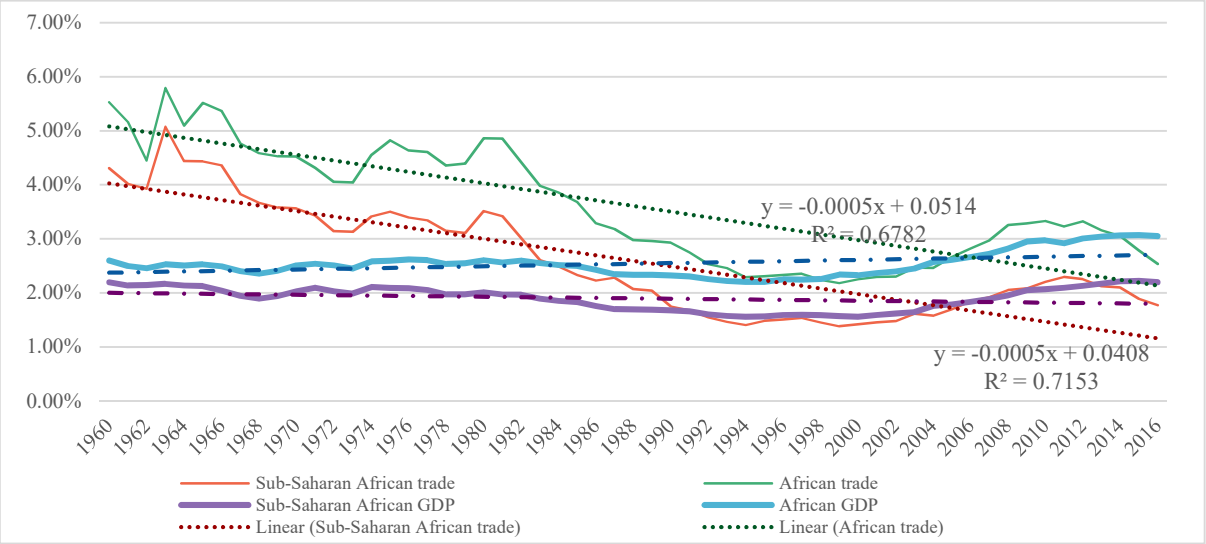
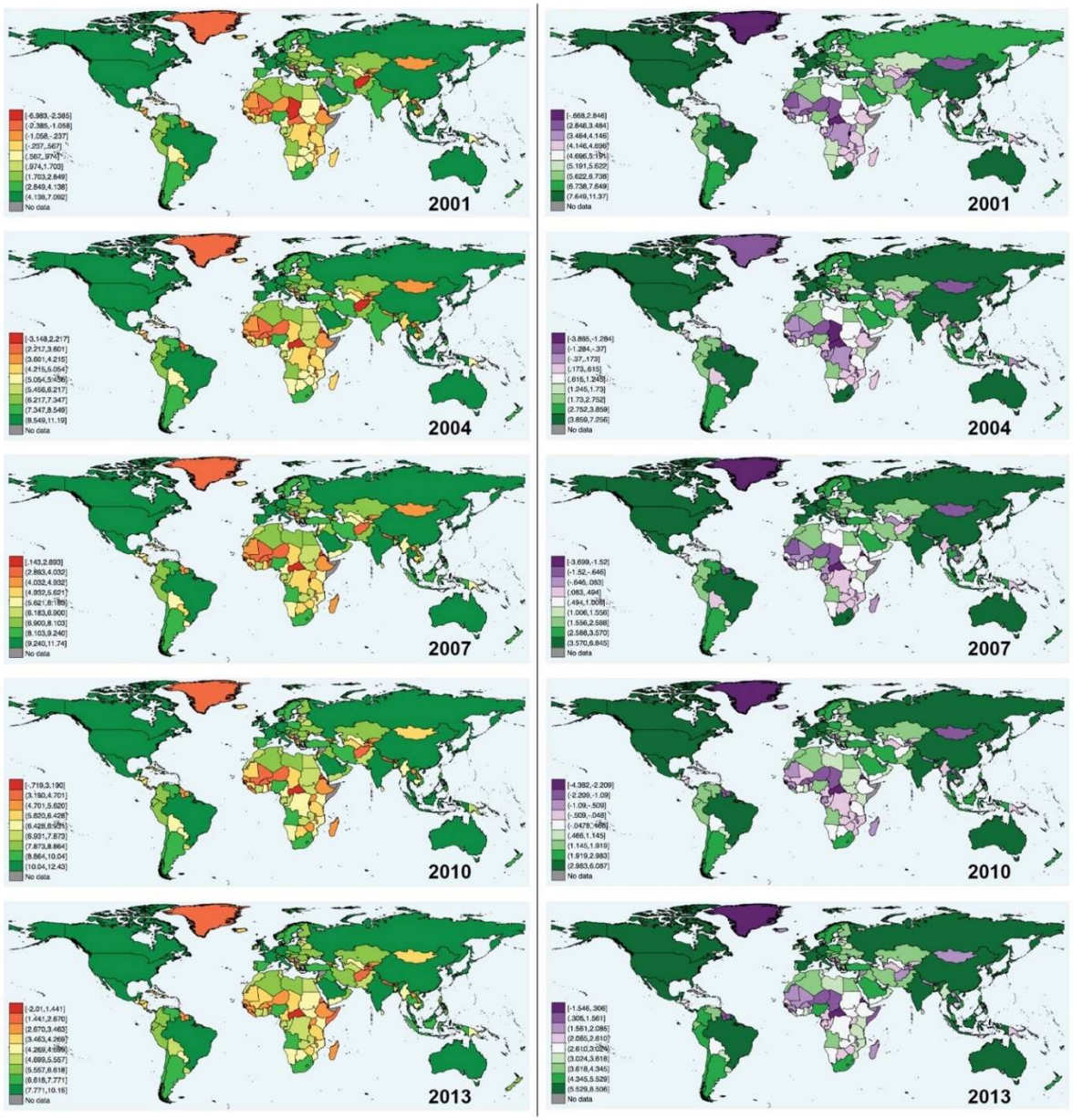


