Border Effects and East-West integration *

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December 9, 2002

Abstract

This article studies the different methods used in the literature to estimate border effects and proposes that different theoretical settings (and estimation equations) are to be applied for different trade flows. Differences in the implied border effect due to the use of different competition structures are presented. Theoretical derivations are applied to the trade of three central and East European countries with EU countries. Feenstra et al. (2000) results are used for determining the most appropriate model to be used for each trade type. An additional element of the paper is a study of distance elasticity of trade, which varies depending on trade type and distance values.

1 Introduction

The integration of European countries is the key phenomenon shaping the continent's economy during the last decades. The creation of the European Union was followed by a firm policy of enlargement, which became imminent with the opening of central and east European countries. A major effect of this East-West integration is trade creation, appreciated to be very significant.

Pioneer work on measuring the importance of this effect were using quite simple models of trade: that of trade potential (Baldwin (1993) , Fontagné and Pajot (1997), and Wilson (2000)). Simple gravity equations are used to determine first the level of integration among some already very integrated countries (EU members, OECD countries). This level is considered to be the reference for all other trade flows and is to be reached by less integrated countries when full integration is to be achieved. The difference between the existing trade flows and the reference trade level represents the trade potential or the trade creation that will occur.

A different measure suggested in the literature seems to be more reliable for evaluating integration efforts: that of border effects (Wei 1996, McCallum 1995). Rather than comparing trade with new comers to trade among members, the intranational level of trade is taken as the comparison norm for all international trade flows. The superiority of this approach consists in considering the country as the most integrated geographical unit, as it has not only a unique economic, and infrastructure systems, but also a unified set of norms, laws and more or less uniform preferences. Therefore it captures the entire effect that international borders have on trade. Methodological progress has been registered at the theoretical level, and more rigorous models have been developed to measure the border effect (Wei (1996), Anderson and Wincoop (2001), Head and Mayer (2002)). This progress was however quite disperse and uncorrelated. The present paper proposes a classification and a comparison of these models.

Another point brought out in the paper is the discussion of which particular model are to be adopted for different trade types. Four types of trade flows are considered: trade among EU member

*I would like to thank Eric van Wincoop (University of Virginia) and Dorin Cheptea (SUNY at Buffalo) for helpful insights, Francoise Le Gallo (INSEE, France) for the kind provision of trade and price index data, and all the members of TEAM laboratory - International Trade Department for encouragements and helpful discussions.

countries, trade among Central and East European countries, EU imports from CEE countries, and CEE countries' imports from EU members.

In the next section different models of estimating border effects are presented. Section 3 deals with distance calculation and distance elasticity of trade, and following section discusses main results.

2 Estimation of border effects

2.1 The gravity equation

A basic reference of the literature on border effects is the paper of John McCallum (1995). He uses the simple gravity equation augmented by a dummy variable for the border, to compare intra-national to international trade flows:

$$\ln x_{ij} = \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln d_{ij} + \alpha_4 Border_{ij} + \epsilon_{ij} \quad (1)$$

Y_i and Y_j stand here for country products, d_{ij} for the bilateral distance and $Border_{ij}$ for the border dummy. The same equation is used by Helliwell (1996) on a different data base. Wei (1996) adds a remoteness variable, or multilateral distance, to the equation (1) in order to capture the effect of relative isolation of a country from its trading partners. This correction of border effect is integrated farther in the estimation equation by other authors as well (Wolf (1997), Nitsch (2000), Evans (2000)).

Trade volume is most usually expressed by a gravity equation. Its use is firstly explained by the good fit of empirical data. While its early application lacked a theoretical foundation, a dozen of theoretical frameworks which permit the derivation of such an equation have been developed lately. All of them bring rather different explanations for why gravity works. For a detailed review of literature on gravity see Feenstra et al. (2000), Head (2000), and Deardorff (1998). Gravity can be derived on the basis of product differentiation, be it of a Dixit-Stiglitz-Krugman type in a monopolistically competitive setup as in Krugman and Helpman (1985) or Bergstrand (1989), of Armington type in a perfect competition setup as in Anderson (1979) or Anderson and van Wincoop (2001), or based on different factor intensities in a neoclassical framework as in Deardorff (1998). Another point brought out by Feenstra et al. (2000) is that gravity can be obtained even for trade in homogeneous products with monopolistic competition and market segmentation (i.e. with price discrimination) as in Brander and Krugman (1983). Hummels and Levinshon (1995)'s empirical work reveals that gravity works for a wide range of countries, suggesting that it is consistent with different models of trade, and, as Deardorff (1998) states, "is therefore not evidence of anything, but just a fact of life".

Although different theoretical frameworks lead to similar or even identical forms of gravity equation, they predict rather different values of estimated coefficients. Feenstra et al. (2000) focuse on differences in production coefficients, and uses the gravity equation to differentiate between new and old trade theories. They argue that new trade theory implies higher trade elasticities for the exporter than the importer, while the opposite holds in traditional trade models. The same differentiation test is applied in section (4) to infer the most suitable model for computing border effects.

The literature provides two different theoretical frameworks for estimating border effects: that of imperfect (monopolistic) competition, and that of perfect competition. The main difference between monopolistically competitive and perfect competition models is that the former apply to industry level data, while later apply only to aggregate data. The reason is that second type models adopt the market clearing condition, an assumption that can be made at most at the aggregate level. Models presented in this section are based on product differentiation.

2.2 The utility function and the corresponding demand

Theoretical models used to estimate border effects share common features of the utility function and price setting:

1. *Hypothesis 1:* Products differentiated by place of origin

   Consider each industry as consisting of a single differentiated product of which many varieties are available, or the entire economy a single differentiated product sector. Differentiation can be at firm level (i.e. of Dixit-Stiglitz-Krugman type), or at country level. The later can be of Armington type or due to different factor intensities (e.g. in a Heckscher-Ohlin setting with no factor price equalization as in Deardorff, 1998[1]).

2. *Hypothesis 2:* Homothetic preferences represented by a CES utility function

   The representative consumer's utility is given by the following expression:

   $$u_j = \left[\sum_i (a_{ij} c_{ij})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

   Coefficients $a_{ij} \neq 1$ are introduced in order to allow for different preferences across countries. Preferences can be modelled in either of the two ways generally found in the literature:

   - ⋆ identical for all countries, $a_{ij} = a_i, \forall j$, yielding a symmetric utility function ,or
   - ⋆ revealing a home bias in preferences $a_{ij} = \exp e_{ij}$ if $i \neq j$ and $a_{jj} = \exp(e_{jj} + \beta)$, and yielding an asymmetric utility function[2].

   The original approach of authors is preserved for each model discussed herewith, but this does not influence final results.

3. *Hypothesis 3:* Mill pricing and Samuelson "iceberg" trade costs

   The mill pricing assumption ensures that there is no price discrimination between consumers. Combined with "iceberg" trade costs it produces a multiplicative price structure:

   $$p_{ij} = p_i t_{ij} \tag{3}$$

   The price difference observed for the same good is totally explained by positive trade costs. The later include transport costs, tariffs, non-tariff barriers, information costs, partner search costs, etc.

Depending on the model, assumptions 1 to 3 are applied to each sector or to the economy as a whole, and sectoral or aggregate border effects are estimated. In both cases consumers chose quantities that maximize their utility [3] under the budget constraint:

$$\sum_i p_{ij}\, c_{ij} = m_j \tag{4}$$

m_j denoting country j's expenditure (on a particular sector or the entire economy). Total demand (imports) of country j for country i products is then given by the following expression:

$$x_{ij} \equiv c_{ij} p_{ij} = \frac{a_{ij}{}^{\sigma-1} (p_i t_{ij})^{1-\sigma} n_i}{\sum_k a_{kj}{}^{\sigma-1} (p_k t_{kj})^{1-\sigma} n_k} \cdot m_j \tag{5}$$

[1]One can argue that in Deardorff's (1998) model differentiation is by place of origin, since he assumes that each product is produced and exported by only one country.

