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**IN GRAVITY NO *VERITAS*:
DUBIOUS TRADE ELASTICITY
AND WEAK EFFECTS OF
REGIONAL TRADE AGREEMENTS
IN AFRICA**

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In Gravity no *Veritas*: Dubious Trade Elasticity and Weak Effects of Regional Trade Agreements in Africa

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Abstract

This article puts into question the use of the gravity equation to analyze RTAs in Africa. Both by surveying the field and by leading estimations (on the so-called “structural gravity equation”, i.e. with bilateral fixed effects and individual-time effects), we find that the RTAs elasticity of trade are unreliable due to their unrealistic high level and/or due to their erratic change when additional controls are introduced. We thus use a general equilibrium model and analyze how results are affected by studying the effects of RTAs under different assumptions regarding these elasticities. We find that even with high level of RTAs elasticity, the effect of RTAs on welfare is small, in part in reason of trade diversion but more importantly in reason of the small share of trade in GDPs.

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1 Introduction

For more than forty years, African countries have enforced many different Regional Trade Agreements (RTAs) that differ in their degree of integration, going from free trade areas to customs and monetary unions, with the ultimate goal to promote trade and growth. What have been the effects of these agreements on trade?

In the meta-analysis on RTAs undertaken by Cipollina and Salvatici (2010) and by Head and Mayer (2014), it is striking to observe that the bulk of the literature has been interested mainly in the EU, NAFTA, MERCOSUR or by RTAs in general, but not by RTAs in Africa.¹ Starting from the fact that trade between African countries only represents small part of their exchange with the world² and has apparently not fostered any significant growth, the conventional wisdom has been that many of the RTAs enforced were inefficient. Foroutan (1992) well summarized this consensus for African RTAs enforced before the 90s by noticing that “Regional Integration in SSA has fundamentally failed to achieve its goals” and Carrere (2004) finds that the trade creation of RTAs in Africa has been offset by trade diversion. However this early literature does not control for the long list of individual and bilateral variables that can explain the weak continental integration (specialization patterns, regional or civil conflicts, preferential agreements with developed countries, etc). A recent wave of researches has started to estimate RTAs in Africa with adequate controls and find surprisingly high impacts. Mayer and Thoenig (2016) find that members of Regional Economic Community (RECs) have experienced an increase in bilateral trade of 213 percent after the signature the EAC, of 80 percent thanks to the COMESA and of 110 percent via the SADC. Cissokho et al. (2013) find that agricultural trade within ECOWAS has been very high. Nguyen (2019)

¹Focusing on African trade, the review of de Melo and Tsikata (2015) and Hoekman and Njinkeu (2017) document the lack of analysis of RTAs in Africa.

²Around 15% while internal trade between North American countries represents almost 50 percent of their total trade. Similar numbers can be found for Asia, while internal trade in ‘Fortress Europe’ with 27 countries reaches 70 percent. Finally intra-trade between South American countries is around 30 percent.

observes that the WAEMU has increased the intra-bloc trade by more than 80%. Candau, Guepie and Schlick (2019) find more contrasted results and remark that when the heterogeneity of agreements are taken into account (i.e. the different kind of provisions) many RTAs are no longer significant. By surveying this literature, we raise some doubt about the high level of RTAs elasticity obtained for Africa which appears equivalent or even stronger than well-functioning RTAs such as the NAFTA or the EU.

To analyze how problematic are these unrealistic high trade elasticities, we use the quantified model of trade of Arkolakis, Costinot and Rodriguez-Clare (2012) model which has the great advantage of transparency. Moreover, this model allows to quantify the effects of RTAs without data on tariffs which are often lacking for African countries. We find that even with high elasticity, RTAs have only weakly reduced multilateral resistances of trade in part in reason of trade diversion. Finally this increase of trade flows has brought small welfare gains (few countries have gained more than 1%) mainly because the initial African flows were small, and then even a significant increase of trade flows has a weak impact on real income.

The remainder of the paper is organized as follows. In Section II, a brief history of RTAs in Africa is presented and well as results of the empirical literature which are compared with our own estimation. Section III present the theoretical model and its computation. Section IV presents the counterfactual analysis and the final section outlines the study's conclusion.

