The Border Effect in Agricultural Markets Between European Union, OECD and LDC Countries

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Abstract

This paper uses the border effect estimate from a gravity model to assess the level of trade integration in agricultural markets between EU, OECD and LDC countries, over the 1995-2000 period. The empirical analysis confirms that using a gravity equation derived from theory, in the estimation of the border effect, matters. A representative estimate of the border effect shows that crossing a national border into the EU market induces a trade-reduction effect by a factor of 13. The border effect increases strongly on passing from trade between OECD countries to trade between LDCs. In the observed period the access to EU market appears quite stable for trade with other OECD countries, whereas it significantly decreases for trade with LDC countries. Finally, we show that the tariff equivalent implied by the estimated border effects are not implausible when compared to the actual range of direct protection measures.

Keywords: border effect, gravity equation, agricultural trade, European Union, LDCs
JEL Classification: F13, F14, Q17

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1. Introduction

The process of trade liberalization implied by WTO negotiations, as well as by unilateral initiatives such as Everything But Arms (EBA) of the European Union, has increased the demand for studies finalized towards an understanding of the 'real' tariff structure of countries. This paper contributes to this literature by analyzing the market access in agriculture between developed and least developed countries (LDCs). We depart from the recent literature on this subject in that we use an *indirect* estimation approach. Specifically, we estimate the (inverse) level of trade integration between the European Union and two very different country groups – the rich OECD and the poor LDC – using the gravity-border effect methodology.

The use of an *indirect* measure is due to the difficulties in estimating protection by *direct* measurement. Indeed, a look at the literature on the agricultural average protection of the EU reveals a spread of estimates, ranging from the 40% of Messerlin (2001) to the 10% of Gallezot (2003). While these differences can be explained by the data used, and the assumptions made in calculation (see Bureau and Salvatici, 2003), the evidence associated with direct protection measures remains questionable (Fontagné et al., 2004). First, average tariff figures mask a reality based on numerous tariff peaks. Secondly, it is quite difficult to include the complex system of preferential agreements, developed by many rich countries (notably the EU), in the estimation of average ad valorem tariffs. Moreover, zero tariffs and zero quotas do not necessarily mean free access due to measures at the border, such technical regulations and others non-tariff barriers to trade. This recognition is central to the evaluation of the liberalization level of recent initiatives conceding free access to LDCs, such as the Everything But Arms.

Given these problems, the literature now gives consideration to the possibility of using an alternative and indirect measure such as the border effect estimated from gravity models. This approach, initiated by McCallum (1995), recently found a solid theoretical foundation in the work of Anderson and van Wincoop (2003) and Feenstra (2002, 2003). The underlying idea is to measure the (inverse) level of integration between two countries, comparing their bilateral trade with respect to trade flows taking place within their own borders. The estimated *border effect* shows how much trade within countries is above international trade due to cross-border measures such as tariffs, technical regulations and others border costs.

In this paper we apply the theoretical gravity model developed by Anderson and van Wincoop (2003) to agricultural bilateral trade flows between 13 EU, 10 OECD and 23 LDC countries, from 1995 through 2000. In the empirical analysis we try to answer two main questions. First, does a theory based gravity equation do a good job in the estimation of the border effect in the agricultural market? Second, is the border effect a plausible estimate of market access?

A parallel concern of the paper is to give some consideration to the likely impact on LDCs of the EBA initiative, formally adopted by the EU in February 2001. The EBA was finalized to further improve market access for LDCs, extending existing preferences like the ACP and GSP that have already led to quota and duty-free access for most exports from the LDCs.[1] Other things being constant, it is quite evident that the

[1] Specifically, the EBA extends the existing preferences to 919 new tariff lines (HS-8 digit). However, duty and quota free access have immediate effects (March 2001) for only 876 tariff lines. Instead 43 other

effect of EBA on the LDCs tends to be proportional to the real tariff cuts, that ultimately depend on the actual tariff structure (see Yu and Jensen, 2003). However, it is also important to recognize that the EU market access for LDCs will also depend on all the other measures at the border that are not explicitly affected by the EBA initiative, such as rules of origin, quota administration (for sensitive products), regulations, standards and, more in general, non-tariff barriers to trade. Thus, a preliminary estimate of the tariff equivalent of these border barriers could offer some new insight into the evaluation of EBA type initiatives.

Finally, our analysis is linked to a growing literature that uses gravity type models to analyze different features of agricultural trade costs. Recent examples in this direction deal with the effect of food safety standards on bilateral trade (see Otsuki and Wilson, 2001; Otsuki et al. 2001; Nardella and Boccaletti, 2003), the estimation of tariff equivalents of non-tariff barriers (Dihel and Walkenhorst, 2002), the impact of distance on US agricultural export (Wang et al. 2000), the effect of exchange rate uncertainty (Cho et al. 2002) and of tariff and non-tariff barriers on agricultural trade (Haveman and Thursby, 2002). However, till now, the use of a theoretical gravity equation to infer the border effects in agricultural trade has never been applied.[2]

The paper is organized as follows. Section 2 summarizes the structure of the model and derives a theoretical gravity equation. Section 3 describes the data sources and variables used in the empirical model. Section 4 is devoted to the presentation of our empirical results. The final section discusses the main implications and our conclusions.

2. The gravity-border effect approach

The gravity-border effects approach starts with the puzzle finding of McCallum (1995). This author found that trade between a pair of Canadian provinces was much greater than trade between a Canadian province and a U.S. state, even accounting for distance and size. The differences was so large – a factor of 20 (= 2000%!) – that it throws into doubt the view that international markets have become relatively well integrated.