[2]See for example Bergstrand (1985), Armington (1969), Bowen et al. (1998), Head and Mayer (2002).

[3]Each individual consumer maximizes his utility. Since consumers are identical, aggregate consumption is thus maximized.

with n_i the number of varieties produced in country i [4]. The denominator of the above equation can be interpreted as a non linear price index of goods consumed in the importing country j.

The estimation difficulties due to the presence of such a non linear price index can be overcome by imposing particular assumptions on the production side (mainly on the competition among producers).

2.3 Monopolistic competition models

a) Monopolistic competition, trade barriers and home bias

The method for estimating border effects in a monopolistic competition setting was firstly developed by Wei (1996), and used afterwards by Head and Mayer (2000). The border effect is explained through trade protection practiced by the importing country and a consumption bias in favor of domestic products. The original model uses asymmetric preferences, $a_{ij} \neq a_{ik}$, for $k \neq j$ and a more complex structure of trade costs than the one presented below. Nevertheless, this simplified version preserves the main characteristics of original results. The following assumptions are made:

- Product differentiated by region: of Dixit-Stiglitz-Krugman type;
- Two main elements of trade costs: transport costs, proxied by the bilateral distance, and border barriers:

  $$t_{ij} = d_{ij}{}^{\delta} \left(1 + \nu \text{Border}_{ij}\right) \tag{6}$$

  with d_{ij} denoting the bilateral distance and ν the tariff equivalent of border barriers[5].
- Preferences differentiated by country, identical for all goods originating from the same country, and higher for domestic goods:

  $$a_{ij} = \exp\left(e_{ij} + \beta \cdot \text{Intra}_{ij}\right) = \exp\left(e_{ij} + \beta \left(1 - \text{Border}_{ij}\right)\right). \tag{7}$$

  with the dummy Border_{ij} taking the value 1 if i and j are different countries and zero otherwise, and β standing for the home bias in preferences.
- Monopolistic competition with increasing returns to scale

  With monopolistically competitive producers each variety is produced by a single firm, thus in a single location. The model assumes that marginal costs (expressed as a function of wages and technological coefficient) differ across countries, and that all countries share the same production technique. This yields identical mill prices for the goods of a country, and equal quantities produced of each variety. Thus, one can express a country's production as a function of the number of domestically produced varieties and their price: $y_i = n_i \cdot q \cdot p_i$.

With the above assumptions, equation (5) becomes:

$$x_{ij} = a_{ij}{}^{\sigma-1} \left(\frac{p_i t_{ij}}{P_j}\right)^{1-\sigma} y_i m_j \tag{8}$$

the price index on the denominator being defined by the following expression:

$$P_j \equiv \left(\sum_k a_{kj}{}^{\sigma-1} \left(p_k t_{kj}\right)^{1-\sigma} y_k\right)^{1/(1-\sigma)}. \tag{9}$$

[4] A similar equation is reached with a Cobb-Douglas production function of Ethier (1982) type with two factors of production and a CES composite (see Appendix 1).

[5] In the original article these are identified with non-tariff barriers

In order to eliminate the inconvenient non linear price indexes, authors take the ratio of international to intranational trade flows. The border effect is estimated then by the free term of the logarithmic form of this ratio. Taking into account the particular form of preferences, the following estimation equation is obtained [6]:

$$\ln \frac{x_{ij}}{x_{jj}} = \ln \frac{y_i}{y_j} + (1-\sigma)\ln \frac{p_i}{p_j} + \rho\,(1-\sigma)\ln \frac{d_{ij}}{d_{jj}} + (1-\sigma)\left[\ln(1+\nu) + \beta\right] + u_{ij} \tag{10}$$

With identical preferences across countries home bias is eliminated, and the border effect reduces to $\exp\left[(1-\sigma)\left[\ln(1+\nu)\right]\right]$, being entirely attributed to trade barriers.

This model has the advantage of being equally suitable for industry level and for aggregate data.

b) <u>An equation with price indexes and wages</u>

The only possible way to estimate border effects when price data is not available is to substitute prices by wages (more precisely, their ratios). The model allows for such a substitution, only if wages are considered to be the only cost element that varies across countries, and the same labour productivity is assumed for all countries, since under monopolistic competition prices are fixed as a constant markup above the marginal cost (Erkel-Rousse and Mirza 2002):

$$\text{Marginal Cost} = p_i\left(1 - \frac{1}{\sigma}\right).$$

The availability of some additional data for the countries studied allows for the cumulative use of some price indexes [7] and wage data in estimations. The Flubil database (for OECD countries) provides data on the volume and the value of imports of declaring countries at a very disaggregated level, permitting the computation of some evolutionary price indexes: $I_{ij,t/t_0} = \frac{p_{ij,t}}{p_{ij,t_0}}$. These evolutionary price indexes can be introduced directly in the structure of price ratio in equation (8) keeping in mind equation (3):

$$\begin{aligned}\frac{p_i}{p_j} &= \frac{p_{ij}}{p_{jj}} \div \frac{t_{ij}}{t_{jj}} = \frac{I_{ij,t/t_0}}{I_{jj,t/t_0}} \cdot \frac{p_{i,t_0}}{p_{j,t_0}} \\ &= \frac{I_{ij,t/t_0}}{I_{jj,t/t_0}} \cdot \frac{w_{i,t_0}}{w_{j,t_0}}\end{aligned} \tag{11}$$

This leads to the following estimation equation:

$$\ln \frac{x_{ij}}{x_{jj}} = \ln \frac{y_i}{y_j} + (1-\sigma)\ln \frac{I_{ij,t/t_0}}{I_{jj,t/t_0}} + (1-\sigma)\ln \frac{w_{i,t_0}}{w_{j,t_0}} + (1-\sigma)\,\rho \ln \frac{d_{ij}}{d_{jj}} + (1-\sigma)\left[\ln(1+\nu) + \beta\right] + \varepsilon_{ij} \tag{12}$$

with the free term standing for the border effect as in (10).

2.4 Perfect competition and market clearance

Border effects can also be estimated in a perfect competition setup. The only work that does so explicitly is that of Anderson and van Wincoop (2001) using an Armington model of trade. According to the Armington assumption, products from different countries are distinct in eyes of consumers because national origin matters. The same results can be obtained using Deardorff's (1998) approach to country level specialization. In his model "every country produces and exports different goods" [8] too, but the reason behind that is factor price differences between countries.

[6] One can also estimate the border effect by regressing equation (8) in logarithmic form with importing country's fixed effects, but coefficients obtained will be less efficient: $\ln x_{ij} = \ln y_i + \ln m_j - \sigma \ln p_i + (1-\sigma)\ln t_{ij} - \ln \mathrm{fe}_j + e_{ij}$.

[7] different from the price index in equation (9)

[8] Deardorff (1998, p.17)

He obtains the gravity equation assuming positive transport costs and extreme specialization of countries. Specialization, as noted by Grossman (1998), will lead to a gravity-type function of trade volume in almost any model of trade, based on H-O or Ricardian specialization, in an Armington or a monopolistically competitive model.

Under perfect competition one cannot as easily arrive to a gravity equation as in the previous model, because the number of varieties produced per country is fixed to one rather than proportional to production value. To reach a gravity model both articles rely on some common additional assumptions:

- market clearance (i.e. income equals expenditure):

$$y_i = m_i = \sum_j x_{ij}, \forall i \tag{13}$$

  This assumption implies balanced trade (see Appendix 3 for details) and is verified only at equilibrium. Therefore, the use of this model is realistic only for aggregate level data.

