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Abstract:

In this paper we provide an assessment of the impacts of Regional trade agreements (RTAs) on agricultural trade, putting emphasis on the role of rules of origin (RO) which are always part of these agreements. We distinguish trade in raw agricultural products and trade in processed food products. Our sample includes 180 countries over four time periods: 2001, 2004, 2007 and 2011. We consider the main trade agreements involving major world exporting countries of agricultural commodities and food products. Using a gravity model, we introduce dummies for controlling for the multilateral resistance terms and we use the Poisson-Pseudo Maximum Likelihood (PPML) estimation method to deal with zero trade flows. Econometric results globally confirm that RTAs have a positive impact on trade between member countries, a negative or a non significant direct impact of RO, a negative or a non significant cross impact of RTAs and RO. Our estimation results globally support a significant non linear impact of RTAs, its positive effect on trade between members decreasing with the degree of restrictiveness of involved RO. As expected, our results suggest that trade in food products is more sensitive to RTAs and their RO than trade in agricultural products. Contrary to expectations, our estimation results do not support clear differentiated impact of RTAs and involved RO on North to South and South to North agrifood exports. Finally, our results suggest that RO matter regarding the trade impacts of RTAs.

Keywords: regional trade agreements, rules of origin, agricultural trade, food trade, developing countries, gravity, poisson-pseudo maximum likelihood

JEL classifications: F14, Q17

Impact des accords commerciaux régionaux sur le commerce agricole :

Le rôle des règles d'origine

Résumé :

Dans ce papier, nous évaluons l'impact des accords commerciaux régionaux sur le commerce agricole et alimentaire, en mettant en évidence le rôle des règles d'origine qui sont partie intégrante de ces accords. Nous distinguons le commerce de produits agricoles et le commerce de produits alimentaires. Notre échantillon couvre 180 pays observés sur quatre années distinctes : 2001, 2004, 2007 et 2011. Parmi l'ensemble des accords régionaux en vigueur, nous considérons ceux qui concernent les principaux pays exportateurs de produits agricoles et alimentaires. Nous utilisons une équation de gravité, dans laquelle des variables muettes font office de variables de contrôle pour la résistance multilatérale. L'application de l'estimateur Poisson du pseudo maximum de vraisemblance nous permet de prendre en compte les flux de commerce nuls entre certains pays. Les résultats confirment l'impact positif des accords régionaux sur le commerce entre les pays membres. Ils suggèrent que les règles d'origine ont un impact soit négatif, soit non significatif sur le commerce entre pays membres d'un accord régional. Nos résultats indiquent un effet non linéaire significatif des accords régionaux sur les échanges entre pays membres, l'effet positif des accords diminuant avec le degré de restriction porté par les règles d'origine incluses dans les accords. Comme attendu, nos résultats montrent que le commerce de produits alimentaires est plus sensible aux accords régionaux et à leurs règles d'origine que le commerce de produits agricoles. En revanche, nos résultats ne confirment pas notre intuition initiale d'un effet différencié des accords régionaux et de leurs règles d'origine selon qu'ils concernent les flux commerciaux agricoles et alimentaires Nord-Sud ou Sud-Nord. Finalement, nos résultats confirment l'importance des règles d'origine au regard de l'impact des accords régionaux sur le commerce.

Mots-clés : accords commerciaux régionaux, règles d'origine, commerce de produits agricoles, commerce de produits alimentaires, pays en développement, équation de gravité, estimateur poisson du pseudo maximum de vraisemblance

Classification JEL : F14, Q17

The impact of regional trade agreements on agrifood trade flows:
The role of rules of origin