Since then, a large body of literature is emerged to explain the underline reasons of this apparent puzzle (see, e.g., Helivell, 1998; Wei, 1996; Wolf, 2000, Head a Mayer, 2002; and many others). Up to now, the more convincing explanation of the border effect puzzle come from the work of Anderson and van Wincoop (2003).

These authors show that the McCallum finding is a combination of two main distortions: First, an asymmetry effects of the border effect on countries of different size; and, more importantly, a miss-specification of the standard gravity equation with respect to what the gravity theory tell us. More specifically, the recognition that the existence of trade costs, such as transports costs and trade policies, induce price differences across countries. Thus, a consistent estimation of the gravity equation must to take account of these ‘price effects’.

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sensitive tariff lines will come into being in three progressive stages before the end of July 2009. The main sensitive product groups are sugar, rice and bananas (European Community, 2001).

[2] The only paper that specifically have applied the gravity-border effects approach to agricultural markets is that of Furtan and Blain (2004). However, their gravity specification is not based on a theoretical gravity model.

2.1 Theoretical background

Our main goal consists of the estimation of a bilateral trade model with a gravity specification derived from theory. Anderson and van Wincoop (2003) recently demonstrated that a proper derivation of the gravity equation from theory is crucially important to the validity of empirical results, and this is especially true in the case of border effect estimation. A gravity equation can be derived from a variety of different theories. In this paper we follow Deardoff (1998) and Anderson and van Wincoop (2003) who specify a model based on the Hecksher-Ohlin theory. Because our focus is on agricultural bilateral trade, this perfect competition framework appears more appropriate for modeling such trade than imperfect competition models.

The model assumes that each country is specialized in the production of a single good. Combining CES utility with 'iceberg' trade costs (proportionality of trade costs with respect to quantity of trade), and assuming symmetric trade costs, the model yields the following compact characterization of trade pattern between importer *i* and exporter *j*:

$$X_{ij} = \frac{Y_i Y_j}{Y^w} \left(\frac{t_{ij}}{P_i P_j} \right)^{1-\sigma} \qquad (1)$$

with

$$P_i^{1-\sigma} = \sum_j \theta_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \qquad (2).$$

In equation (1) X_{ij} denotes the import of i from j, Y_i and Y_j are levels of gross output (or GDP), Y^w is world output and t_{ij} are the trade costs (equal to one plus the tariff equivalent of all trade costs). Moreover, $\sigma > 0$ is the elasticity of substitution between goods, and P_i and P_j are the so called 'multilateral resistance indices' that summarize the average trade resistance between a country and its trading partners. Finally, $\theta_j = Y_j / Y^w$ is the country share of world output.

As in the traditional gravity equation, trade depends positively on the size of each country and negatively on the trade barriers. However, the key implication of equation (1) is that bilateral trade depends on *relative* trade barriers, namely the bilateral barrier t_{ij} divided by the product of their 'multilateral resistance indices' P_i and P_j. Thus, the gravity equation suggests that trade between two regions, after controlling for size, depends on the bilateral barrier between them, in relation to the average trade barriers that both regions face with all their trading partners. The interpretation is, as Anderson and van Wincoop (2003) suggest, quite intuitive: 'the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner'.

Before deriving an estimable equation, there is the modeling of the unobservable trade cost function t_{ij}. Following other authors, we assume that the trade cost factor t_{ij} is a loglinear function of two observable types of costs: (*i*) non-border cost proxy by bilateral distance d_{ij}, and (*ii*) whether there is an international border between *i* and *j*:

$$t_{ij} = d_{ij}^{\rho} b^{\delta_{ij}} \qquad (3)$$

where b is one plus the tariff equivalent of all the trade barriers associated with the border, and δ_{ij} is equal to zero when two regions are located in the same country (intra-country-trade) and equal to 1 for cross-border or international trade.
Finally, it is very useful to separate the border costs b into those that generate rents and those which do not generate rents (Anderson and van Wincoop, 2002). *Rent-border* costs are related to international trade policy such as tariffs, quotas and technical regulations, and lead to rents for government and/or private beneficiaries. Such costs depend on the level of protection of the country *i*, and consist of an *ad valorem* tariff τ_{ij} and the *ad valorem* equivalent of non-tariff barriers ntb_{ij}

$$b_{rent} = (1+\tau_{ij})(1+ntb_{ij}) \quad (4).$$

On the contrary, most border barriers result from factors unrelated to trade policy, and so do not generate rents. Such barriers are due to transaction costs generated by differences in language, culture, regulations, history, institutions and are, in most cases, more difficult to remove. In empirical studies such *non-rent-border* costs are, for example, proxy by using linguistic ties and contiguity dummy variables to capture information costs, the costs of writing any necessary contracts and the level of both formal and informal networks (see Evans, 2003).
The distinction between *rent* and *non-rent border* costs is important when the researcher uses the results of the estimated gravity model to do welfare analysis, as in Anderson and van Wincoop (2002). However, also in our more modest empirical exercise this distinction will be useful in estimating the tariff equivalent of tariffs and non-tariff barriers for the country groups involved in our model.