2 Gravity with *Gravitas* in Africa

2.1 History and Review of the Literature on the Gravity Equation Applied to RTAs in Africa

In West Africa, the largest regional initiative is the Economic Community of West African States (ECOWAS), created in 1975. This community counts 15 countries of relatively small size at the exception of Nigeria which represents more than half of the total population and a significant proportion of the area's GDP. The ECOWAS has developed significant actions, such as its objective to keep peace in the region with military operations in Liberia and Sierra Leone. The progress of this community toward a deep integration is however recent. In 1993 a customs union is signed by all members, the date to entry into force is enacted by 1995 and the full implementation is scheduled in 2000.³ However the common external tariff has been delayed until 2015 and the common market is still in progress. Rose (2008, Table 3) analyzing this RTA among many other finds a significant coefficient of 1.4 in a traditional gravity equation (with bilateral and individual variables) but observes that the ECOWAS is no longer significant once dyadic fixed effects are introduced. Using a gravity model with kernel estimation techniques to capture the non-monotonic trade effects of RTAs over time, Coulibaly (2009) finds that during its first ten years of existence ECOWAS has had a positive impact on its members' imports from the ROW, but also find that this positive impact vanished over time. Cissokho et al. (2013) focusing on the agricultural trade and leading many different robustness checks still find that the ECOWAS effect remains strong and positive.

Within the ECOWAS, eight mainly francophone African states have formed the West African Economic and Monetary Union, WAEMU (also known as UEMOA from its French

³All the dates of signature, dates of entry into force and implementation come from the WTO's page on RTAs: <https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx>

name, Union Economique et Monétaire Ouest Africaine), in 1994. The Ivory Coast is the biggest country in this group, followed by Senegal. The origin of the WAEMU can be tracked back to the aftermath of the French colonization. After the independence, most of these countries kept their monetary union with France under the West African CFA (Financial Community of Africa) “Franc zone”⁴ and have established different Regional Economic Communities (RECs)⁵ before the WAEMU. The WAEMU may be one of the most integrated RECs, the RTAs was clearly inspired by European common market with a common trade policy and a solidarity fund financed by 1% of the duties on imports from the rest of the world that provides resources for a cohesion mechanism in order to reduce disparities within the region. Eicher and Henn (2011) and Glick and Rose (2016) analyzing different common currency zones, find for instance that the CFA Franc zone has stimulated trade more than the euro zone and/or the US dollar zone. Based on a gravity equation they find an elasticity of the CFA Franc zone around 0.7 while the trade elasticity of the Economic and Monetary Union in Europe (EMU) is around 0.5. Carrère (2004) finds a similar trade creation of 0.76 for the WAEMU but however detects diversion effects of a similar size. Beyond these diversion effects, the common market of the WAEMU is far from being fully integrated. For instance according to the WTO (2010) abusive/illicit tariff barriers and quantitative restrictions are still a reality. Furthermore many Non-Tariff Barriers (NTBs) are known to limit trade in this zone (UNCTAD, 2018).

The Economic and Monetary Community of Central Africa (CEMAC) finds its origin in the Central African Customs and Economic Union (CACEU) established in 1964. The CEMAC has been signed by six countries in 1994 (Cameroon, Central African Republic,

⁴Composed of the WAEMU and of the Central African Economic and Monetary Community (CAEMC). The Franc Zone exists since 1939, but its reality goes back to the 19th century. See De Sousa and Lochard (2005) for a brief history and an analysis of the border effect puzzle in the CFA Franc Zone.

⁵In 1959, a custom union, the UDAO is created but not enforced and soon replaced in 1966 by the UDEAO, itself replaced in 1973 by the CEAO (for Communauté Economique de l’Afrique de l’Ouest) that aim to promote a common market.

Chad, Congo, Equatorial Guinea, Gabon) and enforced in 1999. This RECs composed of relatively poor countries is often viewed as deficient. Carrère (2004) finds that trade diversion almost exactly compensated trade creation. Nguyen (2019) using individual and pair fixed effects finds no significant trade creation.

The East African Community (EAC), founded in 1967 by the three countries of Kenya, Tanzania and Uganda, first collapsed in 1977 based on the idea that Kenya was taking the lion's share of the benefits of this RTAs. The new EAC enforced in 2000 by Kenya, Tanzania and Uganda and then by Rwanda and Burundi in 2007, which became a fully-fledged Customs Union in 2009, adopts a more optimistic point of view by considering this regional integration as mutually beneficial. Mayer and Thoenig (2016) analyze this agreement and indeed find strong creation effect and low trade diversion. Using a gravity equation with all required controls (but estimated only with the OLS estimator), they find a significant coefficient of 0.797. Interestingly these authors also provide results for the The South African Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA).

The South African Development Community (SADC) is a political association created in 1992 by fourteen members. This treaty has numerous binding protocols dealing with issues such as defense, development, migration and free trade. Before the SADC, a previous institution was built without South Africa and with the aim to counter-balance the power of this country. In contrast South Africa joined the SADC in 1994 and has taken a leading role in this REC. The RTA signed in 1996, entered into force in 2000 and ended its period of implementation in 2015. This RTAs has certainly not given all its expected gains. Mayer and Thoenig (2016) find a trade creation equals to 0.397 in their preferred estimation (non significant or much higher in other cases).