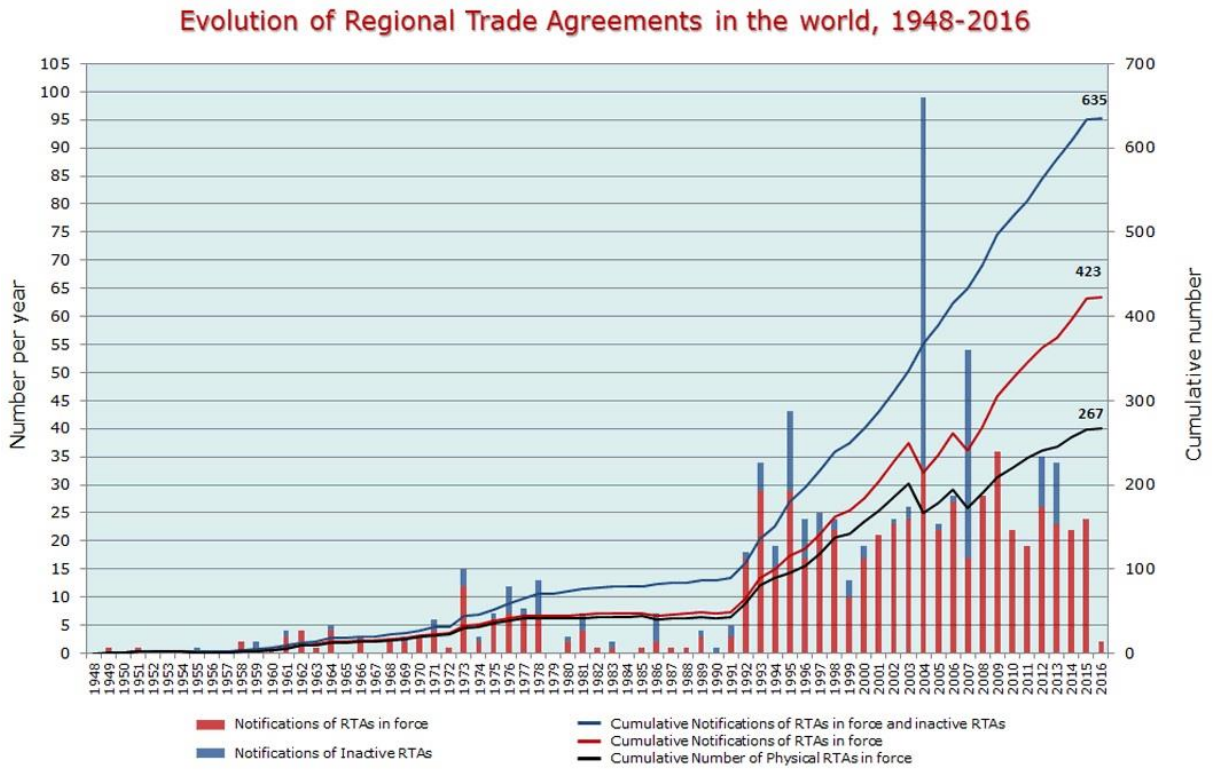
1. Introduction

Regional trade agreements (RTAs) have become increasingly prevalent since the early 1990s (see Figure 1). As of 19 July 2016, some 423 RTAs were in force according to the World Trade Organization.[1] Regional Trade Agreements (RTAs) are preferential trading arrangements between countries or groups of countries. They are designed to encourage open and competitive markets in the participating countries. There are various types of RTAs including free trade agreements (where members have both preferential rates for goods or services but keep their own external tariff rates), customs unions (where members have both preferential rates for goods or services and the same external tariff rates) and non-symmetrical agreements (where members offer each other non-symmetric preferences).

The proliferation of RTAs generates some discussion regarding their impacts on trade and welfare but also their role as regards the multilateral trade liberalization process. A large body of the literature is concerned with the empirical assessment of the trade and welfare effects of RTAs, either at the global trade level or for some specific sectors. Cardamone (2007) and Cipollina and Salvatici (2010) both provide an extensive review of the main findings in the existing literature. First of all, existing work do not provide conclusive results on the welfare impacts of RTAs for both participating member countries and the world at large. Secondly, studies that decompose the trade effects of RTAs into trade creation and trade diversion effects find divergent results, which do not allow for definitely concluding about the net trade-creating or the net trade-diverting effects of considered RTAs. Thirdly, most studies find a positive impact of RTAs on trade between the member countries. However there is still no consensus on the extent of this effect with many different results according to the time period, the considered geographic areas, the studied sectors, the aggregation level of data, the kind of RTA, the econometric methodology, etc. Finally, a large part of estimates tend to be biased due to a series of conceptual problems (Cardamone, 2007) and there is still no consensus about the methodology to be used.

[1]https://www.wto.org/english/tratop_e/region_e/regfac_e.htm, 19 July 2016.

Figure 1: Evolution of the number of RTAs in the world



Source: WTO Secretariat, http://www.wto.org/english/tratop_e/region_e/regfac_e.htm

More specifically, three main problems have been identified in empirical studies. First, Anderson and van Wincoop (2003) pointed out that specifications of gravity equations used in numerous studies fail to account for price terms (for both the exporting and the importing countries), which may lead to potential bias into the estimations. Second, as underlined by Bureau and Jean (2013), most studies analyzing the impacts of RTAs on trade suffer from an endogeneity problem since the causality between RTA and trade flows is not well-established. Indeed, it is likely that the probability of a RTA to be signed by one country is not independent from this country's trade flows. In such a case, as stated by Bureau and Jean (2013), the dichotomous indicator variable commonly used in empirical studies to account for RTAs' implementation can no longer be considered as independent of the error term and resulting estimates are biased. The third problem relates to the zero trade flows, which are commonly ignored in empirical studies. Santos Silva and Tenreyro (2006) propose to use a Pseudo Maximum Likelihood estimation technique, which in addition to be consistent in the presence of heteroscedasticity, allows for dealing with the zero values of trade flows in gravity estimations.

In this paper, we are interested in analyzing the impacts of RTAs on trade in agricultural and food products. Furthermore, we pay specific attention to the role of rules of origin which are always part of these agreements. There are few studies providing assessment of the impacts of RTAs on agricultural trade, and among them very little differentiate trade in raw agricultural products from trade in processed food products. To our knowledge there is no existing study analyzing the role of rules of origin in the impacts of RTAs on agricultural trade.

Most existing studies dealing with RTAs' impacts on agricultural trade flows focus either on raw agricultural products or on raw agricultural and food products (e.g., Grant and Lambert, 2008; Jayasinghe and Sarker, 2008; Korinek and Melatos, 2009; Bureau and Jean, 2013).[2] To our knowledge only Lambert and McKoy (2009) distinguish trade in raw agricultural products from trade in food products. Focusing on trade creation and trade diversion, they find a positive impact of preferential trade associations on intra-bloc trade in both agricultural products and food products. Their findings support trade creation in agricultural products but are inconclusive regarding food products.

The aim of our paper is to add to the existing literature on the impacts of RTAs on agrifood trade by contributing in four directions. First of all, contrary to most existing studies which limit their study sample to specific countries or group of countries, we propose a more systematic analysis by considering nearly all countries (180 countries); the dataset span 2001-2011 at three or four-year intervals: 2001, 2004, 2007, 2011[3]). Secondly, we put emphasis on the role of rules of origin in the trade impacts of main RTAs which are in force in agrifood trade. Thirdly, we distinguish trade in raw agricultural products and trade in processed food products in order to be able to compare the impacts of RTAs on trade of both types of products. Fourthly, we propose a methodological approach allowing for dealing with two of the main problems that have been identified in gravity studies: we introduce dummies for controlling for the multilateral resistance terms and we use the Poisson-Pseudo Maximum Likelihood (PPML) estimation method to deal with zero trade flows.

[2] In the following, we name "agricultural trade" the trade in raw agricultural products (i.e., chapters 1 to 14 in the HS classification) and "food trade", the trade in processed food (and feed) products (i.e., chapters 15 to 24). Agrifood trade will be used for designating trade in both agricultural and food products.