2.2 Empirical specification

Moving the output terms, Y_i and Y_j, from the right to the left of equation (1), to take account of the endogenity of gross output, and replacing the trade costs factor with (3), yields the following logarithmic form of the theoretical gravity equation:

$$\ln\left(\frac{X_{ij}}{Y_i Y_j}\right) = (1-\sigma)\rho \ln d_{ij} + (1-\sigma)(\delta_{ij})\ln b - (1-\sigma)\ln P_i - (1-\sigma)\ln P_j \quad (5).$$

In the estimation of a theory driven gravity equation the main problem is to take account of the unobservable multilateral resistance factors P_i and P_j . To this end the literature proposes three main, but different, approaches: the use of *price index* such as consumer price index (CPI) to measure the price effects in the gravity equation, as in Baier and Bergstrand (2001) and Fontagné at al. (2004), the use of non-linear least squares to solve the system of equations (1) and (2) as in Anderson and van Wincoop (2003) and, finally, the replacement of multilateral resistance terms with country dummies as in Hummels (2001) and Feenstra (2002). As recently shown by the last author, only the two latter approaches lead to consistent estimates[3], but while the former of these is more complex (and more efficient), the use of the fixed effect method is preferable due to its simplicity, since the estimation can be performed with ordinary least squares. Thus we will run our key estimations using the fixed effects for source and destination countries. That is to say, by adding a constant *k*, and introducing the border coefficient γ equal to (1- σ)ln*b*, we obtain:

$$\ln\left(\frac{X_{ij}}{Y_iY_j}\right) = k + \rho(1-\sigma)\ln d_{ij} + \gamma(\delta_{ij}) + \beta_1^i\phi_i + \beta_2^j\phi_j + (1-\sigma)\varepsilon_{ij} \tag{6}$$

where ϕ_i is a dummy variable indicating whether country *i* is the importer, and ϕ_j another dummy variable indicating if country *j* is the exporter. Then the coefficients β_1^i=(1- σ)lnP_i and β_2^j=(1- σ)lnP_j will be an estimate of the multilateral indexes. In equation (6) the key parameters to be estimated, other than the fixed effects, are the constant *k*, the distance coefficient ρ(1- σ), and the border effect coefficient γ = (1-σ)ln*b*.[4]

We apply the above equation to bilateral trade flows of 46 countries: 13 EU, 23 LDCs and 10 (non EU) OECD countries observed over 6 years (1995-2000). We assume that border barriers *b* may differ for EU-EU trade, EU-OECD trade, EU-LDC trade, and also in both OECD-OECD and LDC-LDC trade. Thus, we will estimate five different border coefficients γ.

Finally it is important to highlight that, due to the assumption of symmetric trade costs $t_{ij} = t_{ji}$ underlying the theoretical structure of the model, we have to interpret the tariff equivalent implied by the border effects estimate to be a *trade-weighted average* of the barriers in both directions. Indeed, the symmetric assumption does not imply that empirically $t_{ij} = t_{ji}$, because there are many equilibria with asymmetric barriers that lead to the same equilibrium trade flows as with symmetric barriers (see Anderson and van Wincoop, 2003).

3. Data and measures

Our gravity model includes 10 OECD, 23 LDCs and 13 EU countries (see Appendix 1).[5] The database considers the imports of the EU countries from all other countries over the period 1995-2000 (13 x 46 x 6), plus bilateral trade flows existing within LDCs and OECD countries. As a result the data set we use is not ‘square’ because some countries have more partners than others, and presents a total of 4,878 observations. Those observations consider almost 40% of world agricultural trade flows for the period.

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[3] A problem in using the published prices index to measure the multilateral resistant terms is that these indexes may not accurately reflect the true border effects (see Feenstra, 2002). Moreover, price indexes such as CPI also include non-tradables and are affected by local taxes and subsidies.

[4] Note that the elasticity of substitution σ, because it is always in a multiplicative form with trade cost parameters, is not identified.

[5] The observations on Belgium and Luxembourg are not considered due to a large zero value.

The needed data involve primarily bilateral trade and production data in a comparable industry classification. The trade data come from the World's Agricultural Trade Matrix (WATM) made by FAO. These trade data are detailed official data, reported by the country of origin (for imports) and the country of destination (for exports). We consider here the data reported by the importer countries, with the exception of shipments from EU to LDC countries, where we use the European countries exports declarations because of great lack of LDC declaration data. Summary figures for this bilateral trade flow are given in Appendix 1.

Like most databases on bilateral trade, the WATM lacks observations when trade equalled zero or when it fell below a reporting threshold. Following Zahniser et al. (2002), to ensure that these observations do not drive the results, a country's observations are included only if there are at least four non-zero data during the 1995-2000 period. Moreover, following Chen (2004), we express the dependent variables as $\ln(1+X_{ij})$, so that for high levels of trade flow $\ln(1+X_{ij}) \cong \ln(X_{ij})$ and when $X_{ij} = 0$, $\ln(1+X_{ij}) = 0$ also.

Although the database covers over 600 food and agriculture commodities, we consider here only the aggregate trade flow of 198 agricultural products.[6] This selection allows us to include in the database many developing countries whose data on food and agricultural production values, required by the model, would not normally be present. On the other hand it is easier to find, from the same data source, the agricultural production value. Thus, the agricultural production data and the trade flow data have a fully comparable classification. Indeed, the output data come from the FAO Statistical Database (FAOSTAT CD) where the same 198 agricultural product codes are considered.[7]

The empirical implementation of equation (6) needs intra-country trade data. For example, McCallum (1995) uses Canadian province-level data to show that trade between two Canadian provinces is about twenty times as large as their trade with the American states. However, we do not have this figure on intra-country trade for our country sample. Thus, as is common in this literature, country's 'imports' from itself, are calculated as in Wei (1996). Such imports are defined as the difference between total agricultural production and total export to the rest of the world. Both data come from the same FAO source described above. However, while the trade flow data are in current US$, the agricultural production value are in constant (1989-91) international $. Thus, for comparability purposes, the production data have been converted to current US$ using parity between international $ and US$, for the base period 1989-91, and the American CPI.