The Common Market for Eastern and Southern Africa (COMESA) is a very large free trade area with twenty-one member states formed in 1994 and replacing a Preferential Trade Area (PTA) which had existed since 1981. The period of implementation ended in 2000.

Table 1: RTAs in Africa

	Date of signature/in force/full implementation Type of RTA	Articles	Coefficients
<i>EAC</i>	1999-09/2000-10/2005-15. CU	Mayer & Thoenig (2016)	0.797 ^a
		Nguyen (2019)	-0.361 ^b
<i>COMESA</i>	1993/1994/2000. FTA	Rose (2008)	-0.149
		Mayer & Thoenig (2016)	0.245 ^a
<i>WAEMU</i>	1993/1995/2000. C&MU	Nguyen (2019)	0.620 ^a
		Carrère (2004)	TC: 0.76 ^a ; TD: -0.65 ^a
<i>ECOWAS</i>	1994/2000/2000. FTA	Rose (2008)	-0.522
		Carrère (2004)	TC: 0.17; TD: 0.48 ^a
<i>CEMAC</i>	1994/1999/1999. CU	Nguyen (2019)	0.029
		Carrère (2004)	TC: 0.79 ^a ; TD: -0.76 ^a
<i>SADC</i>	1996/2000/2015. FTA	Mayer & Thoenig (2016)	0.397 ^a
		Carrère (2004)	TC: 1.28 ^a ; TD: -0.59 ^a

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively. TC: Trade Creation, TD: Trade Diversion. As explained in the text, various estimators have been used by the literature to obtain these reported coefficients.

The COMESA CU has been launched in 2009 and is far from being fully implemented. The COMESA includes countries of the EAC and the majority of countries belonging to the SADC. In their specification with individual and bilateral fixed effects, Mayer and Thoenig (2016) find a coefficient of 0.245 (not significant in other specification). Table (1) summarizes these findings.

These results are worth comparing with what has been obtained for RTAs in the rest of the world, in particular with respect to NAFTA and to the EU. Cipollina and Salvatici (2010) find in their meta-analysis that the mean coefficient for NAFTA is equal to 0.90 and 0.52 for the EU. From this comparison, three facts are surprising. The first one is the high level of the coefficients generated by the EAC and by the WAEMU, the second one is the ranking itself where the EAC and the WAEMU seem to have created more trade between African countries than between the members of the EU and seem almost as efficient as the NAFTA (according to Mayer and Thoenig, 2016 and Nguyen, 2019). The third surprising result is the lack of consensus indeed depending on the estimator used (OLS in Mayer and Thoenig, 2016; PPML in Nguyen, 2019) and the controls introduced (random effects in Carrère, 2004; fixed effects in Mayer and Thoenig, 2016) opposite results are obtained (e.g. see the EAC).

One potential problem of these analysis is the lack of control concerning all variables that like RTAs varies bilaterally and over time. This bias of omitted variable may explain an over estimation of the effects of RTAs in Africa. In particular, as we have briefly exposed in our history of RTAs, the enforcement of these agreements have taken time and many agreements were initiated by the formation of political communities that may have contributed to foster trade.

2.2 The Force (of Gravity) is not with African RTAs⁶

We thus introduce dummies that take into account these past agreements and replicate the so-called structural gravity equation using the pseudo-maximum likelihood (PML) estimator as follows:

$$X_{odt} = \exp(\alpha + f_{ot} + f_{dt} + f_{od} + \phi_{odt} + \epsilon_{odt}) \quad (1)$$

where f_{ot} and f_{dt} are time-varying country-specific effects approximating exporting and importing capacity and we also consider bilateral fixed effects f_{od} to control for all unobserved time-unvarying bilateral determinants of exports (Baier and Bergstrand, 2007; Magee, 2008). The variable ϕ_{odt} takes into account RTAs and other regional agreements including agreement that were implemented before RTAs:

$$\phi_{odt} = \lambda \cdot otherRTA_{odt} + \psi \left\{ \begin{array}{c} EAC_{odt} \\ COMESA_{odt} \\ \dots \end{array} \right. + \beta \left\{ \begin{array}{c} pastEAC_{odt} \\ pastCOMESA_{odt} \\ \dots \end{array} \right. \quad (2)$$

⁶This title paraphrases the Section 3 of Rose (2000), namely “The Force (of Gravity) is with Me”. It is possible that the “Force” of gravity is in part hidden by informal trade that is much more developed in Africa than in the rest of the world (see Bensassi et al. 2019). However one can imagine that such a fact is constant over time and thus the measurement error of trade registered in the official statistics may be taken into account partially in fixed effects in the gravity equation.