[3] This methodology is commonly used in the literature (see Lambert and McKoy (2009), Grant and Boys (2012) for instance) due to the availability of data and also to avoid the criticism arguing that dependent and independent variables may not fully adjust in a single year.

Following Lambert and McKoy (2009)'s results, our intuition is that the trade impacts of RTAs is likely to be different for raw agricultural products and processed food products, and that the rules of origin involved in RTAs could play a role to this regard. Rules of origin (RO) are helping to determine whether a product exchanged between two countries which are members of a RTA may be considered as originating from the export country and so may benefit from the preferential tariff provided by this RTA or not. Usually rules of origin require that the product wholly originates or has undergone a substantial transformation in the exporting country. According to Fulponi, Shearer, and Almeida (2011), in most RTAs which are in force in agrifood trade, RO require a chapter change (in the Harmonised System 2 digit) for making the proof of a substantial transformation in the exporting country. Hence, we think that this makes sense to distinguish trade of raw agricultural products and trade of food products since raw agricultural products are inputs for food products and thus both types of products do not face the same RO restrictions. Fulponi, Shearer, and Almeida (2011) show that RO are likely to be more restrictive and less easy to meet for processed food products than for raw agricultural products.

The paper is organized as follows. Section 1 provides a brief review of the literature on the impacts of agrifood regional trade agreements, both theoretically and empirically. Section 2 describes data and the econometric approach used. Section 3 analyzes empirical results and section 4 concludes.

2. Literature review: Agrifood Regional Trade Agreements and rules of origin

Few studies provide assessments of the impacts of RTAs on agrifood trade. Grant and Lambert (2008) find, using economic gravity equations for the period 1982-2002, that the positive impacts of RTAs on trade between member countries is much larger for agrifood products (HS chapters 01 through 24) than for non-agrifood products. They control for the time-varying multilateral resistance terms using country-by-time fixed effects and all time-invariant bilateral barriers using bilateral pair fixed effects. Then, focusing on six agreements (North American Free Trade Agreement: NAFTA; Canada-United States Free Trade Agreement: CUSTA; European Union agreement: EU, MERCOSUR, Andean Pact, Closer Economic Relations, Association of South-East Asian Nations: ASEAN), their result is confirmed for all considered agreements but the ASEAN.

Korinek and Melatos (2009) use a gravity model and a panel dataset, containing annual bilateral trade data for 55 products (3-digit SITC) comprising all agrifood products for the period 1981 to 2006, in order to estimate the trade effects of three RTAs: AFTA (ASEAN Free Trade Area), COMESA (Common Market for Eastern and Southern Africa) and MERCOSUR. RTAs are introduced through dummy variables in the gravity equation and several econometric methods are used, such as OLS or maximum likelihood Poisson for correcting heteroskedasticity. However zero trade flows are not included in the dataset. Their results suggest that the implementation of AFTA, COMESA and MERCOSUR has positively affected trade in agrifood products between member countries. According to the authors, this may be explained by the following points. Within COMESA and MERCOSUR, members offer each other duty-free access to their markets for almost all agrifood products while AFTA members' tariffs are less than one third most favoured nation rates on average. Besides, they find no robust indication of trade diversion. Finally, they show that trade costs such as transport and logistics remain important factors in determining agrifood trade flows.

Bureau and Jean (2013) focus on measuring the effects of tariff preferences accorded by agreement partners over the period 1998-2009 through 78 agrifood trade agreements, using difference-in-differences panel estimations. They find that trade flows are significantly positively affected by the trade agreements both with respect to impacts on intensive margin (pre-existing trade flows) and extensive margin (new trade flows).

Finally, Lambert and McKoy (2009) use a gravity model to isolate the effects of various preferential trade agreements (PTAs) on both intra- and extra-bloc trade in agricultural and food products for three time periods (1995, 2000, and 2004). They find PTA benefits in terms of increased intra-bloc trade for both types of products. Besides, trade creation is observed in agricultural products. For food trade, PTA membership is associated with both trade creation and trade diversion depending on the concerned PTA.

Several studies have focused on the impacts of rules of origin on trade but they all consider aggregate trade flows. Anson *et al.* (2005) have investigated the effects of rules of origin of the NAFTA on trade between partner countries. From a gravity model and cross-sectional data for the period 1999-2001, they find that the Agreement has increased the volume of intra-trade but the restrictiveness of rules of origin had a negative impact.

Manchin and Pelkmans-Balaoing (2008) analyze the effectiveness of preferential arrangements on intra-regional trade flows in ASEAN in order to provide a rough estimate of the costs of preferential arrangements. The results suggest that preferential tariffs favorably

affect intra-regional imports only at very high margins (around 25 percentage points). This highlights the likelihood of high administrative costs attached to the exploitation of preferences, particularly with regard to the compliance with AFTA's rules of origin.

As part of NAFTA, using data on Mexican exports to the United States in 2001, Carrère and de Melo (2006) estimate the likely restrictiveness of different kinds of rules of origin differentiating finished and intermediate products and compare these results with those obtained from a synthetic index. The econometric results indicate that the change in tariff classification-type RO is in average more restrictive for final products than for intermediate products.

Gretton and Gali (2005) compared the restrictiveness of rules of origin in the main preferential trade agreements proposing a new synthetic index. This index relies on a classification of the trade restrictions stated by the rules of origin and facilitates comparisons on a common basis. The results show a significant variation in the restrictiveness of rules of origin through the Economic Partnership Agreements (EPAs). Furthermore they suggest that NAFTA, the related agreements and the agreements signed by the EU tend to have more restrictive rules.

Our paper adds to this literature by proposing an assessment of the trade impacts of RTAs on agrifood trade, putting emphasis on the role of rules of origin, distinguishing trade in raw agricultural products and trade in processed food products and considering nearly all countries as well as a set of major RTAs in force in agrifood trade.