- symmetric trade costs:

$$t_{ij} = t_{ji}, \forall i, j \tag{14}$$

  and $t_{ij} = b_{ij} \cdot {d_{ij}}^{\rho}$, with $b_{ij} - 1$ the tariff equivalent of the border barrier between i and j [9].

- perfect competition between producers.

Identical preferences across countries: $a_{ij} = a_{ik}, \forall i, k, j$ are used to ease calculations [10]. This does not modify results significantly since the difference in preferences is not the only source of border effects[11]. Trade volume is still given by equation (5), but with identical preferences and only one variety per country it reduces to:

$$x_{ij} = \frac{{a_i}^{\sigma-1} \left(p_i t_{ij}\right)^{1-\sigma}}{{P_j}^{1-\sigma}} m_j \tag{15}$$

with P_j defined as in (9). Central in this model is the market clearing assumption, which permits the derivation of a nice form of gravity [12]:

$$x_{ij} = \frac{y_i \; y_j \;\; {t_{ij}}^{1-\sigma}}{\left(\sum_j \left(t_{ij}/P_j\right)^{1-\sigma} y_j\right) {P_j}^{1-\sigma}} \equiv y_i \; y_j \; \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}. \tag{16}$$

In the equation above P_j can be interpreted as the importer's price index, and Π_i as the average price index of all trading partners (including itself), weighted by country size and bilateral trade costs to that partner. The other two assumptions imply that $\Pi_i = P_i, \forall i$ is a solution of (16), leading to a more elegant form of the estimation equation:

$$x_{ij} = \; y_i \; y_j \; \left(\frac{t_{ij}}{P_i P_j}\right)^{1-\sigma}. \tag{17}$$

With asymmetric trade costs, non linear price indexes P_i, P_j are simply replaced by weighted average price indexes Π_i, Π_j.

[9] This trade costs' structure is used by Anderson and van Wincoop (2001). Deardorff does not precise anything on trade costs structure, which in his model reduce to transport costs, except the fact that they should be proportional to distance.

[10] Both original articles use a utility function slightly different from (2): $u_j = \left[\sum_i a_{ij} \left(c_{ij}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$.

[11] As Ottaviano (course notes, 2002) nicely noted, almost everything [in international trade] can be explained by different preferences.

[12] Sum x_{ij} (equation 15) across j to obtain country i's income, find $a_i^{\sigma-1} p_i^{1-\sigma}$ and substitute in (15).

As in the previous subsection, border effects can be estimated by taking the ratio between international and intra-national trade flows in logarithmic form, but difficult to compute non linear price indexes P_i, P_j will not eliminated. One can still estimate border effects under perfect competition by regressing equation (17) in logarithmic form with a border variable and country dummies:

$$\begin{aligned} \ln x_{ij} &= \ln y_i + \ln y_j + \rho(1-\sigma)\ln d_{ij} + (1-\sigma)\ln b_{ij} + (\sigma-1)\ln P_i + (\sigma-1)\ln P_j + \epsilon_{ij} \quad (18) \\ &= \ln y_i + \ln y_j + \rho(1-\sigma)\ln d_{ij} + (1-\sigma)\ln b_{ij}\text{Border} + \text{Country dummies} + \epsilon_{ij} \quad (19) \end{aligned}$$

The border effect is measured by the coefficient of the border dummy.

2.5 Elimination of unobserved variables

Equation (5) holds in both monopolistic competition and perfect competition models when CES preferences are assumed. An estimation equation derived directly from it would have the advantage of working in both theoretical settings and will correct for shortages resulting from an (arbitrary) choice of the competition structure. The embarrassing element in equation (5) is the non linear denominator. Head and Ries (1998) make manipulations that allow them to eliminate the non linear expression on the denominator. The explained variable they consider is the geometric mean of bilateral-to-domestic imports ratios of the two trading partners:

$$X_{ij} = \sqrt{\frac{x_{ij}}{x_{jj}} \cdot \frac{x_{ji}}{x_{ii}}}.$$

It is important to notice that their manipulation of equation (5) leads as well to a lower number of explanatory variables, difficult to measure or unavailable variables being eliminated:

$$X_{ij} = \sqrt{\left(\frac{a_{ij}}{a_{jj}} \cdot \frac{a_{ji}}{a_{ii}}\right)^{\sigma-1} \left(\frac{t_{ij}}{t_{jj}} \cdot \frac{t_{ji}}{t_{ii}}\right)^{1-\sigma}}. \quad (20)$$

Thus one can reach an estimation equation without the need of making constraining and unrealistic assumptions (such as market clearance). The elimination of all other explanatory variables except for bilateral trade costs makes possible for estimation of border effects through the use of equation (20) at every level for which trade data is available. It allows to overcome unavailable or inconsistent (due to different classifications used) data problems. Trade costs are usually expressed as a function of distance (e.g. as in 6), yielding the following estimation equation:

$$\ln X_{ij} = \rho\,(1-\sigma)\ln D_{ij} + 1/2\,(1-\sigma)\ln b_{ij}b_{ji} + v_{ij}, \quad (21)$$

with $D_{ij} = \sqrt{(d_{ij}d_{ji})\,/\,(d_{ii}d_{jj})}$ the average bilateral distance and the free term measuring the average border effect of bilateral trade between countries i and j (trade in both directions). It comprises the effect of differences in both consumer preferences and other elements of trade costs beside those proportional to distance. [13]

The advantage of this specification is that it allows estimation of border effects for all products for which trade data is available (distance is considered a more or less easily observed variable), at both industry and aggregate economy level, and independently of the competition form. However, it does not permit to differentiate the value of border barriers in function of trade direction, as was possible for the models in subsection 2.3 and 2.4. Regression results of equations obtained in the previous two subsections are compared to those obtained by regressing (21). This can be used as an additional test [14] of which theoretical model is more reliable.

Table 1 summarizes the above discussion emphasizing the particular form of the demand function in different theoretical settings.

[13] With a different trade costs specification, e.g. non multiplicative, above manipulations lead to an estimation equation with average trade costs as the only dependent variable. But in this case border effects can not be separated from other trade cost elements.

[14] Aside from Feenstra, Markusen and Rose (2000) test.

Table 1: The equation of demand in different theoretical frameworks

The model	*Competition*	*Product differentiation*	*Pricing*	*Demand function*
Wei (1996)	monopolistic	by region of origin	mill pricing	$x_{ij} = {a_{ij}}^{\sigma-1}\left(\frac{p_i t_{ij}}{P_j}\right)^{1-\sigma} y_j m_j$
Deardorff (1998)	perfect	by country of origin	mill pricing	$x_{ij} = {a_{ij}}^{\sigma-1}\left(\frac{p_i t_{ij}}{P_j}\right)^{1-\sigma} m_j,$
			symmetry:	$x_{ij} = y_i y_j \left(\frac{t_{ij}}{P_i P_j}\right)^{1-\sigma}$

Given the expression of demand, one can estimate border effects in either of the two ways used in the literature, as a ratio of international to intranational trade flows, or as a ratio of observed trade flows to hypothetical flows in absence of national frontiers. The first method is adopted here. For the discussion of the second and differences between the two methods see Appendix 4.