Moreover, we need measures of distance between and within countries. We use the intra-national distance estimate, recently proposed by CEPII. This distance database has the considerable advantage of making internal distance constructions consistent with international distance calculations. Note that as it is evident from the specification of trade costs (3), and as shown empirically by Head and Mayer (2002), any overestimate of the internal distance relative to the external one will mechanically translate into an overestimate of the border effect.

[6] The share of those agricultural commodities on total agri-food trade is 80% for the 23 selected LDC exports and 40% for the OECD exports to the EU.

[7] The 198 selected item codes represent agricultural raw material, while the other 355 codes consider processed agricultural items, like beverages, cheeses, cigarettes, etc.

Various measures of intra-national distances have been computed in the literature. For example, Wei (1996) and Wolf (2000) employ fractions of distances to the centers of neighbor countries. In the new CEPII database, the calculation is based on bilateral distances between cities weighted by the share of the city in the overall population of the country. This procedure is used for both internal and international distances.

Finally, as in the previous literature, we take into account also whether or not two countries share a common border, a common language, and common colonial histories. Thus, three dummy variables are included in some specifications. The first two dummies take value 1 when country *i* and country *j* speak a common language and/or share a common border (0 otherwise). The third one, the colonial dummy, is equal to 1 if *i* ever colonized *j* or *viceversa*, and comes from Rose (2002, 2003).

4. Results

4.1 Base model vs. fixed effects

Table 1 reports ordinary least squares regressions (OLS) of different specifications based on the gravity equation (6), pooled over the 1995-2000 period. For comparison purposes, we also report two traditional a-theoretic specifications (base model) where the estimation does not take account of the multilateral trade resistances implied by the theory.

The first column reports the results of estimating a McCallum type gravity equation, that allows for non-unitary output elasticity. The overall fit of this regression, equal to 0.53, is in line with the usual findings in gravity literature, confirming the ability of the gravity equation to explain bilateral trade flow. All the estimated coefficients have the expected sign and are highly significant ($p < 0.01$). The importer and exporter production elasticity, equal to 0.94 and 0.93 respectively, are both near the unitary value predicted by the theory. The coefficient on distance, around –1.0, is also comparable with the usual findings, with coefficients ranging from –1.2 to –0.6.

In this basic specification, the estimated border effects are all particularly large. For example, considering the estimated border coefficients between the EU countries, this means that intra-country trade is, on average, about 103 (= *exp* (4.63)) times larger than the cross-border EU trade. A comparable estimate for agricultural trade does not exist. However, Fontagné et al. (2004), for all manufactured goods, finds an intra EU border effect ranging from 20 in the late seventies to 13 in the late nineties. Moreover on comparing the magnitude of the border coefficients between different country-group combinations, a clear inconsistency emerges with respect to the *a-priori* expectations. For example, the average border effect between LDCs is lower than the average border effect of intra-EU trade. These results appear inconsistent with the zero tariff and zero non-tariff barriers implied by the European Common market, especially when associated with the high tariff protection of LDCs (see Gibson et al. 2001).

The specification in column (2) extends the basic gravity model by constraining the coefficients on production terms at unity. By doing this the potential endogeneity in production is accounted for. However controlling for production endogeneity does not substantially change the magnitude of the border coefficients, that remain large. However, it does induce a slight reduction in the overall fit of the regression, a result very close to the findings of Anderson and van Wincoop (2003).

In column (3) we include fixed effects for source and destination countries, to check for the unobserved multilateral resistance indices implied by the theory. Comparing columns (3) and (2) shows that this theoretical modification strongly reduces the estimated border coefficients in all but the LDC-LDC combinations where, differently, the border coefficient increases. Now the estimated border effects are more in line with previous findings. First of all, the lower border effect is detected for intra EU country trade. Thus, the level of trade integration among EU countries is higher than the other combinations considered here. Crossing a national border inside the EU reduces trade by a factor of 13.5 (= *exp* (2.60)), a very close figure with the 13.2 estimation of Fontagné et al. (2004) in the period 1996-1999.

Second, the LDCs show a very low level of integration with other LDC countries. Here, the cross border trade is 90 times lower than their intra-country trade. This border effect is impressively large, but consistent with the existing estimates in other developing countries (see Helliwell, 1998; de Sousa and Lochard, 2003). On the contrary the average level of integration between LDCs and EU countries seems substantially higher, and of the same order of magnitude as that between EU and OECD countries. In these two cases the cross border trade is 26 times lower than intra-country trade.

Overall, these results confirm that using a gravity equation derived from theory, in the estimation of border effects, matters. Indeed, a-theoretic gravity equation strongly inflates the border effect estimate, that suffers an omitted variable bias, as discussed in section (2).

Column (4) adds two variables found to be important in earlier work (see, Wei, 1996; Helliwell, 1997): contiguity and the use of common language. We follow Wei in interpreting these variables, namely 'how much more intensely does a country trade with itself than with another country with which it shares a common border and a common language?'. As can be seen both variables have a positive and significant coefficient. Thus, two countries speaking the some language tend to trade 156% (= *exp* (0.94)-1) more with each other than otherwise, while sharing a land border has a slightly lower impact.

The inclusion of the language and contiguity dummies reduces the average border effects in all but the LDC-LDC combinations. Thus, the results suggest that sharing a common border and a common language, partially explains why trade is more prevalent between national borders than across borders. These two variables explain between 35-55% of the border effect, with the higher value related to intra EU trade, and the lower one to EU-LDC trade. However this is not the case of LDC-LDC combination. The different effects of the two dummies on passing from EU-EU trade to LDC-LDC trade, simple suggests that these dimensions are not key elements in determining the strong border effect of LDC countries. In LDCs features such as insecurity associated both with contractual enforcement and with corruption (see Anderson and Marcouller, 2002), probably are dominant with respect to the dimension captured by language and contiguity dummies.