3. Data and Methodology

We estimate a gravity model on trade in agricultural and food products. Agricultural and food trade flows are total bilateral exports from country *i* to country *j* in year *t* (X_{ijt}) and come from the BACI trade database constructed by CEPII. Flows in BACI are Free on Board in current million USD. Agrifood is defined as chapters 1 to 24 of the Harmonized System (HS).[4] Once the sample is divided in two, agriculture correspond to chapters 1 to 14 and food to chapters 15 to 24.

4 Following the WTO definition of agriculture, we excluded chapter 3 (Fish and crustaceans) from our analysis.

The database covers 180 countries with a population greater than 200 000 in 2007.[5] We consider the period 2001 to 2011. Years 2001, 2004, 2007 and 2011 are used to cover this period while avoiding the criticism arguing that as dependent and independent variables may not fully adjust in a single year, time fixed effects estimations should not be performed on pooled data over consecutive years (Anderson and Yotov, 2011).

3.1. Building the RTA and the Rules of origin variables

The agreements considered in this study are those involving the main world exporting countries of agricultural and food products: NAFTA, MERCOSUR, ASEAN, ASEAN-South Korea, ASEAN-India, ASEAN-Japan, EU-27, EU-Egypt, EU-Turkey, ASEAN-Australia-New Zealand.

For measuring the trade impact of these agreements, a dummy variable RTA_{ijt} is introduced in the gravity equation. This dummy takes value 1 if countries *i* and *j* are both members of a same agreement on year *t*. At this stage, it is important to notice that for our set of retained RTAs over our considered time period, and as far as agricultural and food products are concerned, there is no country pair belonging to more than one RTA in our country sample. Hence, whatever the pair of countries, our dummy RTA_{ijt} always equals either 0 or 1.[6]

For testing the influence of rules of origin, we construct an index which is aimed to capture the restrictiveness induced by the rules of origin of each agreement. The difficulties regarding the measurement of the degree of restrictiveness of rules of origin in regional trade agreements result from the fact that they are more or less expressed in the form of complex legal texts. Thus, to give a statistical sense to these rules, they have first to be codified and then an ordinal restrictiveness index has to be defined, that summarizes all the information of the first step. Such an approach has been introduced for the first time by Estevadeordal (2000) who proposes a synthetic index at the tariff line level, ranging from one (least restrictive) to seven (most restrictive), based on an observation rule which summarizes the restrictiveness of rules of origin. Estevadeordal (2000) applied his approach to NAFTA.

For this study, we adopt the approach proposed by Anson et al (2005) which is more general and more elaborated than the one developed by Estevadeordal (2000). The construction of the

[5] The list of the 180 considered countries is provided in Annex.

[6] For one pair of countries this variable may take either 0 or 1 according to the time period.

restrictiveness index relies on the "substantial transformation" criterion evaluated at the tariff line level. In RTAs, the degree of transformation one product has experienced in one country is first measured through changes of tariff classification (CTC). For the latter, Anson *et al.* (2005) adopt the following observation rule:

- a change of classification at the chapter level (CC) is more restrictive than a change at the Heading (CH) level; a change at the heading (CH) level is more restrictive than a change at the sub-heading (CS) level; a change at the subheading level is more restrictive than a change at the tariff line or item level (CI). This implies the following observation rule: $\Delta CC > \Delta CH > \Delta CS > \Delta CI$.

Then, RTAs may include restrictions attached to CTC (ECTC) stating that non-domestic materials from certain subheadings or headings or chapters are forbidden. Third, other requirements may be added such as Value content (VC), setting a minimum percentage value to be added by the considered country, or technical requirement (TECH) stating that the product must undergo certain manufacturing operations. VC and TECH attached to a given CTC add to the index's restrictiveness. Thus, the observation rule assigns higher values to the index resulting from the CTC when these other requirements are added on (and a lower value when there is an allowance). Like Estevadeordal (2000), Anson *et al.* (2005)'s index ranges from one (least restrictive) to seven (most restrictive).

We thus undertook a huge work of coding and rating of CTC and other restrictions by tariff line in all ten RTAs we are considering in this study. We used the appendix of legal texts of these trade agreements provided by WTO. Then we computed the average restrictiveness index for each agreement distinguishing agricultural products and food products.[7]

Our variable "rules of origin" (RO_{ij}) which is introduced into the gravity model corresponds to the computed restrictiveness of the agreement RTA_{ijt} countries *i* and *j* both belong to in year *t*. As we already mentioned in the case of the RTA_{ijt} variable, there are no country pair belonging to more than one of our considered agreements. Hence for each country pair, there is no or at most one RTA-RO pair concerned.

3.2. The estimated gravity model

The following gravity model is estimated:

[7] See an example for ANASE in annex 2.

$$X_{ijt} = \exp(\beta_0 + \beta_1 \ln(dist_{ij}) + \beta_2 RTA_{ijt} + \beta_3 \ln(1+RO_{ij}) + \beta_4 RTA_{ijt} * \ln(1+RO_{ij}) + \beta_5 contig_{ij} + \beta_6 clang_{ij} + \beta_7 colony_{ij} + \gamma_{it} fe_{it} + \gamma_{jt} fe_{jt}) + \varepsilon_{ijt} \quad (1)$$

Where X_{ijt} stands for the bilateral exports between *i* and *j* in year *t*, RTA_{ijt} is a dummy equal to 1 for country pairs belonging to the corresponding RTA signed in year *t*, RO_{ij} is the restrictiveness index of rules of origin involved in the corresponding RTA.

As we are interested in the role of rules of origin regarding the trade impact of RTAs, we add an interaction term $RTA_{ijt} * Log(1+RO_{ij})$ as to test for a non-linear effect of RTAs on export flows due to the rules of origin.

Other bilateral trade costs are introduced, data coming from CEPII: the distance between exporting *i* and importing *j* countries following the great circle formula ($dist_{ij}$), a dummy contiguity variable for countries *i* and *j* sharing a common border ($contig_{ij}$), a dummy variable for countries *i* and *j* sharing a common language ($clang_{ij}$), and a dummy variable for countries *i* and *j* having had a colonial relationship after 1945 ($colony_{ij}$).