3 Distance and data

3.1 The debate on distance calculation

A central point in the discussion of trade costs is their structure. Trade costs are generally thought to be proportional to distance:

$$t_{ij} = f(d_{ij}), \quad \text{with} \quad \rho \equiv \theta \equiv \frac{\frac{\Delta t_{ij}}{t_{ij}}}{\frac{\Delta d_{ij}}{d_{ij}}}, \quad \rho > 0.$$

Recent empirical work shows that costs implied by the physical transportation of commodities across space account for the largest part of trade costs, and establishes the central role of distance as transport costs determinant.[15] The distance elasticity of trade, θ, in the above trade models translates into a function of the substitution elasticity of traded products and the distance elasticity of transport costs:

$$\theta \equiv \frac{\frac{\Delta x_{ij}}{x_{ij}}}{\frac{\Delta d_{ij}}{d_{ij}}}, \quad \theta = \rho(1-\sigma).$$

Empirical studies generally find that θ takes negative values close to -1.

Another debate takes place around the way in which distance is to be measured. As simple as it can seem, measuring the distance is not always obvious. This is due to the fact that we deal with distance between territorial units with positive area and unequally distributed economic activity, and not simple points. There is some uniformity in measuring international distances (between two countries) in the literature: the distance between capitals or the largest cities is usually used. The same cannot be affirmed about intra-national distances[16]. Wei (1996) is the first to introduce intranational distances in the estimation of border effects, after developing a very easy way of computing unobserved intranational trade as the difference between domestic production and exports[17] His work constitutes the basis of a genuine refinement of intra-national distance calculation. Wei himself computes intranational distance as one fourth of the distance between the considered country and its closest neighbor. Wolf (1997) takes the distance between the largest

[15](Hummels (1998), Deardorf (1999).

[16]d_{jj} in equation (12), (18) or (20)

[17]McCallum (1995)and Helliwell (1996, 1998) use interprovincial and interstate trade data, i.e. between subnational units.

two cities, while Nitsch (2000) takes the radius of the circle of area identical to the country area. Head and Mayer (2000) develop a similar measure for a particular theoretical framework: when all producers are located in the center and consumers are equally distributed on the area of the circle:

$$d_{jj} = \int_0^R \frac{2\pi r}{\pi R^2} r = \frac{2}{3} R \tag{22}$$

Following Helliwell and Verdier (2000) and Head and Mayer (2000) compute the two types of distances, international and intranational, as the weighted average of interregional distances, with production or population used as weights.

$$d_{ij} = \sum_{l \in j} \left(\sum_{k \in i} d_{kl} \frac{y_k}{y_i} \right) \frac{y_l}{y_j} \tag{23}$$

In another article[18] the same authors show that calculating distance as harmonic rather than arithmetic mean is more consistent with negative values for distance elasticity of trade generally obtained in empirical studies:

$$d_{ij} = \left[\sum_{l \in j} \left(\sum_{k \in i} {d_{kl}}^{\theta} \frac{y_k}{y_i} \right) \frac{y_l}{y_j} \right]^{\frac{1}{\theta}} \tag{24}$$

Their affirmation follows from the derivation of the above formula directly from the aggregate level gravity equation $x_{kl} = G y_k y_l d_{kl}^{\theta}$, assumed to be verified at regional (intra-national) level. The use of formula (24) implies a new expression for the intranational distance:

$$d_{jj} = \left(\int_0^R \frac{2\pi r}{\pi R^2} r^{\theta} \right)^{1/\theta} = \left(\frac{2}{2+\theta} \right)^{1/\theta} R,$$

which becomes equal to $\frac{1}{2}R$ for $\theta = -1$.

3.2 What distance elasticity of trade?

It should be noticed that equation (24) assumes equal distance elasticity for all trade types and all distance levels. But nothing tells us that this should be true; it is assumed only to ease calculations. In reality distance elasticity of trade varies across countries, and distance. The evidence of that constitute different values obtained for the distance coefficient in regressed equations of trade flows. Higher absolute values of distance elasticities are obtained when intranational trade flows are included[19]. For the data used in the empirical part of this paper (section 4) differences across country sets are also observed.

Non linear regressions have been run to determinate whether the distance elasticity of trade, θ converges to a single value, at least for some distance values. The right θ is the one which when introduced in equation (24) yields the inter-regional distance values which used, together with production, in the regression of trade flows in logarithmic form produce this very value of θ. The algorithm used is constructed as to verify this basic property:

$$\theta \text{ such that } \begin{cases} d_{ij} = \left[\sum_{l \in j} \left(\sum_{k \in i} {d_{kl}}^{\theta} \frac{y_k}{y_i} \right) \frac{y_l}{y_j} \right]^{\frac{1}{\theta}} \\ \ln x_{ij} = a_0 + a_1 \ln y_i + a_2 \ln y_j + a_1 \ln d_{ij} + a_1 \epsilon_{ij} \end{cases}$$

In a first step the departure value of θ is one. The next value is obtained by regressing the gravity equation (using international trade data) using distances obtained by applying the (23) formula,

18 Head and Mayer (2002).

19 See Hummels (1998), and Rauch (2002).

corresponding to $\theta = 1$. The value of distance elasticity obtained (the coefficient on $\ln d_{ij}$) is the new value of θ. It is introduced in equation (24) in order to obtain new distance values and the regression is run again. The process ends when the new θ value reached does not differ from the previous step value with a second decimal precision. When all trade data in the data set are used (trade between EU and CEEC, among EU countries and among CEE countries) one obtains $\theta = -1.45$.

But when differentiating across distance values, different values of θ are obtained. With at least 4000 observations per sample, its value varies from -2.87 to 0.37, always very significant. For very small distances (<100 km) production and distance are collinear. For very large distances (>4000 km) θ gets extremely large in absolute value ($\theta \approx -9$), and trade becomes negatively related to the importing country's production.

Table 2: The distance elasticity of trade

STAN sector	θ*
Food products	-1,54
Beverages	-1,64
Tobacco	-2,36
Textiles	-1,21
Wearing apparel	-1,38
Leather products	-1,40
Footwear	-1,59
Manufacture of wood	-1,66
Funiture	-1,63
Paper and paper products	-1,48
Publishing and printing	-1,81
Chemicals products	-1,18
Drugs and pharmaceuticals	-1,22
Other non classified chemical products	-1,48
Refined petroleum products	-2,50
Petroleum and coke products	-1,64
Rubber products	-1,25
Plastic products	-1,52
Other non metallic mineral products	-1,56
Manufacture of basic metals	-1,41
Fabricated metal products	-1,45
Machinery and equipment	-1,17
Office, accounting and computing machinery	-1,10
Electrical machinery and equipment	-1,13
Radio, TV and communication equipment and apparatus	-1,12
Transport equipment	-1,29
Professional apparel	-1,12
Other manufacturing	-1,35
Total manufacturing	-1,45

* all reported coefficients are significant.

Table 2 gives the sector values of θ, computed according to the algorithm mentioned above.

3.3 Data

Disaggregated data on 49 product sectors (according to the STAN classification used by the OECD) and aggregated data at the industry level for a panel of 18 countries, the 15 members of European Union[20] and three Central and East European countries (Poland, Hungary and Czech Republic), is used in this empirical study.

The time range considered is that of six years: from 1993 to 1998. Before 1993 separate trade and production data for the Czech Republic is not available[21], and 1998 is the last year for which production and price index data is available at sector level in the data sets used.

[20] Belgium and Luxembourg are aggregated under a single observation.

[21] Cumulated data for both Czech and Slovak republics are provided prior to that date.