Table 2: RTAs in Africa

	PPML	GATT/COW	Trend
<i>EAC</i>	0.337 (0.342)	0.284 (0.360)	-0.417 ^b (0.163)
<i>COMESA</i>	0.674 ^a (0.258)	0.633 ^a (0.244)	-0.189 (0.275)
<i>WAEMU</i>	0.149 (0.276)	0.103 (0.259)	-0.026 (0.289)
<i>ECOWAS</i>	0.907 ^a (0.295)	1.052 ^a (0.305)	1.001 ^a (0.333)
<i>CEMAC</i>	0.076 (0.594)	0.035 (0.584)	-0.251 (0.871)
<i>SADC</i>	1.178 ^a (0.190)	1.170 ^a (0.191)	0.469 ^b (0.230)
OBS	835315	792200	835315
Log likelihood	-4.575e+12	-3.836e+12	-2.549e+12
R ²	0.990	0.990	0.996

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively. Robust clustered standard errors are reported under each coefficient. Individual and bilateral effects (f_{ot} , f_{dt} , f_{od}) are introduced in this last column as well as past agreements (such as the COMESA before the agreement of 1994, the EAC before 2000, etc. See the list in Appendix) but are not reported here to make the table readable.

We lead our analysis of trade flows on the bilateral TRADE HISTorical series, TRADHIST, a database from the CEPII (see Fouquin and Hugot, 2016). The dummy of regional trade agreements, RTA_{odt} , comes from Jeffrey Bergstrand’s homepage⁷ and all dummies concerning specific agreements (e.g. “COMESA before 1994”) are also built from these data.

In Column 1 of Table (1), we report the result of this estimation. In Column 2, we add two dummy variables that vary over time: the GATT/WTO membership (from the CEPII database TRADEHIST) and bilateral military conflicts from the Correlates of War (COW) project that makes available a very large array of data sets related to armed conflicts. Finally, because bilateral fixed effect captures all time-invariant factors that might otherwise be picked up by RTAs but not trends over time in the effects of unobserved bilateral heterogeneity, we interact a time trend with bilateral fixed effects ($f_{od} \times trend$) in Column 3. This last strategy has also been used by Bergstrand, Larch and Yotov (2015).

In Column 1, we find that the introduction of past political agreement leads to consider

⁷<https://www3.nd.edu/~jbergstr/> 2017

that many agreements are no longer significant such as the EAC, WAEMU and CEMAC. Other agreements are still significant and strong such as the COMESA, ECOWAS and SADC. It is however difficult to be confident on these results because for these agreements we cannot appropriately control for bilateral relationships that vary over time.⁸ The ranking of the coefficients also raises doubts about the validity of results. The SADC apparently has a stronger effect than the NAFTA while ECOWAS and COMESA are much more trade creating than the EU. These FTAs are also more significant than some CUs, which is clearly an unexpected result. In Column 2, the introduction of time varying dummies does not change the previous findings. Column 3 in contrast where a bilateral-time trend has been introduced leads to reduce strongly the elasticity of RTAs concerning SADC and to consider the COMESA as insignificant to explain trade in the region. Surprisingly however, the EAC has now a significant negative impact on trade. We have also run the structural gravity equation with the negative-binomial and the zero-inflated regression models and have found similar results.⁹ We do not report these results because in contrast to the PPML estimator which has not obvious problems, these two regressors have the important drawback of not being invariant to the scale of the dependent variable. To quote Sylviana Tenreyro¹⁰ “measuring trade in dollars or in thousands of dollars will lead to different estimates of the elasticities of interest”. Finally we have also used different databases (BACI, COMTRADE) without success.

Consequently, we conclude that the trade elasticity of RTAs in Africa, obtained with structural gravity equations are not reliable.¹¹ This may finally explain the difficulty to

⁸For instance, concerning SADC (for which like Carrère (2004) we find an unrealistic high coefficient) we do not control for the SACU since a dummy for this old monetary union cannot be introduced since it would take one during all the period and thus it would be perfectly colinear with our bilateral fixed effect.

⁹We have also implemented the Heckman two-step procedure without obtaining better results.

¹⁰<http://personal.lse.ac.uk/tenreyro/LGW.html>

¹¹It is important to keep in mind that our result concerns only the elasticity of RTAs, indeed coefficients of distance (or border), not analysed here, are much less sensitive which justifies the use of the gravity equation for a wide range of other analysis.

publish articles on RTAs in Africa with the gravity equation in comparison to similar studies accepted concerning the the EU and NAFTA. This result, or more accurately this lack of results, makes the used of structural model essential. Only a quantified model of trade can allow to assess the effects of RTAs with different values of trade elasticity. Here we use the Arkolakis, Costinot and Rodriguez-Clare (2012) model for its transparency and simplicity which fit relatively well to the characteristic of African economies. This model requires only trade flows and GDPs to assess the effect of RTAs and to set only one parameter: the RTAs elasticity on which the previous discussion was based. More sophisticated models required input/output tables and tariffs at the sector level for different years that are simply not available for African countries (only countries of the EAC provides reliable tariffs over the past twenty years). Finally, African countries are highly specialized and thus the ACR model with its implicit assumption of national product differentiation (Armington, 1969) and constant returns to scale, seems more appropriated than models with increasing returns and monopolistic competition¹² in the production of final and/or intermediate goods.