Figure 1: The share of Africa and Sub-Saharan Africa in world trade of goods and services and in world GDP (constant 2010 US$) - 1960/2016
Source: World Development Indicators - WDI [14] and authors' calculation.

With this graph we can only conclude there is a declining African share in world trade but we cannot conclude if this share is abnormally low or high, since no norm has been defined. Meanwhile, we observe a slight increase in the African share in world gross domestic product (GDP). Gravity models offer a theoretical way to define a norm of trade between two countries. In a simple and symmetric form, a gravity equation relates bilateral trade to each country's size, bilateral trade barriers, and multilateral trade resistance [4, 15].

Anderson and van Wincoop [15] and Hummels [16] have proposed a simple and interesting approach to estimating the importance of trade resistance with the help of a gravity equation. Multilateral resistance is included through the use of country-time-specific dummies. The time dimension of fixed effects allows for looking at the time evolution of a potential under trading status. Figure 2 shows the multilateral trade resistance coefficients for exporters and for importers respectively.

[1] Similar graphs may be built based on only exports or imports.



MTR coefficients for exporters MTR coefficients for importers

Figure 2: The world map of multilateral trade resistance (MTR) coefficients, exporters and importers, 2001, 2004, 2007, 2010 and 2013
Source: Authors' calculations using data from DOTS [17] and CEPII [18].

The coefficient of distance is close to -1 and significant. The coefficients of most country-time fixed effects are significant. Concerning African countries, these multilateral trade resistance coefficients are often negative and significant, indicating that these countries trade less than the norm defined by the gravity equation. Compared with the rest of the world,

most African countries have a higher resistance to trade, both in terms of exports and imports, with the exception of coastal northern, western, and southeastern African countries.

There has been a slight improvement in the trading status of Africa over time, even if countries like Burkina Faso, Central African Republic, Mali, and Niger remain significantly resistant to trade.

We now know that African countries exhibit significant resistance to multilateral trade, on both the export and the import sides. Let us examine the relative level of determinants of trade in Africa.

3. Determinants of trade-in and outside Africa

Before conducting econometric estimations in the next section, we discuss now what could explain the low level of trade in Africa. We compare the level of the explanatory variables of trade in Africa and the level in the rest of the world in order to identify which of the forces supposed to affect trade could be suspected of explaining the low participation of African countries in world trade.

3.1. Gravity factors

From listing the determinants of trade, we may identify the elements that could explain why Africa trades so little. Let us start with the usual gravity bilateral variables.

Figure 3 compares the level of trade and usual bilateral gravity variables influence (distance, contiguity, common official language, common colonizer, colonizer (i.e., one country has colonized another one), common currency, Regional Trade Agreement (RTA), and the applied duty imposed by the importing country on products coming from the exporting country) on the bilateral relation either between two African countries or between an African country and a non-African country, by reference to the level of this variable for a bilateral relation between two non-African countries.[2]

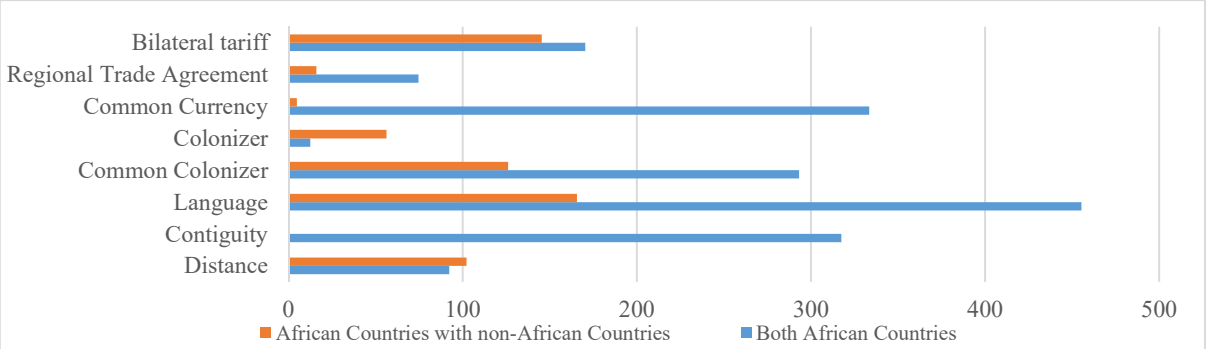


Figure 3: Gravity factors (ij variables) – 100=average level of the variable in case of trade between two non-African countries – 2013

Source: DOTS [17], CEPII [19], MAcMap-HS6 [20] and authors' calculation.