Trade flows and evolutionary price index data at sector level and aggregate industry level is obtained from the Flubil data base of OECD[22]. Two different sources were used for production data: OECD and UNIDO statistics. OECD data is obtained from all production units indifferently of their size, and uses the same classification as for trade data, but is generally incomplete. UNIDO data, containing production data from enterprises counting generally al least 20 employees[23] and using a different classification (4-digit ISIC codes), has been used to obtain a more complete production data set [24]. In order to ensure compatibility, data has been adjusted by applying a conversion rate equal to the average ratio of the two statistics computed at the aggregate industry level for all countries and years for which data were available in both sources. For every year and country missing data has been replaced by total production in each year multiplied by the average weight of the particular industry in total industry in the closest two preceding and following years for which data were available.

The source for wage data in the base year (1993) are UNIDO statistics. For this variable sector level data is available for 13 EU countries only (except for Belgium and Portugal). Aggregate wage data has been obtained from the International Labour Center Statistics.

Distances are calculated for different values of θ, with 1995 population as weights. Interregional distances are geodesic distances between the economic centers (largest and most central cities) of the two regions given their geographical coordinates.

4 Results

The border effect of East-West trade (between EU and Central and East European countries) is estimated according to the models discussed above and is compared to intra-EU trade integration. The Chow test suggests that regressions can separately for EU imports from CEEC, and CEEC imports from EU countries. Taking into account the discussion on bilateral distance in section 3, all estimations are run twice. Results are reported for both cases when bilateral distance is calculated as arithmetic mean ($\theta = 1$) and for $\theta = -1.45$. At a first stage bilateral trade flows are regressed on countries' production and bilateral distance (simple gravity) to get a simplified form of the Feenstra, Markusen and Rose (2000) (FMR) test. According to FMR higher trade elasticities for the exporter than the importer imply that trade flows are better explained by new trade theories (i.e. monopolistic competition models), and lower trade elasticities for the exporter reveal that traditional trade models are rather verified (i.e. the pertinence of the perfect competition hypothesis). Results of the gravity are reported in Table 3. The FRM test suggests that CEEC imports of EU products fit better the monopolistic model, and thus equation (10) should be used to infer more accurate border effects. In what concerns EU imports from CEEC, the difference in trade elasticity between the importer and the exporter is smaller and its sign varies upon the econometric specification used. Assuming that the second value of θ is the one that should be preferred [25], it can be affirmed that according to the FMR test EU imports originating from CEEC have a better fit of traditional trade models and the perfect competition model will yield more accurate border effects for this trade flows. This finding is the same whether aggregate or disaggregate trade data is to be used.

[22]I would like to thank Fancoise Le Gallo for kindly providing me this data set.

[23]Some exceptions exist across countries and industries, e.g. units with 3 or more employees for Ireland, 10 or more employees for Greece, 50 or more employees for Luxembourg, 100 or more employees for Portugal, and all production units for Denmark and Czech Republic.

[24]Missing data have been detected in both data sets used.

[25]See the discussion in section 3.

Table 3: The simple gravity

Dependent variable: imports $\ln x_{ij}$	CEEC imports from EU								EU imports from CEEC							
Econometric specification	OLS	Heckman	Tobit	OLS*	OLS	Heckman	Tobit	OLS*	OLS	Heckman	Tobit	OLS*	OLS	Heckman	Tobit	OLS*
Explanatory variables:																
$\ln y_i$	0.88[a]	0.89[a]	1.14[a]	0.98[a]	0.89[a]	0.91[a]	1.16[a]	1.02[a]	0.68[a]	0.69[a]	0.79[a]	0.90[a]	0.51[a]	0.52[a]	0.64[a]	0.62[a]
	(0.013)	(0.015)	(0.017)	(0.056)	(0.013)	(0.014)	(0.017)	(0.045)	(0.017)	(0.018)	(0.033)	(0.089)	(0.016)	(0.017)	(0.032)	(0.070)
$\ln m_j$	0.32[a]	0.32[a]	0.18[a]	0.69[a]	0.30[a]	0.30[a]	0.16[a]	0.67[a]	0.64[a]	0.64[a]	0.82[a]	1.03[a]	0.73[a]	0.73[a]	0.90[a]	1.08[a]
	(0.017)	(0.017)	(0.022)	(0.106)	(0.016)	(0.016)	(0.022)	(0.086)	(0.016)	(0.016)	(0.031)	(0.072)	(0.015)	(0.015)	(0.030)	(0.055)
$\ln d_{ij}$ $[\theta = 1]$	-2.44[a]	-2.44[a]	-2.68[a]	-2.33[a]					-2.61[a]	-2.61[a]	-1.95[a]	-2.21[a]				
	(0.030)	(0.030)	(0.032)	(0.095)					(0.020)	(0.020)	(0.038)	(0.076)				
$\ln d_{ij}$ $[\theta = -1.45]$					-1.76[a]	-1.76[a]	-1.91[a]	-1.85[a]					-1.76[a]	-1.76[a]	-1.39[a]	-1.56[a]
					(0.020)	(0.020)	(0.027)	(0.058)					(0.011)	(0.011)	(0.023)	(0.038)
Log likelihood	–	-13239.09	-13463.39	–	–	-13036.50	-13408.74	–	–	-20607.71	-25378.49	–	–	-19625.33	-25076.91	–
R^2	0.69		0.19	0.83	0.71		0.19	0.89	0.78		0.10	0.80	0.82		0.11	0.93
Number of observations	6050	7050	6348	252	6050	7050	6348	252	9059	9764	9741	252	9059	9764	9741	252

	Intra EU imports								Intra CEEC imports							
	OLS	Heckman	Tobit		OLS	Heckman	Tobit		OLS	Heckman	Tobit	OLS*	OLS	Heckman	Tobit	OLS*
Explanatory variables:																
$\ln y_i$	0.63[a]	0.56[a]	0.59[a]		0.55[a]	0.48[a]	0.52[a]		0.76[a]	0.77[a]	0.83[a]	0.76[a]	0.77[a]	0.77[a]	0.84[a]	0.78[a]
	(0.055)	(0.056)	(0.081)		(0.060)	(0.066)	(0.083)		(0.004)	(0.004)	(0.005)	(0.019)	(0.004)	(0.004)	(0.005)	(0.016)
$\ln m_j$	0.66[a]	0.63[a]	1.05[a]		0.64[a]	0.53[a]	1.00[a]		0.46[a]	0.46[a]	0.52[a]	0.71[a]	0.47[a]	0.47[a]	0.53[a]	0.73[a]
	(0.054)	(0.054)	(0.078)		(0.059)	(0.064)	(0.080)		(0.004)	(0.004)	(0.005)	(0.020)	(0.004)	(0.04)	(0.005)	(0.016)
$\ln d_{ij}$ $[\theta = 1]$	-5.62[a]	-5.64[a]	-5.32[a]						-1.93[a]	-1.93[a]	-1.59[a]	-1.48[a]				
	(0.120)	(0.126)	(0.179)						(0.009)	(0.009)	(0.012)	(0.030)				
$\ln d_{ij}$ $[\theta = -1.45]$					-2.11[a]	-2.17[a]	-2.08[a]						-1.41[a]	-1.41[a]	-1.15[a]	-1.11[a]
					(0.052)	(0.056)	(0.073)						(0.006)	(0.006)	(0.008)	(0.017)
Log-likelihood	–	-2072.31	-2370.34		–	-2126.21	-2387.68		–	-93925.87	-104949.95	–	–	-92401.65	-104505.40	–
R^2	0.75		0.16		0.70		0.16		0.73		0.19	0.86	0.75		0.19	0.90
Number of observations	1013	1079	1051		1031	1079	1051		48435	49639	49420	1176	48435	49639	49420	1176

[a] stands for 1% significance level of estimated coefficients; * indicates that aggregate data has been used in estimations.