Finally, the last column of table 1 adds a dummy which is equal to 1 if country *i* has ever colonized *j* or *vice versa*. Its estimated coefficient is positive and highly significant, suggesting that ex-ante colonies trade more with their colonizers. As in our data set the colonial dummy is equal to one, especially in EU-LDC country pairs, it is not surprising that its inclusion especially affects this border coefficient.

Our main concern does not lie in explaining border effects in agricultural trade, a very important topic for further research, but in using the estimated parameters to better understand their potential implications from a market access perspective. However, before doing that, let us look at the time variation in border effects.

4.2 Time variation in border effects

Table 2 and figure 1 analyze the evolution of the border effects over the observed period. In table 2 the regressions are estimated pooling the data over three different time periods: 1995-96, 1997-98 and 1999-2000. From table 2 we first note that our estimated equation is quite stable across the years, although the border coefficients show a generalized tendency to increase on passing from the 1995-96 period to the 1997-98. Then in the last period the border coefficients remain quite constant and, in some cases, decrease. A better picture of the time variation in border effects is given in figure 1, where we plot their year to year variation. As can be seen, all but one border effect combination show a rather smooth and regular evolution, with a slight border effect increase, especially in the first half of the period. Excluding from the discussion the trade combination EU-LDC, to which we return later, it is quite difficult to draw strong conclusions from this little increase in border effects, due to the short time period involved. However, note that these results are not inconsistent with the implementation of the Marrakech agreement, where the OECD average agricultural protection does not show a substantial reduction when measured with respect to trade with other developed countries (see Boüet et al. 2003).[8]

However, this last conjecture is more difficult to apply to the sharp increase in the EU-LDC border effect, evident in figure 1. In fact, the actual estimate of the average protection of EU import from LDCs tends to decrease during the 1995-2000 period (see Gallezot, 2003; Boüet et al. 2003). A potential explanation of this border effect jump could be found in the difficulty encountered by LDCs to meet the stringent sanitary and phitosanitary measures and product standards of the EU market, a hypothesis consistent with recent empirical evidence (see, e.g., Henson et al, 1999; Otsuki et al. 2001; Olper and Banterle, 2002; Unctad, 2003). If this interpretation is correct, it casts some doubts on the real value of market access concessions given to LDCs, because the increases in these border barriers could erodes the actual preferential margin.

4.3 Policy-related border barriers: a tentative evaluation

The border effects discussed above represent all-inclusive border barriers and can be usefully split into *policy-related* (or rent) and *policy-unrelated* (or non-rent) border costs (see section 2.1). Although an attribution of the effects of these two components it is not a trivial task, a preliminary and rough division could provide useful information on the economic significance of these different effects (see Evans, 2003). Thus, to evaluate the contribution of policy-related border barriers, we use the results of the preceding section, making the assumption that intra EU border effect is a lower bond estimation of policy-unrelated border costs, due to the zero tariffs and zero non-tariff

[8] There are different conceptual difficulties in the estimation of the average protection implied by the Uruguay Round implementation (see the discussion in Boüet et al. 2003). However, there is a widespread suspicion that tariff, as an effect of the tariffication process, could be increased.

barriers implied by the Common Market since 1993.[9] Then, to estimate the policy-related component of the border costs of the others trade combinations, we subtract from their absolute border coefficients the absolute border coefficient of the EU. Table 3 reports the results.

The first three columns calculate the total implied *ad valorem* tariff equivalent of border effects $\left(= \exp\left[\gamma/(1-\sigma)\right]\right)$, using the border coefficients γ estimated in regressions from 3 to 5 of table 1, and a range of reasonable values of substitution elasticity σ of 3, 5 and 8 respectively. Those tariff equivalents are all-inclusive border barriers and are clearly sensitive to substitution elasticity. Instead columns from 4 to 6 report the tariff equivalent of policy-related border barriers obtained as described above. Finally, for comparability purposes, the last column reports some representative estimates of average (*direct*) tariff rates taken from previous studies.[10]

Let us focus the discussion on an intermediate value of $\sigma = 5$.

The all-inclusive average tariff equivalents for trade between developed countries ranges from 56% for intra EU trade to 125% for EU-OECD trade. These values are some what higher than the results of previous studies based on OECD countries and all manufactured goods, ranging from 45% to 116% (see table 7 of Anderson and van Wincoop 2004, survey). Though these differences are in line with the higher level of protection that characterizes agricultural vs. manufactured goods in OECD, the tariff equivalent of border barriers are far higher than recognized tariff barriers, suggesting that transaction costs and non-distortionary barriers are substantial. In other words, in relation to our hypothesis, the results show that policy-unrelated border barriers dominate trade policy, as suggested by Anderson and van Wincoop (2002) and Evans (2003).

For the same elasticity value $\sigma = 5$, policy-related border barriers show an average bilateral tariff equivalent that ranges from 2.5% for OECD trade to 99% for LDC trade, with intermediate value for EU trade with OECD and LDC ranging from 18% to 36% (see column 5). To give sense to these figures the reader is reminded that the policy-related border barrier is the sum of two things: the *ad valorem* tariff plus the *ad valorem* equivalent of non-tariff barriers. Thus our tariff equivalents estimate will be realistic only if their value are higher than (or close to) the average tariff rates reported in the last column of table 3. As can be clearly seen this happens in almost all the cases reported there, independently of the choice of the elasticity of substitution. The only systematic inconsistency appears to be the estimated equivalent tariffs for trade between OECD

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[9] Indeed, the process of harmonization or mutual recognition in standards and other regulations implied by the Common market, does not actually find equality around the world. Moreover, as suggested by Evans (2003: 1306), 'EU membership implies both a reduction in trade restriction and the creation of supranational government institutions and policies, that go beyond the scope of any single national government and beyond what would be implied by completely free trade among independent nations'.