In order to perform a consistent estimation of the structural gravity model (Anderson and van Wincoop, 2003; Head and Mayer, 2013), multilateral resistance terms are controlled for with exporter-year fe_{it} and importer-year fe_{jt} specific effects (as recommended by Baldwin and Taglioni, 2006, and Feenstra, 2004). Finally, ε_{ijt} is a random error term satisfying usual assumptions and clustered at the country-pair level to control for the potential dependence between RTAs from a same country.

We suspect that Ordinary Least Squares and Least Squares Dummy Variables estimators that do not allow taking into account zero trade flows to suffer from a selection bias. Indeed, an endogeneity problem arises if unobserved bilateral trade costs explain the existence of such zero trade flows. Santos-Silva and Tenreyro (2006) recommend to use the Poisson-Pseudo Maximum Likelihood (PPML) estimator that deals with heteroskedasticity problems and has the subsequent advantage of allowing an easy incorporation of zeros in the trade flows variable (Head and Mayer, 2013). The PPML is expected to produce consistent estimates provided the conditional mean is correctly specified. [8] Another way to deal with the presence of zero trade flows is the 2-step Heckman-based approach (Helpman, Melitz, and Rubinstein 2008). The first step involves using a Probit to estimate the probability that *i* exports a

[8] The conditional mean must satisfy $E(X_{ij} / Z_{ij}) = \exp(Z_{ij}\hat{\beta})$, with Z the vector of explanatory variables.

positive amount to *j*. The second step estimates the gravity equation on the positive-flow observations including a selection correction. However, in our context it is difficult to find an exclusion restriction as this variable must be dyadic and time varying in nature, as both empirical steps already include country-year dummies to control for multilateral resistance terms. Furthermore, a 2-step Heckman-based approach would separate the effect of RTAs on the extensive margin from the effect on the intensive margin (Head and Mayer, 2013). Santos-Silva and Tenreyro (2009) further argue that this estimation method is also biased in the presence of heteroskedasticity in trade data. Considering that the RESET test performed over our sample confirms the presence of heteroskedasticity, we choose the PPML estimator for our empirical strategy.

4. Results

We estimate the previous gravity model for two country sub-samples and two sub-sectors. The first sub-sample covers exports flows from developed (North) countries to developing (South) countries. The second sub-sample considers exports flows from developing (South) countries to developed (North) countries. In both cases, we distinguish trade in agricultural products and trade in food products.

Estimation results are reported in Table 1 for North to South exports and in Table 2 for South to North exports. Our intuition is that rules of origin are more constraining for developing countries than for developed countries so we expect that South to North exports will be more negatively affected by rules of origin than North to South exports. In the same way, following Fulponi, Shearer, and Almeida (2011), we expect that rules of origin affect more negatively trade in food products than trade in agricultural products.

In Tables 1 and 2, the first three columns report the results for exports in agricultural products while the last three columns report the results for exports in food products. Results suggest that, for both countries' sub-samples and whatever agricultural or food trade, all coefficient estimates exhibit the expected signs and are statistically significant. Higher distance between countries tends to discourage their bilateral exports. Countries sharing common frontier, common language or former colonial links tend to trade more together. As expected, RTAs tend to increase bilateral trade between member countries while RO have a negative impact, sometimes non significant however.

Table 1: Estimation results for the North to South sample

	(1) Agriculture	(2) Agriculture	(3) Agriculture	(4) Food	(5) Food	(6) Food
Variables	North-South PPML	North-South PPML	North-South PPML	North-South PPML	North-South PPML	North-South PPML
Ldist	-1.139***	-1.154***	-1.143***	-0.953***	-0.954***	-0.957***
	(-18.710)	(-18.710)	(-18.260)	(-13.860)	(-13.660)	(-13.820)
Rta	0.356**	0.742***	2.275***	0.260*	0.290	3.754***
	(2.290)	(4.700)	(3.680)	(1.770)	(1.520)	(3.940)
ln(ro+1)		-0.326***	-0.298***		-0.0177	0.0293
		(-2.890)	(-2.690)		(-0.120)	(0.190)
rta*ln(ro+1)			-1.085**			-2.103***
			(-2.400)			(-3.650)
Contig	0.920***	0.889**	0.951***	1.144***	1.143***	1.014***
	(6.560)	(6.680)	(6.770)	(6.810)	(6.750)	(5.790)
Clang	0.301**	0.327**	0.311**	0.422***	0.424***	0.465***
	(2.310)	(2.520)	(2.390)	(4.100)	(4.110)	(4.540)
col45	1.038***	1.009***	1.020***	0.821***	0.820***	0.807***
	(6.040)	(5.910)	(5.940)	(6.020)	(4.110)	(5.960)
Constant	6.794***	6.775***	6.201***	5.152***	5.154***	5.442***
	(9.850)	(9.940)	(8.500)	(7.450)	(7.430)	(7.800)
Observations	38,061	38,061	38,061	37,982	37,982	37,982
R-squared	0.867	0.869	0.869	0.827	0.827	0.832
Fixed effect *it*	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effect *jt*	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets (clustered by country pairs). South (North) countries are defined using the World bank classification by Gross National Income per capita: using 2012 figures, North countries are the high income countries as defined by the World Bank; South countries are other countries.
** p<0.1; ** p<0.05; *** p<0.01*
Source: Authors' estimates.

Focusing on Table 1, our results confirm that RTAs have a positive and significant direct impact on agricultural and on food exports from North to South countries. We find that the RTAs' direct impact is greater for food exports than for agricultural exports, even if from a statistical point of view, both corresponding coefficients are not statistically different. Our results also confirm that RO involved in RTAs impact negatively and significantly agricultural exports from North to South countries. In the case of trade in food products, the impact of RO is not significant. Hence, contrary to our expectation, our results suggest that as regards exports from North to South countries, RO are likely to have greater negative direct influence on agricultural than on food exports.