Border effects under the assumption of monopolistic competition are estimated by regressing equation (12) and are reported in Table4. The use of this equation is preferred to regressing directly (10) because of important missing wage data for the chosen sample and sector disaggregation (much less missing data are observed for the reference year 1993 and evolutionary price indexes are available for all six years of the sample). Except for EU imports from CEE countries, border effects obtained are close to values generally found in the literature. The presence of some missing (null) bilateral trade in the data when disaggregated by sector requires OLS estimations be corrected by the Tobit or Heckman procedure (not reported in the table). The reasoning behind that is that registered null trade flows do not correspond to real null trade flows, but rather to a trade level inferior to a lower limit below which trade is not reported (Tobit) or to very low (eventually null) production values which do not make exports rentable (Heckman). Using both methods leads to even higher border effect values, the difference being most notable when the Tobit procedure is used to correct for this lower (left) censoring in data. [26] Border effects of the pooled sample, lie bellow border effects in either trade direction. This result suggests that the free term, which measures the border effect, captures some elements depending on the heterogeneity of the sample used. Possible explanations can be different levels of the home bias in preferences, or different levels of intranational integration of the two country sets.

For the perfect competition model border effects are estimated by the equation (19) and results are reported in Table 5). The perfect competition model generally holds for aggregated data only, therefore results obtained with sector data are not shown in the table. Much larger border effects are obtained when regressions are run at sector level, implying a strong (inflating) impact on results of the balanced sector-level trade assumption.

The question arises: which of the models produces the most accurate results? Simply applying the FMR test leads to the conclusion that CEEC imports of EU products represent somewhat less than a tenth of the intranational trade of Central and East European countries, while EU residents buy nearly twenty-seven times more national than Central or East European products. Put it otherwise, CEEC goods on the EU market face a trade barrier that is more than twice that faced by EU goods exported to CEE markets. The trade barrier gap is preserved if border effects of trade flows in both directions are estimated according the perfect competition model, but almost vanishes with the monopolistic competition model applied for both trade directions.

[26] The Heckman method does not produce results very different from OLS (see Appendix 4).

Table 4: Border effects with monopolistic competition

Dependent variable: $\ln x_{ij}/x_{jj}$ MONOPOLISTIC COMPETITION MODEL	CEEC imports from EU						EU imports from CEEC					
	OLS	OLS	FE*	FE*	OLS	OLS	OLS	OLS	FE*	FE*	OLS	OLS
Explanatory variables:												
$\ln \frac{y_i}{y_j}$	1.01^a	1.02^a	1.00^a	1.01^a	1	1	0.43^a	0.42^a	0.41^a	0.39^a	1	1
	(0.020)	(0.020)	(0.016)	(0.016)			(0.025)	(0.027)	(0.020)	(0.021)		
$\ln \frac{I_{i,t/93}}{I_{j,t/93}}$	-0.43^a	-0.41^a	-0.08^{ns}	-0.07^{ns}	-0.43^a	-0.41^a	-0.45^a	-0.40^b	-0.18^{ns}	0.13^{ns}	0.66^a	0.57^a
	(0.122)	(0.122)	(0.097)	(0.097)	(0.122)	(0.121)	(0.158)	(0.160)	(0.121)	(0.123)	(0.171)	(0.172)
$\ln \frac{w_{i,93}}{w_{j,93}}$	-0.04^{ns}	-0.08^{ns}	0.11^b	0.04^{ns}	-0.06^{ns}	-0.01^{ns}	-0.30^a	-0.30^a	-0.72^a	-0.73^a	-0.32^a	-0.24^a
	(0.063)	(0.066)	(0.053)	(0.056)	(0.061)	(0.063)	(0.074)	(0.076)	(0.060)	(0.063)	(0.080)	(0.082)
$\ln \frac{d_{ij}}{d_{jj}}$ $[\theta = 1]$	-1.46^a		-1.39^a		-1.45^a		-0.72^a		-0.64^a		-1.11^a	
	(0.065)		(0.050)		(0.060)		(0.059)		(0.045)		(0.065)	
$\ln \frac{d_{ij}}{d_{jj}}$ $[\theta = -1.45]$		-1.30^a		-1.23^a		-1.27^a		-0.53^a		-0.42^a		-1.09^a
		(0.057)		(0.044)		(0.052)		(0.066)		(0.050)		(0.065)
Constant	-3.61^a	-2.42^a	-3.89^a	-2.74^a	-3.64^a	-2.50^a	-5.46^a	-5.09^a	-6.67^a	-6.51^a	-4.12^a	-2.56^a
	(0.237)	(0.279)	(0.194)	(0.230)	(0.230)	(0.268)	(0.232)	(0.312)	(0.186)	(0.249)	(0.243)	(0.311)
R^2	0.47	0.47	0.47	0.47	0.20	0.20	0.11	0.08	0.10	0.08	0.11	0.10
Number of observations	3053	3053	3050	3053	3053	3053	2924	2924	2924	2924	2924	2924
Border effect	**36.97**	**11.25**	**48.91**	**15.49**	**38.09**	**12.18**	**235.10**	**162.39**	**788.40**	**671.83**	**61.56**	**12.94**

[*] estimations with sector fixed effects.
[a], [b] and [c] indicate 1%, 5% and 10% significance level of estimated coefficients.

Table 5: Border effects with perfect competition

Dependent variable: $\ln x_{ij}$; OLS* with country dummies	CEEC imports from EU				EU imports from CEEC				Pooled CEEC-EU trade			
PERFECT COMPETITION MODEL*												
Explanatory variables:												
$\ln y_i$	1.40^a	1.50^a	1	1	0.42^a	0.47^a	1	1	0.94^a	0.94^a	1	1
	(0.154)	(0.155)			(0.136)	(0.136)			(0.109)	(0.106)		
$\ln y_j$	0.64^a	0.56^a	1	1	1.27^a	1.22^a	1	1	0.83^a	0.83^a	1	1
	(0.143)	(0.145)			(0.140)	(0.140)			(0.109)	(0.105)		
$\ln d_{ij}$ $[\theta = 1]$	-1.86^a		-1.43^a		-0.92^a		-1.12^a		-1.07^a		-1.07^a	
	(0.272)		(0.241)		(0.107)		(0.116)		(0.093)		(0.093)	
$\ln d_{ij}$ $[\theta = -1.45]$		-1.63^a		-1.16^a		-1.07^a		-1.33^a		-1.27^a		-1.27^a
		(0.223)		(0.192)		(0.122)		(0.123)		(0.099)		(0.099)
Border	-2.83^a	-0.45^{ns}	-3.32^a	-2.65^a	-3.41^a	-1.77^a	-3.22^a	-1.04^a	-3.25^a	-1.51^a	-3.25^a	-1.51^a
	(0.737)	(0.814)	(0.399)	(0.496)	(0.524)	(0.614)	(0.258)	(0.389)	(0.205)	(0.310)	(0.207)	(0.311)
R^2	0.96	0.96	0.95	0.95	0.96	0.96	0.92	0.92	0.93	0.94	0.90	0.90
Number of observations	170	170	170	170	235	235	235	235	504	504	504	504
Border effect	**16,95**	–	**27,66**	**14,15**	**30,27**	**5,87**	**25,03**	**2,83**	**25.79**	**4.53**	**25.79**	**4.53**

* aggregated trade data used in estimations.
[a] and [b] indicate 1% and 5% significance level of estimated coefficients.

The McCallum (1995) model, gravity augmented by a border dummy, produces estimates of the CEEC-EU border effect of a magnitude close to other results in the literature and somewhere between the values obtained with the above two models (see Table 6). As before, the trade barrier gap is in favour of EU goods exported to Central and East Europe (at least two times lower than the one imposed to CEE exports to the EU).