Trade between two African countries is penalized by relatively high tariffs. Trade between two African countries is 70% more taxed on average than trade between two non-African countries, while trade between an African country and a non-African country is 45% more taxed. Gravity factors like distance, a common currency, a common colonizer, a common language, and contiguity may help trade between two African countries. Trade

[2] For the source of data, see below.

between an African country and a non-African country is penalized by a low occurrence of RTAs, the quasi-absence of common currency agreements, and the total absence of contiguity.

3.2. Access to markets

We look now at access to markets, in terms of tariff and non-tariff barriers (NTBs). Based on the most recent version of the MAcMap-HS6 database [20], which measures worldwide protection in 2013 (see 0), we conclude that in terms of import duties, Africa is the least open continent in the world. Africa's average import duty on all merchandise is 9.7% (with a high rate of protection in the agricultural sector).

However, the average duty faced by African exports is relatively low (2.7%). This is not only due to regional agreements, such as the Economic Community of West African States (ECOWAS), the Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), and preferential regimes negotiated by and granted to African countries (Everything But Arms, African Growth and Opportunity Act), but also to the product structure of African exports, consisting mainly of energy or mineral products, which benefit from low import duties throughout the world.

Table 1: Access to markets: tariff measures - 2013

Continent	Average duty applied on imports			Average duty faced on exports		
	All	Agr.	Non Agr.	All	Agr.	Non Agr.
Africa	9.7%	19.6%	8.3%	2.7%	9.9%	1.4%
Asia	5.2%	19.0%	3.9%	4.0%	14.4%	3.5%
Europe	2.7%	13.3%	2.0%	4.4%	16.4%	3.3%
Latin America	7.1%	14.4%	6.3%	4.7%	14.1%	2.3%
North America	2.1%	7.3%	1.6%	4.4%	14.0%	3.2%
Oceania	3.0%	2.4%	3.0%	5.7%	20.4%	1.9%

Source: MAcMap-HS6 and authors' calculation.

Concerning NTMs, if African countries do not implement many restrictive barriers on their imports relative to other countries (see [21, 22] for a synthesis - see 0), these types of barriers may impact negatively African trade on the export side. Disdier, Fontagné, and Mimouni [23] show that NTMs, particularly Sanitary and Phyto-Sanitary barriers and Technical Barriers to Trade especially hurt exports from developing countries.

Table 2: Access to markets: Non-tariff measures (NTMs)

Continent	Average NTM	
	All	Agric.
Africa	15.7%	20.9%
Asia	13.1%	23.0%
Europe	6.5%	28.3%
Latin America	10.5%	28.1%
North America	7.7%	24.2%
Oceania	9.7%	29.1%

Source: Bouët, Cosnard, and Laborde [4].

3.3. Infrastructure and institutions

The quality of trade infrastructure is frequently mentioned as an important explanation for the decreasing participation of Africa in world trade. Bougheas, Demetriades, and Morgenroth [24] design a simple model which predicts a positive relationship between the level of transportation infrastructure and the volume of trade. They confirm it empirically with European data. Francois and Manchin [25] find that infrastructure and institutional quality are significant determinants of the intensive and the extensive margins of exports and that this relationship is stronger than the impact of tariffs on trade. Based on a gravity model with Heckman specification, Bouët, Santosh, and Roy [26] find that accounting for transport (roads, airports) and communication (telephone) infrastructure reduces the under-trading status of Africa. In some specifications, the under-trading effect vanishes altogether. Using a semiparametric specification, Bouët, Santosh, and Roy [26] also find evidence of complementarity across transport and communication infrastructure, implying that much greater impacts will be likely if the infrastructure is developed jointly rather than in isolation. Brenton, Portugal-Perez, and Regolo [10] find a substantial effect of distance and the share of paved roads on the level of market integration, as measured by relative prices, in Central and Eastern Africa. Edwards and Odendaal [27] design a gravity model of bilateral trade with country infrastructure (ports, air transport, rail, and telecommunications) determining transport costs, and find that African countries' trade would benefit from improved infrastructure.

With data coming from the WDI database [14] and the Logistics Performance Index (LPI) database [28], Figure 4 compares the level of trade infrastructure in Africa to the level outside Africa in 2001, 2007, and 2013. Africa is clearly behind concerning broadband penetration and fixed telephony penetration but is now catching up concerning mobile penetration.

Figure 5 shows the levels of six Doing Business variables, in particular the number of documents and the cost and time to export and import, in five groups of countries. African countries are at the tail end of the world ranking.

In the next section, we proceed to an econometric investigation of the determinants of trade.