3 A Simple General Equilibrium Analysis

The ACR model is based on basic assumptions that are Dixit-Stiglitz preferences, a linear costs functions with only one factor of production (labour), a complete specialization and iceberg trade costs. In addition to these assumptions, two macro-level restrictions are satisfied: a CES import demand system; and a gravity equation that takes the following form:

$$X_{od} = \phi_{od} \frac{Y_o}{\Pi_o^{1-\sigma}} \frac{Y_d}{P_d^{1-\sigma}} \quad (3)$$

¹²Candau, Guepie and Schlick (2019) test whether there is a Home Market Effect in Africa, which is associated with monopolistic competition, and find no evidence of this effect.

where σ is the elasticity of substitution between varieties ($\sigma > 1$), ϕ_{od} an unversed measure of trade costs τ_{od} ($\phi_{od} = \tau_{od}^{1-\sigma}$ i.e an indicator of trade openness) between o and d , Y_d and Y_o the aggregated expenditures/incomes at the destination of exports d and at origin o . $\Pi_o^{1-\sigma}$ represents the market potential in o . This term is sometimes considered as an indicator of the market access from o and/or called outward multilateral resistance because it represents a GDP share weighted measure of trade cost resistance that exporters in o face when shipping their goods to consumers on their own and outward markets. Concerning African RTAs, this term may matter since the recent History of Africa (e.g. slavery, colonialism, preferential trade agreements¹³) has affected bilateral trade costs between African countries *relatively* to trade costs with distant countries. The term $P_d^{1-\sigma}$ in this gravity equation (3) is the accessibility-weighted sum of exporters- o capabilities also called inward multilateral resistance since it is a reversed measure of the openness of a nation to import from the world. Anderson and Yotov (2010) also consider this term as the buyers' incidence because it represents the weighted sum of trade costs paid by buyers.

The real market potential of exporters in this structural gravity equation is defined by:

$$\Pi_o^{1-\sigma} \equiv \sum_{d=1}^n (\tau_{od}/P_d)^{1-\sigma} Y_d \quad (4)$$

while the price index of the consumption basket in the destination country is given by:

$$P_d^{1-\sigma} \equiv \sum_{o=1}^n (\tau_{od}/\Pi_o)^{1-\sigma} Y_o \quad (5)$$

Considering a Log-differentiation of the gravity equation (3) we present, hereafter and step

¹³The first Generalized System of Preferences were non-reciprocal schemes implemented by the European Economic Community and Japan in 1971 and by the USA in 1976, i.e. only a few decades after the wave of Independence, to facilitate LDCs access to markets of rich countries. See Candau and Jean (2009) for a detailed analysis on the utilisation of these trade preferences in Africa.

by step, the impact of a change in trade costs due to RTAs. Starting by analyzing a change of trade costs ϕ_{od} in the numerator of (3), from ϕ_{od} to ϕ_{od}^c , we obtain the direct effect of trade costs. The upper-script c is used to characterize the counterfactual experiment. Assuming the part of trade costs related to RTAs is a linear function of $\ln \phi$ with a coefficient ψ , we can write the *direct* effect of the enforcement of RTA on bilateral trade flows in a very simple form:

$$Direct_{od} \equiv \dot{\phi}_{od} = \frac{\phi_{od}^c}{\phi_{od}} = \exp [\psi (RTA(1)_{od} - RTA(0)_{od})], \quad (6)$$

where $RTA(0)$ means no RTA and $RTA(1)$ enforcement. The “dot” is used in this paper to represent the proportional change in a variable between its initial value and the counterfactual scenario.¹⁴ As shown in this equation (6), the direct effect does not take into account price indices.