Table 6: Border effects with augmented gravity

Dependent variable: $\ln x_{ij}$ McCallum method	CEEC imports from EU				EU imports from CEEC			
	OLS*	FE**	OLS*	FE**	OLS*	FE**	OLS*	FE**
Explanatory variables:								
$\ln y_i$	0.93^a	1.02^a	0.92^a	1.01^a	0.34^a	0.53^a	0.35^a	0.53^a
	(0.012)	(0.011)	(0.013)	(0.012)	(0.015)	(0.017)	(0.015)	(0.017)
$\ln m_j$	0.28^a	0.59^a	0.28^a	0.59^a	0.80^a	0.93^a	0.80^a	0.92^a
	(0.015)	(0.022)	(0.016)	(0.022)	(0.014)	(0.013)	(0.014)	(0.013)
$\ln d_{ij}$ $[\theta = 1]$	-1.61^a	-1.66^a			-0.92^a	-1.13^a		
	(0.039)	(0.032)			(0.033)	(0.029)		
$\ln d_{ij}$ $[\theta = -1.45]$			-1.29^a	-1.32^a			-0.81^a	-0.97^a
			(0.033)	(0.028)			(0.028)	(0.026)
Border	-3.11^a	-3.16^a	-2.17^a	-2.21^a	-4.28^a	-3.77^a	-3.46^a	-2.83^a
	(0.100)	(0.083)	(0.123)	(0.104)	(0.068)	(0.067)	(0.096)	(0.092)
R^2	0.85	0.85	0.73	0.73	0.85	0.85	0.85	0.85
Number of observations	6050	6050	6050	6050	9059	9059	9059	9059
Border effect	**22.42**	**23.57**	**8.76**	**9.12**	**72.24**	**43.48**	**31.82**	**16.95**

* ordinary least squares;
** sector fixed-effects;
[a] and [b] indicate 1% and 5% significance level of estimated coefficients.

A different way to select the most suitable model to estimate border effects is to compare results of different models (monopolistic competition, perfect competition, "augmented gravity") to those yield by the "only observables" model which applies equally well to all theoretical settings and disaggregation levels. The latter produces most accurate estimates of the average border effect of crossing the same international frontier in both directions and therefore can be used as a benchmark. Surprisingly, this 'benchmark' model yields results (Table 7) very close to the "augmented gravity" (Table 6).

Border effects obtained with the monopolistic competition model lie slightly above the 'benchmark' values for both trade directions (when unit income coefficients are imposed), suggesting that the model correctly predicts border effects of at most one of the two trading directions. The use of the perfect competition model in both cases leads to an average border effect bellow the 'benchmark' value. After adjusting for country size, bilateral distance and other country specific variables, domestic trade is in average four and a half times larger the bilateral CEEC-EU trade (the pooled sample). This value is an average of a higher-than-the-'benchmark' border effect for CEEC imports and lower-than-the-'benchmark' border effect for EU imports.

Once again the scenario supported by the FMR test (monopolistic competition model for CEEC imports from EU and perfect competition model for EU imports from CEEC) stands out as the most reasonable (yields results closer to the 'benchmark' model). It can be argued, thus that East-West European trade is subject to trade cost asymmetry, and that EU exports have a better market access on the Central and East European markets than CEEC exports on the EU common market despite the larger and earlier bilateral trade liberalization measures undertaken by the European Union.

This asymmetry in trade costs is caused by elements independent from distance and country specific variables. These may include quality bias in transport infrastructure, tariffs and non tariff barriers, etc.

Table 7: Border effects of CEEC-EU trade: "only observables" model

Dependent variable: $\ln\sqrt{\frac{x_{ij}}{x_{jj}}\frac{x_{ji}}{x_{ii}}}$; OLS regressions	Disaggregate trade		Aggregate trade	
Explanatory variables:				
$\ln\sqrt{\frac{d_{ij}}{d_{jj}}\frac{d_{ji}}{d_{ii}}}$ $[\theta = 1]$	-1.42^a		-0.99^a	
	(0.027)		(0.092)	
$\ln\sqrt{\frac{d_{ij}}{d_{jj}}\frac{d_{ji}}{d_{ii}}}$ $[\theta = -1.45]$		-1.20^a		-1.10^a
		(0.026)		(0.098)
Constant	-3.19^a	2.11^a	-3.41^a	-2.00^a
	(0.051)	(0.080)	(0.178)	(0.292)
R^2	0.23	0.19	0.27	0.29
Number of observations	9416	9416	312	312
Border effect	**24.29**	**8.25**	**30.27**	**7.39**

^{a} indicates 1% significance level of estimated coefficients.

A common result for all of the models discussed above is the large distance elasticity of trade, comprised between -0.7 and -2.6, but even higher for intra-CEEC trade (e.g. more than -5, Table 3). This reveals the high sensibility of East-West European trade to transport and other distance related costs. The higher distance elasticity of CEEC imports reveals a quality gap in transport infrastructure. Shipping goods from EU to Central and Eastern Europe becomes costlier with the distance that needs to be covered, and also with the worsening of infrastructure; shipping from Central and East Europe to EU is costlier with the distance but less costlier due to improvement of infrastructure quality.

Lower border effects and lower distance elasticities are generally obtained when bilateral distance is computed using the θ value found in section 3 rather than as weighted arithmetic mean, in support of Head and Mayer's (2002) finding that inadequate distance measurement inflates border effects.

The "only observables" method is used to estimate intra-group border effects as well (Table 8). Once again border effects obtained are close to the "augmented gravity"'s estimates. European Union firms trade in average 2.4 times more with national partners than with other EU partners.

A full trade integration of the three Central and East European countries considered in the sample into the EU, corresponding to a reduction in trade barriers (border effects) of CEEC-EU trade to the levels within the European Union (for intra-EU trade), will lead to a trade creation of 8.25/2.39=3.45. [27] A comparable level of trade creation is obtained when distance as arithmetic mean is used in estimations: 24.29/7.34=3.31. Distance measurement has no significant impact on predicted trade creation as long as the same model is used.

Assuming a substitution elasticity σ of 9, the average between the most frequently obtained values for σ [28], one can calculate the tariff equivalent of border effect applying the formula below:

$$exp\left(|\text{Border Effect Coefficient}|/(\sigma - 1)\right) - 1$$

With bilateral distance as arithmetic mean the 24.29 border effect of EU-CEEC trade corresponds to a 49% tariff equivalent, and with distance as harmonic the 8.25 border effect correspond to a 30% tariff equivalent.

[27] This value is obtained by dividing the border effect of East-West trade to the border effect of trade among EU member countries.

[28] Head and Ries (1999), Head and Mayer (2000), Erkel-Rousse and Mirza (2002).

Table 8: Border effects of intra-CEEC and intra-EU trade: "only observables" model

Dependent variable: $\ln\sqrt{\frac{x_{ij}}{x_{jj}}\frac{x_{ji}}{x_{ii}}}$; OLS regressions; disaggregate trade	Intra-CEEC trade		Intra-EU trade	
Explanatory variables:				
$\ln\sqrt{\frac{d_{ij}}{d_{jj}}\frac{d_{ji}}{d_{ii}}}$ $[\theta = 1]$	0.18^{ns}		-1.49^{a}	
	(0.641)		(0.012)	
$\ln\sqrt{\frac{d_{ij}}{d_{jj}}\frac{d_{ji}}{d_{ii}}}$ $[\theta = -1.45]$		1.24^{ns}		-1.26^{a}
		(0.124)		(0.010)
Constant	-5.09^{a}	-7.34^{a}	-2.02^{a}	-0.87^{a}
	(0.488)	(0.245)	(0.024)	(0.033)
R^2	0.00	0.16	0.27	0.27
Number of observations	530	530	36874	36874
Border effect	**162.39**	**1540.71**	**7.34**	**2.39**

[a] indicates 1% significance level of estimated coefficients.