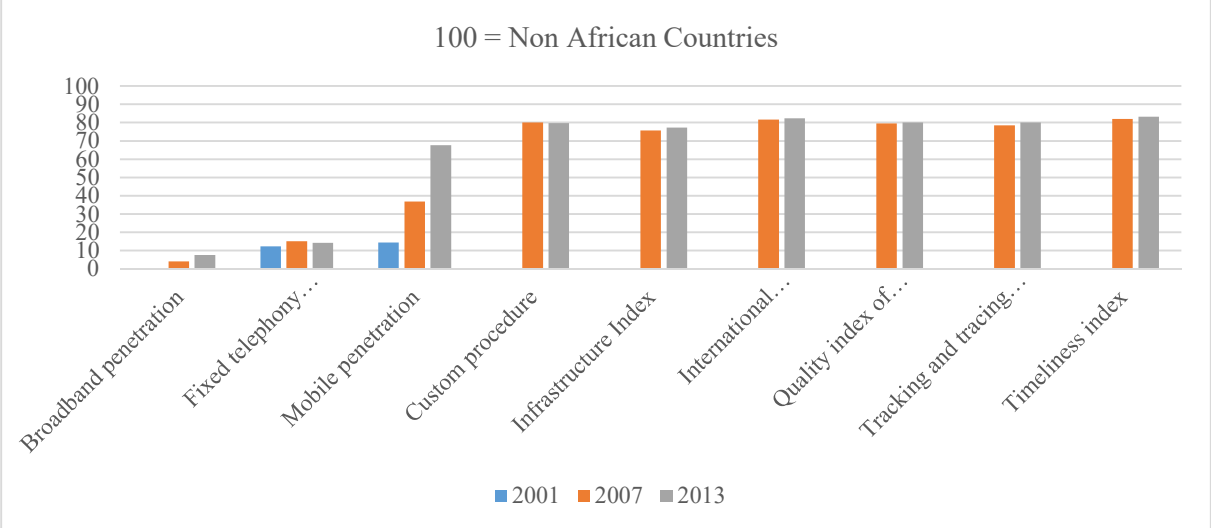


Figure 4: Trade Infrastructure
Source: WDI, LPI and authors' calculation.

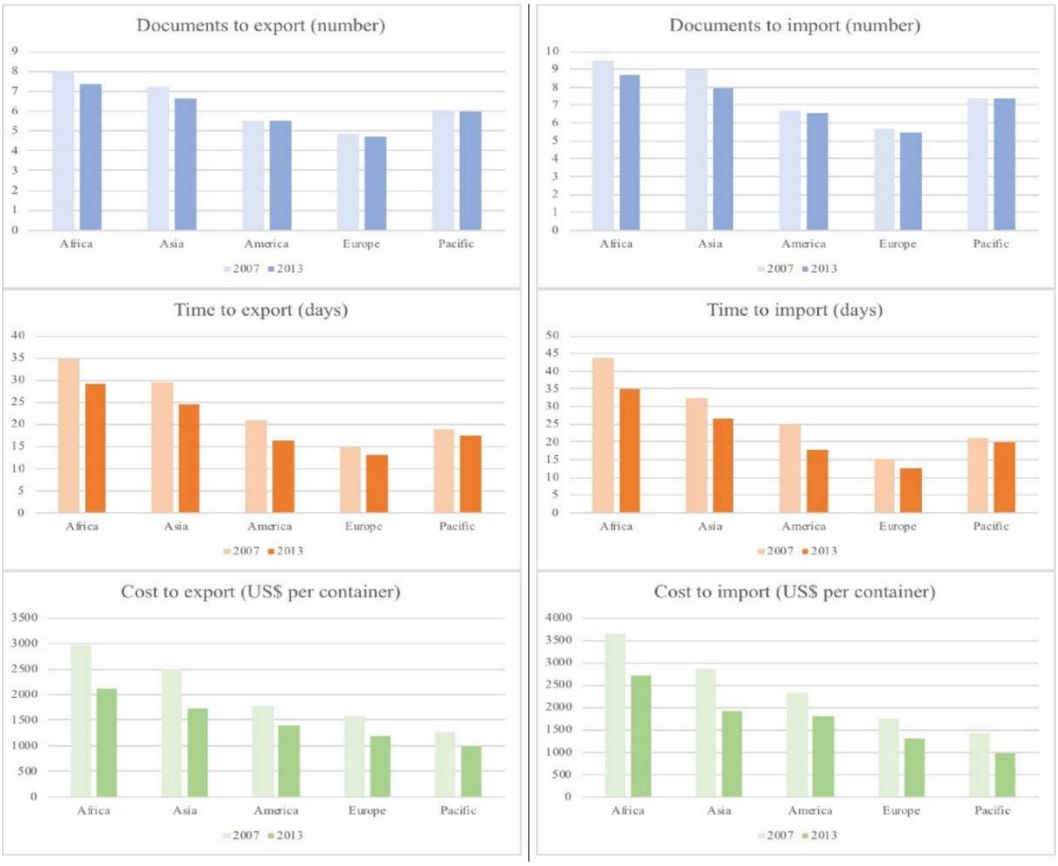


Figure 5: Number of documents, cost and time to export and to import
Source: *Doing Business* [29] and authors' calculation.

4. An econometric investigation

We first present the tested equation together with the econometric techniques used in this estimation, then the data on which this regression is based. Finally, we present the results of the estimation.

4.1. Model

In the past, empirical studies based on gravity equations have encountered two main problems. The first one concerns the multilateral trade resistance term. Trade between two countries depends on trade barriers between these two countries relative to average barriers, which these two countries face when trading with all their partners. As said by Anderson and van Wincoop [15], "the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner". This defines what is commonly called multilateral resistance and we take into account this by either including a remoteness term or a country-time fixed effect.

In this paper, estimations are based on the following specification[3], which controls multilateral resistance terms with remoteness indexes.