Now adding in this analysis how multilateral resistances vary after regional trade liberalization gives the *Price Index Effect* of RTAs¹⁵:

$$PIE_{od} \equiv \frac{\Pi_o P_d}{\Pi_o^c P_d^c} \exp [\psi (RTA(1)_{od} - RTA(0)_{od})]. \quad (7)$$

To compute this, we set the value of the trade elasticity, hereafter denoted $\hat{\psi}$, to compute ϕ_{od} such as $\phi_{od} \equiv \exp[\hat{\psi} RTA_{odt}]$. Using this measure of ϕ_{od} with expenditures Y_o and Y_d in Equation (4) and (5) with the contraction mapping of Head and Mayer (2015) gives the multilateral resistances Π_o and P_d . Thus in comparison with the literature that uses only one estimation of $\hat{\psi}$ from the gravity equation (2), here we take a range of elasticity between $\hat{\psi} = 0.1$ and $\hat{\psi} = 0.8$. This range is chosen according to the critical analysis

¹⁴The literature usually work with a “hat”, a notation here preserved to notify the predicted value of coefficients.

¹⁵Head and Mayer (2015) call this effect the Modular Trade Impact in reference to Anderson (2011). We prefer the term Price Index Effect which may be more telling.

of the results reported in the first section of this article (see Table 1). Then using these measures of ϕ_{od} , we get from Equation (6) the counterfactual trade costs ϕ_{od}^c , i.e. $\phi_{od}^c \equiv \phi_{od} \exp \left[\widehat{\psi} (RTA(1)_{od} - RTA(0)_{od}) \right]$. Using again the contraction mapping with ϕ_{od}^c and with the same expenditures Y_o and Y_d provides the counterfactual multilateral resistances Π_o^c and P_d^c . All these findings give the *PIE* of RTAs presented in Equation (7).

However one important aspect of trade liberalization has been neglected: the impact of RTAs on wages/incomes. Taking into account this change, the General Equilibrium Trade Effect (GETI), is defined as follows:

$$GETI_{od} = \frac{Y'_o X'_d}{Y_o X_d} \frac{\Pi_o P_d}{\Pi_o^c P_d^c} \exp [\psi (RTA(1)_{od} - RTA(0)_{od})]$$

Where Y'_o and X'_d denote respectively the production in origin country and the expenditures in destination country after trade costs changes.

Considering the production side with labour as the sole factor of production in each country $i = (o, d)$, $Y_i = w_i L_i$, and by considering change in the labour force as constant, then changes in incomes are determined by changes in wages $\dot{w} = \dot{Y}$). Since trade deficit are constant, change in expenditures equals change in incomes (indeed with $X_d = w_d L_d (1 + d_d)$) where d_d is the deficit of country d , gives $\dot{X}_d = \dot{w}_d = \dot{Y}_d$). To determine the equilibrium change in income we use the share of expenditure of consumers in o spent on goods produced in d , $\pi_{od} = X_{od}/X_o$. Finally, the change in expenditure due to a trade shock is given by:

$$\dot{\pi}_{od} = \frac{\dot{\phi}_{od} \dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld} \dot{\phi}_{ld} \dot{Y}_l^{1-\sigma}}. \quad (8)$$

Inserting this expression in the market clearing enables to solve the system and to get the income change due to the enforcement of a RTA:

$$\dot{Y}_d = \frac{1}{Y_d} \sum_{o=1}^n \frac{\pi_{od} \dot{\phi}_{od} \dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld} \dot{\phi}_{ld} \dot{Y}_l^{1-\sigma}} \dot{Y}_o X_o. \quad (9)$$

Using the direct effects calculated earlier, with Y_o approximated by GDPs, and the trade share π_{od} of each country o , gives from (9) a system of equations defining \dot{Y}_o , which once inserting in the trade share expenditure (8)¹⁶, gives the General Trade Equilibrium Impact (GETI) of trade shock: $\dot{\pi}_{od} \dot{Y}_d$. We also compute the welfare gains of RTAs under this quantitative exercise, given by $\dot{\pi}_{dd}^{1/(1-\sigma)}$, since welfare depends only on changes in the trade to GDP ratio.

To assess the removal impact of African RTAs, it is essential to have internal flows to measure domestic expenditures in order to re-calculate multilateral resistances and GDPs after a change in trade costs. As a consequence, we use the Input-Output Tables coming from EORA Database. This database contains the Input-Output tables for 195 countries. We choose the 2006's table as benchmark year and the Uruguay as a reference since this country shares characteristics with some African countries in terms of size and in terms of trade agreements. Readers have to keep in mind that with a General Equilibrium model, the solution is independent of the normalization by the reference country. However to avoid any doubt about that, we have checked that changing reference country does not modify our results. With Perou, Paraguay and Vietnam which are more close to Subsaharian Africa in terms of GDP per capita, findings are still the same. We have also analysed different benchmark year (2010 and 2000). Results are similar.

¹⁶To resolve the system we need an estimate of the constant elasticity of substitution between variety, we use $\sigma = 4.03$ which is the number obtained in the meta-analysis of Head and Mayer (2014).