[10] Because the estimated tariff equivalent of border effects are *weighed average bilateral* tariffs between each country trade combinations, the average tariffs reported in the last column of table 3 are computed starting from 'representative' bilateral tariffs, weighted by our trade figures (see appendix). For example, to estimate the EU-LDC average bilateral tariff we start from an average 1995-2000 duty on EU imports from LDCs of 4% (see Gallezot, 2003; Boüet et al., 2003: table yy). Then we assign a tariff of 45% to LDC import from EU, starting from Gibson et al. (2001) tariff estimate on LDCs. Finally, using our trade figures as a weight, we have an average bilateral tariff of 9.3%[=(4%*0.87)+(45%*0.13)]. A similar procedure was applied to EU-OECD and OECD-OECD combinations, starting from bilateral tariff taken from Boüet et al. (2003: table yy and ttt).

countries that, especially for high elasticity value, show implied tariff equivalents that are too low.
The equivalent tariffs of policy-related border barriers show some what different patterns and magnitude when calculated using the results from regression 3, instead of those of regressions 4 and 5. The reason for this is that we put forward different hypotheses concerning the 'assigned' weight to policy-unrelated border costs. Indeed, in using results from regression 3 we make the hypothesis that non-rent border costs are the same in each country trade combinations, and equal to that of intra EU trade. Instead, in using the results from regressions 4 and 5, where we have ruled out the effect of language, contiguity and colonial ties, we make the assumption that these dummies have the same effect in each country combinations, a hypothesis out of our data. Indeed, as shown in section 4.1 those dummies induce a stronger reduction in the border effect of intra EU trade. Thus, the tariff equivalent estimated from the results of regressions 4 and 5 are probably biased upward. However, no speculation is made on this point as the calculations provide only same preliminary rough numbers.
Now, let us go a step further. If we take the ratio between the equivalent tariff of *policy-related* border barriers and average tariffs, we have an estimate of the *ad valorem* equivalent of non-tariff barriers (see equation (4)). For example, using results of regression 3 and $\sigma = 5$, the implied non-tariff barrier is equal to 11% (= 1.61 / 1.45), 8% (= 1.18 / 1.09) and 2% (= 1.18 / 1.15) tariff for LDC-LDC, EU-LDC and EU-OECD trade, respectively. Thus, our rough estimation of the tariff equivalent of non-tariff barriers shows that they especially affect trade from LDC to other LDC or to EU countries. A result consistent with common belief.
Obviously, making different assumptions leads to different figures, but this does not change the qualitative message of the results. For example, all the above results are quite sensitive to the import elasticity of substitution, σ. Increasing this elasticity decreases the estimated tariff equivalent of the border barriers, and *vice versa*. Though there is no good guidance on the correct value of σ, Hummels (2001) shows that the elasticity of substitution depends on the disaggregation of industries, with elasticity increasing from around 4 to 7 on passing from 1 to 3 digit industry, respectively. Thus, an average value of $\sigma = 5$ is not necessarily implausible for our data.

6. Concluding remarks

In this paper we apply the theoretical gravity model developed by Anderson and van Wincoop (2003) to agricultural bilateral trade flows between rich and poor countries. The empirical analysis investigates the level of market access among different country-'bloc' combinations through the border effect approach, that is to say through all the factors that contribute to a country's internal trade volume deviation from the gravity model prediction. The analysis strongly confirms that a proper derivation of the gravity equation from theory matters in estimating border effects .
A representative estimate of border effect in the EU market lies, after controlling for economic size, transport costs, language ties etc., between 13 and 6, depending on the specifications (exclusion or inclusion of language and contiguity dummies, respectively). This means that crossing a national border within the EU induces a trade-reduction effect of the same order of magnitude. This border effect increases progressively on passing from OECD-OECD trade (15 and 9.6, respectively), to LDC-

LDC trade (90 and 93, respectively). Thus, given the order of magnitude of these border costs, their explanation could be a very important topic for further research. Moreover the large size of the estimated border barriers in trade between LDC countries, where policy related barriers often matter, also points to the need for an increase in LDC market access.

In the observed period the border effect remained quite stable for all but the EU-LDC combination, showing progressive difficulty for LDC exports to gain market access in the EU market. An explanation of this deterioration in the market access of LDC exports lies in the difficulty these countries have in meeting the growing sanitary, phitosanitary and technical measures of the EU market. Our tentative estimate of the tariff equivalent of non-tariff barriers gives some credence to this hypothesis. This tendency can markedly reduce the potential benefits of EBA type initiatives because it erodes the actual preferential margin. Thus, LDC countries should be given more assistance to meet the growing standards of the developed world.

Finally, given the structural derivation of our gravity equation, let us force the peculiarity of zero tariff and zero non-tariff barriers of intra EU trade to split the border costs into two very different elements: those related to trade policy (rent-border barriers) and those unrelated to it (non-rent border barriers). By doing so, we are able to estimate the tariff equivalent of policy-related border barriers and the implied non-tariff trade barriers, showing that this figures are not implausible when compared to actual tariff rates. However, the central point is that non-rent border barriers dominate rent-border costs, confirming previous finding. This result has many important implications. For example, with regard to the LDC preferential access, it suggests that by retaining the benefits of a less distorted agricultural world market, it is necessary to give such countries more assistance to build institutions, infrastructures and so on, to reduce border costs. Indeed, the potential payoff of such aids appears higher than EBA type initiatives, that focus only on trade policies.