The interaction term however may change this conclusion. Indeed RO also have an indirect effect through this interaction term. The latter has a negative and significant impact for both agricultural and food exports. This means that RTAs have a non linear effect on North to South exports, depending on the level of RO restrictiveness: RTAs have a positive effect on

exports between member countries but this effect decreases with increasingly stringent RO. For exports of agricultural products, the threshold is about 7[9] meaning that the effect of RTAs is always positive since the variable RO is lower or equal to 7. At reverse, for exports of food products, the threshold is about 5[10] implying that RTAs may affect negatively exports from North to South countries when involved RO are highly restrictive. In that sense, RO may have higher negative impacts for food trade than for agricultural trade.

Table 2 indicates that results are almost similar for exports from South to North countries. Main difference is that the coefficient of the interaction term is not significant for agricultural exports. Hence, for South to North agricultural exports, Table 2 shows that the impact of RTAs is positive, significant and constant whatever the restrictiveness of RO. The impact of RO is negative and significant.

Table 2: Estimation results for the South to North sample

	(1) Agriculture	(2) Agriculture	(3) Agriculture	(4) Food	(5) Food	(6) Food
Variables	South-North PPML	South-North PPML	South-North PPML	South-North PPML	South-North PPML	South-North PPML
ldist	-1.057***	-1.068***	-1.064***	-0.859***	-0.861***	-0.865***
	(-13.960)	(-14.330)	(-14.150)	(-8.3500)	(-8.2000)	(-8.3700)
rta	0.860***	1.321***	2.232**	0.163	0.250	4.283***
	(3.460)	(6.100)	(2.300)	(0.880)	(1.210)	(3.820)
ln(ro+1)		-0.442***	-0.433***		-0.0514	-0.00927
		(-2.830)	(-2.880)		(-0.280)	(-0.050)
rta*ln(ro+1)			-0.602			-2.443***
			(-0.910)			(-3.660)
contig	0.890***	0.842***	0.860***	1.465***	1.461***	1.305***
	(4.530)	(4.600)	(4.530)	(6.390)	(6.330)	(5.630)
clang	0.412**	0.453***	0.451**	0.365***	0.371***	0.417***
	(2.320)	(2.580)	(2.560)	(2.600)	(2.620)	(3.020)
col45	0.854***	0.811***	0.813***	0.765***	0.760***	0.746***
	(3.100)	(2.960)	(2.970)	(4.400)	(4.350)	(4.800)
Constant	8.935***	8.942***	8.587***	7.980***	8.004***	8.242***
	(13.640)	(13.720)	(11.670)	(8.990)	(8.710)	(9.280)
Observations	19,028	19,028	19,028	18,949	18,949	18,949
R-squared	0.852	0.858	0.858	0.828	0.829	0.833
Fixed effect it	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effect jt	Yes	Yes	Yes	Yes	Yes	Yes

[9] From Table 1 column 3, we can deduce that $\frac{\Delta X_{ijt}}{\Delta RTA_{ijt}} = \exp(2.275 - 1.085\ln(1 + RO)) - 1 = 0 => RO \cong 7$

[10] From Table 1 column 6, we can deduce that $\frac{\Delta X_{ijt}}{\Delta RTA_{ijt}} = \exp(3.754 - 2.103\ln(1 + RO)) - 1 = 0 => RO \cong 5$

Note: Robust standard errors in brackets (clustered by country pairs). South (North) countries are defined using the World bank classification by Gross National Income per capita: using 2012 figures, North countries are the high income countries as defined by the World Bank; South countries are other countries.
** p<0.1; ** p<0.05; *** p<0.01*
Source: Authors' estimates.

As for North to South exports, the direct RTAs impact is greater for food than for agricultural exports and, contrary to expectations, the direct impact of RO is greater in absolute value for agricultural products than for food products. However, like in the previous North to South exports case, the interaction term may change the conclusion. The threshold for a positive RTAs impact on South to North food exports is 4.77. Hence, RTAs have a positive impact on food exports until the restrictiveness of RO reaches this threshold.

In order to make easier to compare the trade impacts of RTAs (including RO) across sub-samples and between agricultural and food products, Table 3 provides synthetic results. Hence it is clear from the last line of Table 3 that: (i) taking into account the degree of restrictiveness of RO, the range of the intra-trade impact of RTAs is larger for food than for agricultural products, suggesting that trade in food products is more sensitive to RTAs than trade in raw agricultural products. For least stringent rules of origin, RTAs have a greater positive impact on food trade than on agricultural trade. When RO become more restrictive, the intra-trade impact of RTAs remains positive for agricultural products while it turns to negative for food products; (ii) contrary to what we expected, there is not empirical evidence that RTAs and involved RO impact differently North to South and South to North trade flows. The profile of estimated coefficients are very similar across both country sub-samples, except for the coefficient of the interaction term between the RTA and the RO variables which is not significant in the South to North exports of agricultural products sub-sample.

Table 3: summarized estimated RTA (including RO) effects on exports

	North -South		South-North	
	Agriculture	**Food**	**Agriculture**	**Food**
Direct effect of RTA	2.275	3.754	2.232	4.283
Direct effect of RO	-0.298	0	-0.433	0
Total effect of RTA (including RO [7, 1])	[0.02; 1.52]	[-0.62; 2.30]	[2.23; 2.23]	[-0.80; 2.59]

5. Concluding remarks

In this paper, we propose a systematic analysis of the impacts of RTAs, including the role of rules of origin, on trade in agricultural and food products. Using a gravity model, and a dataset covering 180 countries and the 2001-2011 time period, we estimate the impact of RTAs on bilateral trade flows between country pairs, distinguishing agricultural products and food products.