4 Results

In Table (3), we present the results with two extreme RTAs elasticities, i.e. $\lambda = 0.1$ and $\lambda = 0.75$.¹⁷ The first finding is that all trade flows are strongly affected by these elasticities as illustrated by change in the PIE. Indeed when trade flows are rigid to change ($\lambda = 0.1$), all the gains, both in terms of trade creation and in terms of income are below 1%, while when the elasticity is high ($\lambda = 0.75$), the positive effects of RTAs is between 3 and 6% and the income effect adds 3 to 4% to these gains. Interestingly both the PIE and the GETI are magnified by an increase in RTAs elasticities. Indeed while λ is roughly multiplied by seven, the PIE and the GETI are approximately multiplied by ten.

The second result is the importance of trade diversion effect, indeed while in our extreme case RTAs increase trade by 111% ($e^{0.75} - 1$) between each partners, the PIE increase between 3% to 6%. This represents small positive effects in comparison with other RTAs. For instance according to Head and Mayer (2014, Table 6), on average RTAs lead to an increase of the PIE equal to 12% (NAFTA increase the PIE by 36%).

The third, and maybe the most important result, is that even with high trade elasticity, the growth of real GDPs (i.e. “welfare”) is at best equal to 0.6% and sometimes remains very low such as in the case of the ECOWAS (0.04%) or the EAC (0.001%). Regional trade openness in Africa is not a strong contributor of growth. Such a result has been observed in very different settings. For instance Coulibaly et al. (2018) use a gravity equation as an intermediate step to build an instrument of trade openness in order to analyse its impact on growth and find that the African trade with developing countries fails to be growth-enhancing.

Interestingly, as illustrated by Figures (??) and (2), the distribution of gains are unequal.

¹⁷We have run many other simulation with different elasticity not reported here but available on request.

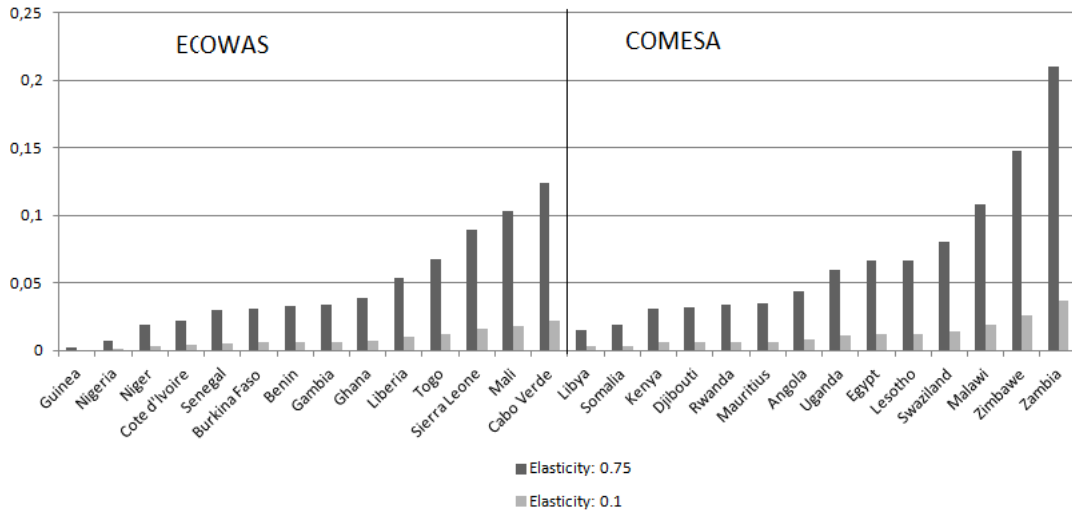
Table 3: General Equilibrium effects

RTAs	Elasticity	PIE	GETI	Welfare
COMESA	0.1	0.65%	0.96%	0.08%
	0.75	6.53%	10.61%	0.54%
ECOWAS	0.1	0.56%	0.75%	0.01%
	0.75	5.79%	8.05%	0.04%
SADC	0.1	0.31%	0.56%	0.09%
	0.75	3.12%	6.23%	0.61%
EAC	0.1	0.036%	0.070%	0.000%
	0.75	0.38%	0.748%	0.001%
CEMAC	0.1	-0.036%	0.211%	0.002%
	0.75	-0.368%	2.373%	0.013%

Notes : The benchmark year is 2006. The direct effect of ECOWAS is 0.403. PIE, GETI and Welfare are the mean effect facing by each country inside each RTAs.