[3] We also carry out specifications using OLS estimations with or without multilateral resistance terms in order to have a direct comparison with our PPML estimations described as below. Results using OLS estimations can be retrieved upon request to the authors.

$$X_{ijt} = \exp[\beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{jt}) + \beta_3 \ln(DIST_{ij}) + \beta_4 COMSEA_{ij} + \beta_5 CONTIG_{ij} + \beta_6 LANDLOCKED_{ij} + \beta_7 LANG_{ij} + \beta_8 COMCOL_{ij} + \beta_9 COLONY_{ij} + \beta_{10} COMCUR_{ijt} + \beta_{11} RTA_{ijt} + \beta_{12} \ln(1 + TARIFF_{ijt}) + \beta_{13} \ln(NTM_{jt}) + \beta_{14} \ln(INFRASTRUCTURE_{it}) + \beta_{15} \ln(INFRASTRUCTURE_{jt}) + \beta_{16} \ln(INSTITUTION_{it}) + \beta_{17} \ln(INSTITUTION_{jt}) + \beta_{18} \ln(REM_{it}) + \beta_{19} \ln(REM_{jt}) + \eta_t] \times \varepsilon_{ijt} \quad (0)$$

where $TARIFF_{ijt}$ is the average import tariff applied by country j on products coming from country i at year t. X_{ijt} is trade from country i to country j at year t, $GDP_{it.}$ (GDP_{jt}) is Gross Domestic Product of country i (j) at year t. $DIST_{ij}$ is geographic distance between countries i and j. $COMSEA_{ij}$ is the existence of a common sea to countries i and j. $CONTIG_{ij}$ measures contiguity of countries i and j. $LANDLOCKED_{ij}$ measures landlockedness of countries i and j. $LANG_{ij}$ measures if countries i and j share a common language. $COMCOL_{ij}$ indicates if countries i and j had a common colonizer. $COLONY_{ij}$ indicates if i has colonized j or j has colonized i. $COMCUR_{ijt}$ is equal to one if countries i and j share a common currency at year t. RTA_{ijt} is equal to one if countries i and j are member of the same reciprocal trade agreement at year t. $APPLIED\_AVE_{ijt}$ is the average applied tariff that country j imposes on products imported from i at year t. NTM_{jt} measures the intensity of non-tariff measures implemented by country j (importer) on its imports at year t. $INFRASTRUCTURE_{it}$ ($INFRASTRUCTURE_{jt}$) measures the quality of country i (j)'s trade infrastructure at year t. $INSTITUTION_{it}$ ($INSTITUTION_{jt}$) measures the quality of country i (j)'s trade institution at year t. ε_{ijt} is an error term and η_t controls for time effects.

Then we take into account REM_{it} (REM_{jt}) as country i (j)'s remoteness index in this specification. We calculate:

$$\ln(REM_{it}) = \ln\left(\sum_j DIST_{ij} / \frac{GDP_{jt}}{GDP_{world}}\right);$$

$$\ln(REM_{jt}) = \ln\left(\sum_i DIST_{ij} / \frac{GDP_{it}}{GDP_{world}}\right), \text{ with}$$

GDP_{world} is the world's GDP.[4]

Moreover, we use a Pseudo-Poisson Maximum Likelihood (PPML) estimator, which is the natural method to address two important issues when estimating a gravity equation - these are the presence of zero trade flows and the heteroskedasticity of trade flows (see Santos Silva and Tenreyro [30]).

Data

We use annual trade data from the International Monetary Fund's Direction of Trade Statistics (DOTS) [17] database and distance data from CEPII [18]. Bilateral tariffs are sourced from the most recent version of the MAcMap-HS6 database [20] which measures worldwide protection in 2001, 2004, 2007, 2010 and 2013[5]. Concerning trading costs, the Doing Business website provided the number of documents to export ($DOCEXP_{i(j)t}$) and to import ($DOCIMP_{i(j)t}$) in country i and j at year t, the number of days to export ($TIMEXP_{i(j)t}$) and to import ($TIMIMP_{i(j)t}$) in country i and j at year t, and the cost in US$ to export ($COSTEXP_{i(j)t}$) or to import ($COSTIMP_{i(j)t}$) in country i and j at year t.

In the following econometric estimation, we include a $COMMONSEA_{ij}$ variable. It takes the value 1 if countries i and j have access to the

[4] We also carry out specification using PPML estimation controlling for multilateral resistance terms with country-and-time fixed effects. However this specification forbids the introduction of infrastructure and institution variables. All exporter-specific and importer-specific variables are absorbed by the exporter-time and by the importer-time fixed effects that need to be taken into account in order to control for the multilateral resistances in the theory-consistent structural gravity model.

[5] Since our bilateral tariffs variables from the MAcMap dataset only cover the years of 2001, 2004, 2007, 2010 and 2013, we carry our estimations based on the period from 2001 through 2013 with three-year intervals.

same sea. We use the classification of ten major seas according to Eakins and Sharman [31].

We also test the impact of variables of trade and transportation infrastructure. A first set of variables comes from the WDI database [14]. They measure communication infrastructure, like the number of fixed broadband subscriptions per 100 people in country *i (j)* at year *t* ($BROADBAND_{i(j)t}$), the number of fixed telephone subscriptions per 100 people in country *i (j)* at year *t* ($FIXEDTEL_{i(j)t}$), and the number of mobile cellular telephone subscriptions per 100 people in country *i (j)* at year *t* ($MOBILE_{i(j)t}$). Alternatively, we test the impact of the Logistics Performance Index (LPI), a ranking score implemented by the World Bank [28] which evaluates the performance in terms of trade logistics of 160 countries.