In doing so, we add to the existing literature in four directions. First of all, contrary to most existing studies which limit their study sample to specific countries or group of countries, we propose a more systematic analysis by considering nearly all countries and major RTAs in force in agrifood trade from 2001 to 2011. Secondly we distinguish trade in raw agricultural products and trade in processed food products in order to compare the trade impacts of RTAs in both sectors. Thirdly, we investigate the role of rules of origin in such RTAs impacts. Fourthly, we propose a methodological approach allowing for dealing with two of the main problems that have been identified in gravity studies: we introduce dummies for controlling for the multilateral resistance terms and we use the Poisson-Pseudo Maximum Likelihood (PPML) estimation method for dealing with zero trade flows.

Our results show clearly that taking properly into account zero trade flows and controlling for multilateral resistance terms matter since estimation results are sensitive to both these factors. This calls everybody to be extremely cautious not to draw policy recommendations on the basis of biased estimates.

We find a clear positive direct impact of RTAs on trade between member countries, a negative or a non significant (depending on the type of products) direct impact of RO, a negative or a non significant cross impact of RTAs and RO. Hence except for exports of agricultural products from the South to the North countries, our estimation results support a significant non linear impact of RTAs, its positive effect on trade between members decreasing with the degree of restrictiveness of involved RO. As expected, our results suggest that trade in food products is more sensitive to RTAs and their RO than trade in agricultural products. In particular, we show that the intra-trade impact of RTAs remains positive whatever the degree of restrictiveness of involved RO as far as agricultural products are concerned, while it becomes negative for most stringent RO in the case of trade in food products.

Contrary to expectations, our estimation results do not support clear differentiated impact of RTAs and involved RO on North to South and South to North agrifood exports. The main difference across country sub-samples lies in the linear effect of RTAs which is specific to South to North exports of agricultural products. Hence our results do not confirm our initial intuition stating that RO are likely to have greater negative impact on South to North than on North to South trade.

Finally, our results suggest that RO matter regarding the trade impacts of RTAs. Indeed we clearly show that in some cases, stringent RO may reverse the positive direct trade impacts of RTAs. Furthermore, our results indicate that such cases are more likely to arise for trade in food products than for trade in agricultural products. This suggests that countries willing to sign a RTA must be very cautious as regards the elaboration of RO, particularly for food products, if they likely want to keep benefits from the RTA in terms of increased exports.

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Annex 1: List of countries

Country	Code	Population_2007	Country	Code	Population_2007
Afghanistan	AFG	26349243	Lao PDR	LAO	6013278
Albania	ALB	3166222	Latvia	LVA	2276100
Algeria	DZA	35097043	Lebanon	LBN	4139813
Angola	AGO	17712824	Lesotho	LSO	1955784
Argentina	ARG	39331357	Liberia	LBR	3522294
Armenia	ARM	2989882	Libya	LBY	5782108
Australia	AUS	21015900	Lithuania	LTU	3375618
Austria	AUT	8300788	Luxembourg	LUX	479993
Azerbaijan	AZE	8581300	Macao SAR, China	MAC	493206
Bahamas, The	BHS	342049	Macedonia, FYR	MKD	2096620
Bahrain	BHR	1032353	Madagascar	MDG	19371023
Bangladesh	BGD	146457067	Malawi	MWI	13713758
Barbados	BRB	276277	Malaysia	MYS	26813819
Belarus	BLR	9560000	Maldives	MDV	308239
Belgium	BEL	10625700	Mali	MLI	12725629
Belize	BLZ	286196	Malta	MLT	409050
Benin	BEN	8707490	Mauritania	MRT	3330037
Bhutan	BTN	679365	Mauritius	MUS	1260403
Bolivia	BOL	9676456	Mexico	MEX	113529819
Bosnia and Herzegovina	BIH	3868665	Moldova	MDA	3576904
Botswana	BWA	1915187	Mongolia	MNG	2595068
Brazil	BRA	189996976	Montenegro	MNE	617800
Brunei Darussalam	BRN	381440	Morocco	MAR	30667086
Bulgaria	BGR	7659764	Mozambique	MOZ	22171404

Burkina Faso	BFA	14235075	Myanmar	MMR	50828959
Burundi	BDI	8328312	Namibia	NAM	2080700
Cambodia	KHM	13747288	Nepal	NPL	25950022
Cameroon	CMR	19097676	Netherlands	NLD	16381696
Canada	CAN	32927517	New Caledonia	NCL	242400
Cape Verde	CPV	483713	New Zealand	NZL	4228300
Central African Republic	CAF	4106897	Nicaragua	NIC	5595533
Chad	TCD	10694366	Niger	NER	14197289
Chile	CHL	16668892	Nigeria	NGA	147187353
China	CHN	1317885000	Norway	NOR	4709153
Colombia	COL	44498390	Oman	OMN	2569739
Comoros	COM	632736	Pakistan	PAK	163928329
Congo, Dem. Rep.	ZAR	57187942	Panama	PAN	3491034
Congo, Rep.	COG	3758858	Papua New Guinea	PNG	6397623
Costa Rica	CRI	4463226	Paraguay	PRY	6125285
Cote d'Ivoire	CIV	17949061	Peru	PER	28328410
Croatia	HRV	4436000	Philippines	PHL	88875548
Cuba	CUB	11301674	Poland	POL	38120560
Cyprus	CYP	1063095	Portugal	PRT	10608335
Czech Republic	CZE	10334160	Puerto Rico	PRI	3782995
Denmark	DNK	5461438	Qatar	QAT	1152459
Djibouti	DJI	798690	Romania	ROM	21546873
Dominican Republic	DOM	9615015	Russian Federation	RUS	142100000
Ecuador	ECU	14268397	Rwanda	RWA	9928143