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Table 1. Border effects in the OECD, LDC and European Union countries

Model	*Base Model*		*Fixed effects*[a]		
Time period	1995-00	1995-00	1995-00	1995-00	1995-00
	(1)	(2)	(3)	(4)	(5)
Ln Y_i	0.94 (0.02)	1	1	1	1
Ln Y_j	0.93 (0.02)	1	1	1	1
Ln Distance $_{ij}$	-1.02 (0.05)	-1.06 (0.05)	-1.35 (0.05)	-1.12 (0.06)	-1.14 (0.06)
Language				0.94 (0.10)	0.35 (0.12)
Contiguity				0.66 (0.14)	0.80 (0.14)
Colonial dummy					1.46 (0.17)
Border coefficients					
EU	-4.63 (0.23)	-4.70 (0.23)	-2.60 (0.25)	-1.79 (0.25)	-2.18 (0.26)
OECD	-4.57 (0.30)	-4.56 (0.30)	-2.73 (0.31)	-2.27 (0.31)	-2.55 (0.31)
LDC	-4.13 (0.41)	-3.86 (0.40)	-4.50 (0.35)	-4.54 (0.36)	-4.86 (0.36)
EU ↔ OECD	-5.40 (0.27)	-5.41 (0.27)	-3.25 (0.25)	-2.70 (0.25)	-3.03 (0.25)
EU ↔ LDC	-3.93 (0.28)	-3.76 (0.28)	-3.26 (0.27)	-2.93 (0.26)	-3.41 (0.27)
Adj R-square	0.527	0.474	0.755	0.761	0.765
# obs.	4878	4878	4878	4878	4878

Notes:
Dependent variable: ln X_{ij} in regression (1); ln (X_{ij}/Y_iY_j) in all other regressions (see text). Robust standard errors are in parentheses.
[a] Included fixed effect for source and destination countries.

Table 2. Time variation in Border effects over three different time periods

Model Time period	*Fixed effects* [a]		
	1995-96	1997-98	1999-2000
Ln Distance $_{ij}$	-1.18	-1.12	-1.14
	(0.10)	(0.10)	(0.10)
Language	0.28	0.29	0.48
	(0.21)	(0.20)	(0.21)
Contiguity	0.83	0.81	0.77
	(0.25)	(0.24)	(0.25)
Colonial dummy	1.66	1.53	1.19
	(0.30)	(0.28)	(0.29)
Border coefficients			
EU	-2.00	-2.24	-2.28
	(0.46)	(0.44)	(0.45)
OECD	-2.51	-2.64	-2.51
	(0.56)	(0.53)	(0.54)
LDC	-4.55	-5.27	-4.75
	(0.64)	(0.61)	(0.62)
EU ↔ OECD	-2.94	-3.12	-3.02
	(0.45)	(0.43)	(0.44)
EU ↔ LDC	-3.17	-3.54	-3.51
	(0.48)	(0.46)	(0.47)
Adj R-square	0.767	0.778	0.768
# obs.	1618	1631	1629

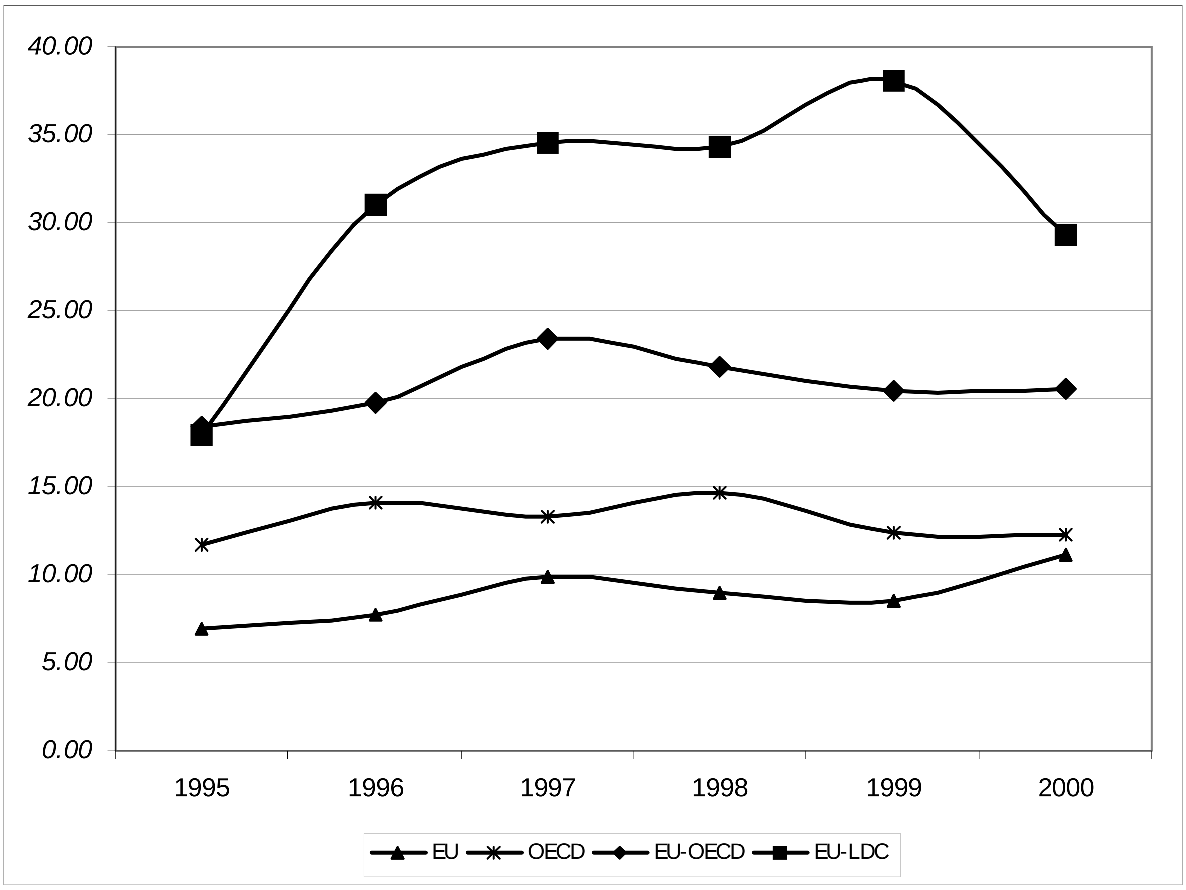
Notes:
Dependent variable: ln (X_{ij}/Y_iY_j). Robust standard errors are in parentheses (see text).
[a] Included fixed effect for source and destination countries.