Regarding the impact of NTMs on African countries' trade, these estimations are based on the CEPII database NTM-MAP [22]. Most of the NTMs indexes in the CEPII NTM-MAP dataset were calculated for the 2012-2014 period while our database covers 2013. This is why we re-constitute a cross-sectional database for studying the impact of NTMs on trade in 2013.

4.3. Results

We first proceed to estimation with infrastructure and institution variables at three-year intervals from 2001 to 2013. Then we include non-tariff measures.

4.3.1. Econometric estimation with infrastructure and institution variables and without non-tariff measures

0 presents our main gravity estimates over the period 2001-2013. In column (1), we show a set of results where trade is regressed on traditional gravity variables. Most gravity variables have the expected sign and are significantly different from 0.

In 0, columns (1) to (3) present results from PPML estimation with remoteness indexes over the period 2007-2013 at three-year intervals.

Table 3: Main gravity estimates over the period 2001-2013

	(1)	(2)	(3)
lnGDPit	0.767**	0.731**	0.759**
	(0.02)	(0.02)	(0.02)
lnGDPjt	0.818**	0.813**	0.811**
	(0.02)	(0.02)	(0.02)
lnDISTij	-0.640**	-0.600**	-0.602**
	(0.05)	(0.05)	(0.05)
LANDLOCKEDij	0.052	0.029	0.037
	(0.08)	(0.08)	(0.08)
COMSEAij	0.238**	0.242**	0.258**
	(0.07)	(0.07)	(0.07)
CONTIGij	0.623**	0.657**	0.670**
	(0.10)	(0.10)	(0.10)
LANGij	0.394**	0.356**	0.356**
	(0.07)	(0.08)	(0.08)
COMCOLij	0.416**	0.560**	0.543**
	(0.15)	(0.16)	(0.15)
COLONYij	-0.172+	-0.178+	-0.193*
	(0.10)	(0.10)	(0.10)
COMCURijt	0.044	0.025	0.008

	(0.08)	(0.08)	(0.08)
RTAijt	0.166*	0.198*	0.180*
	(0.08)	(0.08)	(0.08)
TARIFFijt	-2.640**	-2.888**	-2.988**
	(0.88)	(0.86)	(0.77)
lnDOCEXPit	0.196+	0.418**	0.433**
	(0.10)	(0.11)	(0.11)
lnDOCIMPjt	0.088	0.088	0.099
	(0.06)	(0.07)	(0.07)
lnCOSTEXPit	-0.353**	-0.254**	-0.265**
	(0.09)	(0.09)	(0.09)
lnCOSTIMPjt	-0.284**	-0.268**	-0.256**
	(0.06)	(0.07)	(0.06)
lnLPIit		0.631*	0.661*
		(0.32)	(0.28)
lnLPIjt		0.090	0.111
		(0.30)	(0.26)
lnBROADBANDit		0.056*	
		(0.03)	
lnBROADBANDjt		-0.010	
		(0.02)	
lnMOBILEit			0.362**
			(0.10)
lnMOBILEjt			-0.017
			(0.07)
ln_REM_EXP	1.345**	1.450**	1.482**
	(0.17)	(0.18)	(0.18)
ln_REM_IMP	0.652**	0.671**	0.659**
	(0.20)	(0.21)	(0.21)
Constant	-59.629**	-63.844**	-66.583**
	(5.83)	(6.25)	(6.44)
N	65751	48810	52407
R-squared	0.773	0.785	0.776
Exporter-Time FE	No	No	No
Importer-Time FE	No	No	No
Time FE	Yes	Yes	Yes

Note: +significant at 10%, *significant at 5%, **significant at 1%.
Errors are clustered at the bilateral country-pair level. All specifications use PPML estimator.
The dependent variable in all PPML estimations is the export flows in level.
Source: Authors' calculation.

In 0, column (1) includes $DOCEXP_{it}$ ($DOCEXP_{jt}$) and $COSTEXP_{it}$ ($COSTEXP_{jt}$) from DOING BUSINESS. Columns (2) and (3) include the global International LPI index, LPI_{it} (LPI_{jt}), together with penetration rates of broadband in country *i (j)* at year *t*,

$BROADBAND_{it}$ ($BROADBAND_{jt}$) or of mobile phones, $MOBILE_{it}$ ($MOBILE_{jt}$) and DOING BUSINESS variables[6].

Of 30 explanatory variables, 23 have the expected sign and are significantly different from 0. The coefficient of the $COLONY_{ij}$ variable is negative and significantly different from 0. We obtained the same result without including infrastructure and institution variables under the PPML method with a remoteness index. Indeed, Head, Mayer, and Ries [19] conclude that post-colonial trade is marked by a strong reduction of trade between the colonized country and the metropole after four decades, in particular in case of hostile separations.

The coefficient of $COMCUR_{ijt}$ is never significantly different from 0. In fact, the evidence on the impact of a common currency on trade flows is mixed with studies showing a positive effect [32, 33], while others conclude there is a negative or insignificant effect [34, 35].