Egypt, Arab Rep.	EGY	74229577	Saudi Arabia	SAU	25915624
El Salvador	SLV	6122952	Senegal	SEN	11904974
Equatorial Guinea	GNQ	639618	Serbia	SRB	7381579
Eritrea	ERI	5209846	Sierra Leone	SLE	5416015
Estonia	EST	1341672	Singapore	SGP	4588600
Ethiopia	ETH	80440708	Slovak Republic	SVK	5397318
Fiji	FJI	835392	Slovenia	SVN	2018122
Finland	FIN	5288720	Solomon Islands	SLB	492148
France	FRA	64012572	Somalia	SOM	8910851
French Polynesia	PYF	260361	South Africa	ZAF	48257282
Gabon	GAB	1447388	South Sudan	SSD	8736736
Gambia, The	GMB	1529406	Spain	ESP	44878945
Georgia	GEO	4388400	Sri Lanka	LKA	20039000
Germany	DEU	82266372	Sudan	SDN	33218250
Ghana	GHA	22525659	Suriname	SUR	510433
Greece	GRC	11192763	Swaziland	SWZ	1134977
Guatemala	GTM	13317931	Sweden	SWE	9148092
Guinea	GIN	10046967	Switzerland	CHE	7551117
Guinea-Bissau	GNB	1484337	Syrian Arab Republic	SYR	19561477
Guyana	GUY	770407	Tajikistan	TJK	7111025
Haiti	HTI	9513714	Tanzania	TZA	41119693
Honduras	HND	7178436	Thailand	THA	66076927
Hong Kong SAR, China	HKG	6916300	Timor-Leste	TMP	1046030
Hungary	HUN	10055780	Togo	TGO	5834806

Iceland	ISL	311566	Trinidad and Tobago	TTO	1310040
India	IND	1159095250	Tunisia	TUN	10225100
Indonesia	IDN	230972808	Turkey	TUR	69496513
Iran, Islamic Rep.	IRN	71809219	Turkmenistan	TKM	4858236
Iraq	IRQ	28740630	Uganda	UGA	30728747
Ireland	IRL	4356931	Ukraine	UKR	46509350
Israel	ISR	7180100	United Arab Emirates	ARE	5797347
Italy	ITA	59375289	United Kingdom	GBR	60986649
Jamaica	JAM	2675800	United States	USA	301231207
Japan	JPN	127770750	Uruguay	URY	3338384
Jordan	JOR	5661000	Uzbekistan	UZB	26868000
Kazakhstan	KAZ	15484192	Vanuatu	VUT	220001
Kenya	KEN	37752304	Venezuela, RB	VEN	27655937
Korea, Dem. Rep.	PRK	24111989	Vietnam	VNM	84221100
Korea, Rep.	KOR	48598000	West Bank and Gaza	WBG	3494496
Kosovo	KSV	1733404	Yemen, Rep.	YEM	21182162
Kuwait	KWT	2554920	Zambia	ZMB	12109620
Kyrgyz Republic	KGZ	5268400	Zimbabwe	ZWE	12740160

Annex 2: Construction of the restrictiveness index, the example of ANASE agreement

1/ The codification based on the legal text of the ANASE agreement

Section of HS	HS6 position	Codification of the Rules of origin
I – Live animals	1	TO (22)
	2	TVR (40) or CSP (58)
	3	TO (7)-TVR (40) or CSP (3)
	4	TO (2)-TVR (40) or CSP (20)-TVR (40) or CC (5)
	5	TO (1)-TVR (40) or CC (14)
II – Vegetables	6	TVR (40) or CSP (7)
	7	TO (34)- TVR (40) (2)
	8	TO (32)- TVR (40) or CC (11)
	9	TVR (40) or CSP (10)- TVR (40) or CC (20)
	10	TO (16)
	11	TVR (40) or CSP (3)- TVR (40) or CC (25)
	12	TO (19)-TVR (40) or CC (15)-TVR (40) or CSP (1)
	13	TO (2)-TVR (40) (1) –TVR (40) or CC (7)
	14	TO (3)-TVR (40) or CC (2)
III – Animal and vegetable fats or oils and their cleavage products; prepared edible fats; animal or vegetable waxes.	15	TVR (40) or CC or PC ; TECH (32)-TVR (40) or CC (12)
IV – Food preparations and beverages	16	TVR (40) or CC (25)
	17	TVR (40) or CC (4)
	18	TVR (40) or CC (2)-TVR (40) or CSP (2)
	19	TVR (40) or CC (10)
	20	TVR (40) or CC (42)
	21	TVR (40) or CC (7)- TVR (40) or CSP (4)
	22	TVR (40) or CC (10)
	23	TVR (40) or CC (4)
	24	TVR (40) or CC (3)

Note: Columns 1 to 3 correspond respectively to the sections including chapters, the positions (HS6) and the rules of origin corresponding to the various tariff lines for each HS6 position. In brackets, we indicate the number of times that the rule of origin is repeated.

2/ The restrictiveness index according to agricultural or food sectors.

The rules	Agricultural sector (HS1-14)		Restrictiveness Index	Food sector (HS15-24)		Restrictiveness Index
TO	138	40.35%	1	0	0.00%	
TVR	3	0.88%	4	0	0.00%	
TVR(40) or CSP	102	29.82%	4	6	3.82%	4
TVR(40) or CC	99	28.95%	4	119	75.80 %	4
TVR (40) or CC ou PC + TECH	0	0.00%		32	20.38 %	2
Total	**342**	**100%**		**157**	**100%**	
Average index (RO)			**3.25**			**3.33**

Note : This table gives the rules of origin according to the sections I to IV. Then we compute the sum by sub-sector and we deduce the percentage relative to the total of tariff lines by rule. The RO variable is then obtained by computing the mean of the index

Summary by section and by rule:

I. TO (32) - TVR (40) or CSP (81) - TVR (40) or CC (19)
II. TO (106) - TVR (40) (3) - TVR (40) or CSP (21) - TVR (40) or CC (80)
III. TVR (40) or CC ou PC + TECH (32) - TVR (40) or CC (12)
IV. TVR (40) or CSP (6) - TVR (40) or CC (107)

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