Table 3. Estimate of tariff equivalent of border barriers *vs.* actual tariff rates

	(1 + ad valorem equivalent)						
	All-inclusive border barriers			Policy-related border barriers			Average Tariff
Elasticities	3	5	8	3	5	8	
Regression 3							
EU	3.67	1.92	1.45				
OECD	3.92	1.98	1.48	1.07	1.03	1.02	1.17
LDC	9.49	3.08	1.90	2.59	1.61	1.31	1.45
EU-OECD	5.08	2.25	1.59	1.38	1.18	1.10	1.15
EU-LDC	5.10	2.26	1.59	1.39	1.18	1.10	1.09
Regression 4							
EU	2.45	1.56	1.29				
OECD	3.11	1.76	1.38	1.27	1.13	1.07	1.17
LDC	9.68	3.11	1.91	3.96	1.99	1.48	1.45
EU-OECD	3.86	1.96	1.47	1.58	1.26	1.14	1.15
EU-LDC	4.33	2.08	1.52	1.77	1.33	1.18	1.09
Regression 5							
EU	2.97	1.72	1.37				
OECD	3.58	1.89	1.44	1.20	1.10	1.05	1.17
LDC	11.36	3.37	2.00	3.82	1.95	1.47	1.45
EU-OECD	4.55	2.13	1.54	1.53	1.24	1.13	1.15
EU-LDC	5.50	2.35	1.63	1.85	1.36	1.19	1.09

Notes: see text.

Figure 1. Border effects over time between different trade combinations



Notes: The figure report the antilog of the estimated border coefficients (see text).

A. 1 Trade patterns

Table 3. EU: total trade and combinations share (1995-2000)

	Total trade (million US$)	*EU-EU* (%)	*EU-OECD* (%)	*EU-LDC* (%)
1995	33,370	65.9	29.8	4.2
1996	34,784	68.6	27.8	3.5
1997	33,068	67.1	29.1	3.8
1998	32,406	69.4	27.0	3.6
1999	30,198	70.5	26.0	3.5
2000	27,988	67.5	29.1	3.3

Notes: trade of 13 EU with 13 EU, 10 OECD and 23 LDC countries.
Source: FAO, WATM

Table 4. LDC: total trade, combinations and bilateral share (1995-2000)

	Total trade (million US$)	*LDC-LDC* (%)	*EU-LDC* (%)	*LDC to EU* (%)	*EU to LDC* (%)
1995	1,449	2.3	97.7	89.7	10.3
1996	1,261	2.4	97.6	87.3	12.7
1997	1,277	1.6	98.4	89.0	11.0
1998	1,210	2.3	97.7	83.7	16.3
1999	1,070	2.1	97.9	84.6	15.4
2000	943	0.9	99.1	84.1	15.9

Notes: trade of 23 LDC with 23 LDC and 13 EU countries.
Source: FAO, WATM

Table 5. OECD: total trade, combinations and bilateral share (1995-2000)

	Total trade (million US$)	*OECD-OECD* (%)	*EU-OECD* (%)	*OECD to EU* (%)	*EU to OECD* (%)
1995	27,184	63.4	36.6	78.7	21.3
1996	28,949	66.6	33.4	76.5	23.5
1997	29,193	67.0	33.0	74.8	25.2
1998	27,406	68.1	31.9	73.8	26.2
1999	25,785	69.6	30.4	69.2	30.8
2000	26,213	68.9	31.1	72.7	27.3

Notes: trade of 10 OECD with 10 OECD and 13 EU countries.
Source: FAO, WATM

A. 2 Trading countries in the model

LDC countries	OECD countries
Angola	Australia
Bangladesh	Canada
Benin	Iceland
Burkina Faso	Japan
Burundi	Mexico
Cambodia	New Zealand
Central African Republic	Norway
Chad	Switzerland
Gambia	Turkey
Guinea	United States of America
Guinea-Bissau	
Madagascar	**EU countries**
Malawi	Austria
Mali	Denmark
Mozambique	Finland
Nepal	France
Niger	Germany
Rwanda	Greece
Sierra Leone	Ireland
Sudan	Italy
Uganda	Netherlands
Yemen	Portugal
Zambia	Spain
	Sweden
	United Kingdom