The coefficient of the variable measuring the number of documents to export at year *t*, $DOCEXP_{it}$, is positive and significantly different from 0. Two effects may play a role here. On one side, it represents a transaction cost that should decrease country *i*'s exports. On the other side, more documents to fill in an exporting country may play a positive role as it is a source of information for importers; for instance, it has already been discussed the potential positive impact of Sanitary and Phyto-Sanitary (SPS) rules may play on imports since they constitute a source of information for consumers and a signal of safety [23]. If the second effect is bigger, then the number of documents to fill in to export should tend to increase trade. If the transaction cost implied by filling in a document to export is relatively low, this effect is reinforced. The coefficient of the variable measuring the number of documents to import at year *t*, $DOCIMP_{jt}$ is non-significantly different from 0. We interpret this result as resulting from a low cost implied by filling in this document.

If the LPI_{jt} variable (global LPI index in the importing country) is non-significant, let us note that first the LPI_{it} variable (global LPI index in the exporting country) has a positive and significant impact. $BROADBAND_{jt}$ and $MOBILE_{jt}$ are two communication infrastructures in the importing countries that do not have a significant impact on trade while the same variables in the exporting countries have a positive and significant effect. Francois and Manchin [25] find that infrastructure is not only a significant determinant of exports at the intensive margin, but also at the extensive margin. A certain level of infrastructure quality in the exporting country is a critical condition of trade taking place and the infrastructure of the exporter has a greater impact than the importer's infrastructure. Also, Brenton, Portugal-Perez, and Regolo [10], Edwards and Odendaal [27] point out the role of mobile subscriptions and broadband subscriptions in the low African participation in international trade.

An interpretation is that production is more spatially distributed than consumption, such that the quality of the exporter's infrastructure plays a bigger role. Many studies point out the role of quality in the low African participation in international trade [10, 25, 27]. This includes transportation infrastructure like roads, railways, air transportation, and also communication infrastructure like mobile subscriptions, and broadband subscriptions since these factors remain low in many African countries during the period 2001-2013.

4.3.2. Econometric estimation with infrastructure, institution variables, and non-tariff measures

We conduct these estimations based on a PPML method with a remoteness index to take into account the multilateral resistance.

While these estimations are not shown in this paper but may be requested from the authors, we first regress trade on usual variables including

[6] In our regressions, we do not include together $BROADBAND_{it}$ ($BROADBAND_{jt}$) and $MOBILE_{it}$ ($MOBILE_{jt}$) since they are highly correlated.

broadband, mobile, and infrastructure variables, but not NTMs, within the new sample of observations (only 2013 and 71 importing countries) in order to check if results are unchanged. They are, except for the variables $BROADBAND_{it}$ and $TARIFF_{ijt}$; their coefficients are respectively positive and negative, as expected, but not significantly different from 0.

0 shows the results of estimations including NTMs from the CEPII database, together with other infrastructure and institution variables like $BROADBAND_{it}$ ($BROADBAND_{jt}$), the Doing Business variables, and the LPI variables (global LPI index).

Let us notice a few changes in the evaluated impact of some variables present in previous regressions. First, the coefficient of the Common Currency variable ($COMCUR_{ijt}$) is positive, as expected, and significantly different from 0. Second, the coefficient of the Regional Trade Agreement variable (RTA_{ijt}) is never significantly different from 0. We also note that the coefficient is significantly reduced. Concerning infrastructure and institution variables, the results are quite similar to those obtained previously.

Table 4: Gravity estimates with Doing business, LPI variables and NTMs: 2013

	(1)	(2)	(3)	(4)	(5)	(6)
lnGDPit	0.749**	0.749**	0.748**	0.796**	0.796**	0.794**
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
lnGDPjt	0.751**	0.758**	0.767**	0.743**	0.747**	0.764**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
lnDISTij	-0.716**	-0.719**	-0.731**	-0.701**	-0.704**	-0.718**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
LANDLOCKEDij	0.065	0.071	0.099	0.062	0.066	0.096
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
COMSEAij	0.264**	0.265**	0.269**	0.294**	0.293**	0.302**
	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)
CONTIGij	0.381**	0.380**	0.367**	0.376**	0.376**	0.363**
	(0.12)	(0.12)	(0.13)	(0.11)	(0.11)	(0.11)
LANGij	0.321**	0.317**	0.318**	0.311**	0.309**	0.290**
	(0.10)	(0.11)	(0.11)	(0.08)	(0.09)	(0.09)
COMCOLij	0.689**	0.679*	0.614*	0.672**	0.669**	0.554*
	(0.26)	(0.26)	(0.27)	(0.22)	(0.22)	(0.22)
COLONYij	0.095	0.095	0.100	0.094	0.094	0.107
	(0.10)	(0.10)	(0.10)	(0.08)	(0.08)	(0.09)
COMCURijt	0.172+	0.172+	0.184+	0.197*	0.196*	0.206*
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
RTAijt	0.039	0.037	-0.022	0.086	0.081	0.018
	(0.14)	(0.14)	(0.15)	(0.12)	(0.12)	(0.12)
TARIFFijt	-3.073	-2.952	-3.638+	-2.201	-2.168	-3.053
	(2.19)	(2.19)	(2.19)	(1.92)	(1.90)	(1.87)
freqNTM	-0.552*			-0.468*		
	(0.23)			(0.23)		
covNTM		-0.691**			-0.633**	
		(0.23)			(0.24)	
prevNTM			-0.092*			-0.094**
			(0.04)			(0.03)
lnLPIit	0.676	0.676	0.681	1.009*	1.003*	1.032*