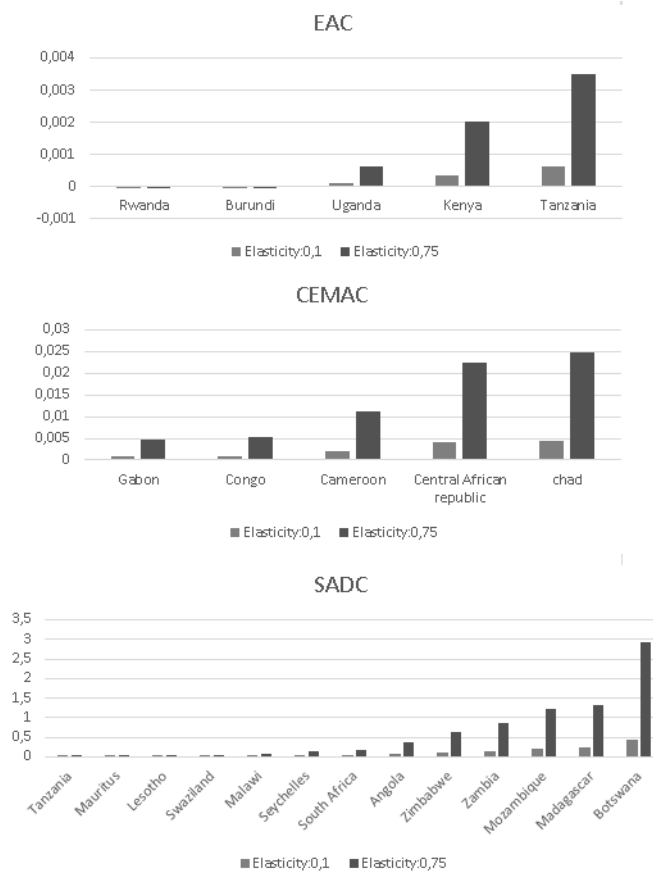
Indeed some countries, like Guinea, Nigeria or Somalia almost gain nothing respectively inside the ECOWAS and the COMESA. Overall, the most significant gains are obtained by small countries. This result is somewhat logical according to the model used, indeed small countries are more dependent from trade and then their multilateral resistances decrease more than for large countries thanks to RTAs, allowing to raise the purchasing power of consumers and then to consume more goods at a cheaper price from abroad.

Figure 1: Welfare gains at the country level



Similar results are obtained in the EAC where Rwanda and Burundi gain no benefit from the EAC even with a high level of elasticity (0.75). Countries inside the CEMAC have slightly better results, however still weak (at best 0.025% for Chad). Only Botswana in the SADC gains a substantial level of economic growth. This last result confirms the finding of McCaig and McMillan (2020) that find large increases in aggregate income in this country due to the trade liberalization of South Africa. However by studying labour force surveys from Botswana spanning a decade, they observe that even in that case of success, the result at the micro level are not obvious with an increase in the prevalence of working in the informal sector and mixed evidence of effects on unemployment.

Figure 2: Welfare gains at the country level



5 Concluding remarks

After surveying the field about the result of gravity equation applied to African countries and by leading our own estimation, we conclude what is often asserted in “off” by experts but rarely written in plain: trade elasticities obtained for African countries are dubious. Some agreements that are considered as efficient, such as the EAC, sometimes appears insignificant while other which have not been fully implemented seems unrealistically significant. This however does not mean that the gravity equation is useless, quite the contrary. The gravity equation is a fundamental module of every quantitative model in international trade. The fact that with some simple model only two statistics, the trade elasticity and the share of expenditures on domestic goods, are enough to solve for all endogenous variables of a general equilibrium model in order to provide the welfare gains of trade integration is particularly interesting to analyze RTAs in Africa. Indeed other statistics that are needed to feed ambitious CGE are often unavailable for these countries.¹⁸ The fact that the real trade elasticity are yet hard to obtain for African countries, makes the use quantitative model even more important by allowing to assess what can be expected under a vast range of trade elasticity.

In this paper we show, that the cost of not implementing the current RTAs were low. In comparison with a situation without RTAs, the increase in trade flows, the reduction in price and most importantly the increase in real GDP due to the current agreements in Africa are small. These agreements have brought for many countries something like a 0.2% increase in the indirect utility of agents. The main culprit, beyond trade diversion, about this poor performance lies in the small share of international trade in the GDPs of many African

¹⁸See for instance Balistreri et al. (2018) who propose the first CGE-microsimulation model to assess the impacts of the reduction of trade costs on poverty and income of the poorest 40% of the population in Eastern and Southern Africa. Despite the strong assumptions done, the great interest of this article (and of CGE models in general) is to provide much more detailed results than what has been presented here. This article for instance shows that trade facilitation would increase the share of income of the poorest 40% of the population.

countries. However, it is also possible that the aggregate small gains presented here, hide significant effects at the micro-level, with Hoekman and Njinkeu (2017) we can thus conclude that more focus is needed on the ‘micro’ dimensions of the regional trade integration.

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