	(0.54)	(0.54)	(0.55)	(0.41)	(0.41)	(0.41)
lnLPIjt	1.489**	1.473**	1.204*	1.419**	1.455**	1.459**
	(0.48)	(0.49)	(0.52)	(0.49)	(0.49)	(0.48)
BROADBANDit	0.111*	0.110*	0.110*			
	(0.05)	(0.05)	(0.05)			
BROADBANDjt	-0.028	-0.028	0.036			
	(0.03)	(0.04)	(0.04)			
MOBILEit				0.880**	0.882**	0.898**
				(0.18)	(0.18)	(0.18)
MOBILEjt				0.083	0.058	0.170
				(0.14)	(0.15)	(0.14)
DOCEXPit	0.580**	0.578**	0.575**	0.606**	0.607**	0.602**
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
DOCIMPjt	0.166+	0.160+	0.180*	0.174+	0.171+	0.165+
	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.09)
COSTEXPit	-0.191*	-0.193*	-0.207*	-0.166+	-0.170+	-0.177+
	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)
lnCOSTIMPjt	-0.090	-0.094	-0.202*	-0.082	-0.082	-0.173+
	(0.11)	(0.11)	(0.10)	(0.10)	(0.10)	(0.09)
ln_REM_EXP	0.932**	0.935**	0.934**	0.952**	0.953**	0.963**
	(0.32)	(0.32)	(0.32)	(0.28)	(0.28)	(0.29)
ln_REM_IMP	2.251**	2.285**	1.729**	2.228**	2.265**	1.702**
	(0.32)	(0.31)	(0.35)	(0.33)	(0.32)	(0.33)
Constant	-90.224**	-91.059**	-77.070**	-96.453**	-97.186**	-84.355**
	(9.64)	(9.61)	(11.09)	(9.99)	(10.01)	(10.40)
N	9091	9091	9091	9300	9300	9300
R-squared	0.772	0.772	0.774	0.792	0.792	0.797

Note: +significant at 10%, *significant at 5%, **significant at 1%.
Errors are clustered at the bilateral country-pair level. All specifications use PPML estimator.
The dependent variable in all PPML estimations is the export flows in level.
Source: Authors' calculation.

0 shows that global NTMs indexes, whether measured in terms of frequency (columns 1 and 4, 0) of coverage (columns 2 and 5, 0) or prevalence (columns 3 and 6, 0) have a significantly negative impact on trade. When estimating NTMs indexes disaggregated by measure types, we observe SPS measures, which include all conformity assessment measures related to food safety, such as certification, testing and inspection, and quarantine. As suggested by Disdier, Fontagné, and Mimouni [23], there is an informational asymmetry issue in the consumption of foreign goods - the consumer does not know the quality of the product. That imported products have to respect a certain number of SPS rules, standards and certificates may have a positive impact on the importation of these goods. Other non-tariff measures, in particular quantitative measures or measures related to customs formalities, may play a negative role in the importation of goods.[7]

5. Concluding remarks

In this paper, we studied the determinants of low participation of African countries in world trade. We focus on the quantitative aspects of the problem. The quality of international specialization is not taken into account. We first

[7] The full regression output is available upon request.

illustrate the under trading status of Africa. The share of African trade in world trade decreases approximatively by 0.5% each decade and African countries exhibit a significant multilateral resistance to trade, except for a few coastal countries.

We proceed to an econometric analysis that identifies the determinants of trade. By checking the level of these determinants for African countries as compared to world levels, we identify the main variables behind this low participation; in most African countries, the quality of trade infrastructure and trade institutions is low. A key example is given by mobile penetration. This variable has a significantly positive, and relatively high impact on national exports while mobile penetration remains low in many African countries. Another example is given by cost of exports, i.e., "all costs related to domestic transport, clearance and mandatory inspections by customs and other agencies, port/border handling, document preparation, etc." according to the World Bank methodology [29]. The level of this variable in African countries is relatively high as compared to other countries and reducing this cost in African countries at the world average would increase, on average, by almost 23% African countries' exports. While the number of RTAs between African countries and/or between African countries and non-African countries is relatively low, the average duty faced by African exports is relatively low while the average duty applied on imports is relatively high. So, negotiating tariff reductions, multilaterally or regionally, may not be the best way to increase African participation in world trade, except for intra-African trade. This indicates clear directions for policy reform in order to boost African trade, an important point in the context of the Malabo declaration.

There is an obvious data issue that can affect our study and/or its conclusions - for at least two reasons.

First, databases on official trade are known to be imprecise, in particular as far as African countries are concerned. Traoré and Mitaritonna [36] review the existing data that measure Africa agricultural and total trade in goods, from global sources and also regional ones. They conclude that there is an obvious problem of reporting African trade data in both international and regional databases.

Second, informal cross-border trade (ICBT) is prevalent in Africa. The ICBT survey in Uganda between 2005 and 2015 found that informal exports represent from 14.1% to 34.5% of total Ugandan exports. On the import side, the importance of ICBT appears to be marginal, while informal imports represent between 0.9% and 3.2% of total Ugandan imports. Concerning smuggling, Bensassi, Jarreau, and Mitaritonna [37] mention that smuggled goods exported from Benin to Nigeria are five times higher than recorded official exports. There is substantial evidence that databases underreport formal trade and that informal trade is significant. The problem is to evaluate the extent of this general underreporting of international trade. This question is difficult to answer, in particular because if some studies point out a substantial share of ICBT, they may have been implemented in places where the problem is acute.

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