Border effects can be equally expressed as distance equivalents. By taking

$$exp\,(|\text{Border Effect Coefficient}|/\text{Distance Elasticity}) * \text{Average Distance}$$

one can find the equivalent in km of crossing the border. For the two possible ways of calculating the distance the "only observables" model estimates that crossing the EU-CEEC border for either EU or CEEC firms (the average border effect for trade in both directions) is equivalent to shipping to a point situated 13111 km, respectively 8047 km, away within the home country. The latter corresponds to almost six times the average distance between a CEE country and a EU member state.

As a reference, for $\sigma = 9$ intra-EU trade is equivalent to a 11.5% border tariff, or to crossing 2277 km (twice the average distance between two EU countries).

Table 9: Border effects under different models

	MC		PC	'Only Observables'	Trade potential models
Trade flows	OLS*	Heckman*	OLS*	OLS	
CEEC-EU bilateral trade	8.76	9.78	4.53	8.25	
– CEEC imports from EU	12.18	11.94		–	
– EU imports from CEEC	12.94	26.84		–	
Intra EU trade	3.67	3.46	3.00	2.39	
Predicted trade creation	*2.39*	*2.83*	*1.51*	*3.45*	*1.08*

* unit income/production coefficients.

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Appendix 1

Derivation of Gravity from the Production Function

One can obtain an estimation equation similar (or even identical) to (5) working through the production side. Assume a Cobb-Douglas production function of Either (1982) type with two factors of production, labor L and an aggregate input of intermediate goods M, the later expressed as a CES function of quantities to be used of each available variety, largely used in economic geography models:

$$Q = M^{\alpha} L^{1-\alpha}.$$

Quantities imported of each variety, identical here to quantities demanded, are found by minimizing the production cost of aggregate M, P_M that minimizes the total production cost (a two-stage minimization problem): $C = M \cdot P_M + L \cdot w$.

Appendix 2

Border Effects and Product Differentiation

In the monopolistic competition model above (section 2.3) the border effect is equal to $\exp[(\sigma - 1)(\beta + \ln(1+\nu))]$ and can be interpreted as how many times intra-national trade exceeds international trade. $(\sigma - 1)$ is the part due to product substitutability, and $(\beta + \ln(1+\nu))$ is the part due to costs implied by the crossing on national borders (their tariff equivalent). The two components go in opposite directions when one modifies the level of product differentiation of traded goods. More differentiated products imply on one side a lower σ (the elasticity of substitution gets smaller indeed, as it is an inverse measure of product differentiation), generating a lower border effect, but on the other side leads to a higher β (more different are foreign varieties with respect to domestic ones, stronger is the domestic bias, implying a more prominent hesitation in the consumption of the former), and consequently a higher border effect. The two effects outweight each other, leading to a quasi-neutral global impact of product differentiation on border effects. Nothing can be concluded upon the importance of information costs or other trade cost elements from the coefficients of explanatory variables that control for the degree of product differentiation. [29] Certain details as the fact that tariffs are generally higher for homogeneous products, while the opposite is true for information costs, may prove useful for the analysis of trade cost elements variation.

Appendix 3

Market Clearance implies Balanced Trade

Income is given by the sum of revenues from sold production internal (assume that all production is sold). Goods produced internally are sold on the domestic market or are exported. Noting by c_{ij} country j's demand for country i products, and by p_{ij} the price of goods produced in i and consumed in j, the income of country i can be written as:

$$y_i = c_{ii}p_{ii} + \sum_{k \neq i} c_{ik}p_{ik} \tag{25}$$

(The shipping costs are supported by the exporter.) A country's expenditure is equal to the sum of domestic consumption and the value of its imports:

$$m_i = c_{ii}p_{ii} + \sum_{k \neq i} c_{ki}p_{ki} \tag{26}$$

[29] For a discussion of border effects and product differentiation see Chen (2002).

Market clearance (13) implies equality between (20) and (21). Using the notation introduced by (5) we have:

$$x_{ii} + \sum_{k \neq i} x_{ik} = x_{ii} + \sum_{k \neq i} x_{ki} \Longleftrightarrow \tag{27}$$

$$\sum_{k \neq i} x_{ik} = \sum_{k \neq i} x_{ki} \tag{28}$$

Observe that the left side of the equation gives the expression of country i's exports, while the right side gives the expression of i's imports. Thus, we have:

$$\text{Exports}_i = \text{Imports}_i \Longleftrightarrow \tag{29}$$

$$\text{Trade Balance} = \text{Exports}_i - \text{Imports}_i = 0 \tag{30}$$

and excludes the possibility of having unbalanced trade.

Appendix 4

Border Effects as Intranational-to-International or as Real-to-Hypothetic Trade Ratio

Given the expression of demand, two way of estimating border effects are found in the literature. The most common way is to take the ratio between international and intranational trade (as in section 2). The other method, introduced by Anderson and van Wincoop (2001), consists in taking the ratio between the observed level of trade in the presence of national borders, and the hypothetical level of trade that would be observed if borders were to be eliminated. When doing so, authors assume that the volume of production is the same in both cases: $y_i p_i = \tilde{y_i} \tilde{p_i}$ [30]. Wiping away borders increases the exporter's production value and reduces that of the importer by an equal factor. Equation (15) is still verified, except that trade costs reduce now to distance proportional transport costs: $\tilde{t}_{ij} = d_{ij}{}^{\rho}$. The border effect is given by the expression bellow:

$$\frac{x_{ij}}{\tilde{x_{ij}}} = \frac{y_i}{\tilde{y_i}} \frac{y_j}{\tilde{y_j}} \left(\frac{t_{ij}}{\tilde{t_{ij}}} \right)^{1-\sigma} \frac{P_j}{\tilde{P_j}} \frac{P_i}{\tilde{P_i}} \equiv b_{ij}{}^{1-\sigma} \frac{P_j}{\tilde{P_j}} \frac{P_i}{\tilde{P_i}} \tag{31}$$

It consists of two main elements: one for the direct impact of bilateral border barriers, and another for the impact of border barriers through the multilateral resistance of trading partners (captured by the non linear price indexes). High bilateral border barriers have a direct negative impact on bilateral trade due to costs that they imply, but also an indirect positive impact due to a higher perceived multilateral barrier of the two partners.

Border effects as given by the above expression can be estimated in two ways: by nonlinear regression of equation (17) subject to restrictions imposed by (6) as in the original article of Anderson and van Wincoop (2001), or by linear regression of (17) with country dummies as in Rose and van Wincoop (2001). More efficient coefficients are obtained with the first method, but both produce unbiased results.

The question arises which of the two methods mentioned above is to be preferred for estimations? The level of intra-national integration seems a reasonable benchmark for international trade flows. Nevertheless, the second definition of border effects seems to give a more exact expression of the phenomenon studied. But this method suffers from an important disadvantage: the need of computing a hypothetical, unobserved level of trade. To do so one must construct a general equilibrium model and certainly make some unrealistic assumptions.

[30] A tilde indicates the hypothetical level of a variable in the absence of international borders.

Appendix 5

Border Effects with Heckman estimations

Table 10: Border effects of east-west trade

Dependent variable: $\ln x_{ij}/x_{jj}$												
MONOPOLISTIC COMPETITION MODEL	CEEC imports from EU				EU imports from CEEC				CEEC-EU trade pooled			
Explanatory variables:												
$\ln \frac{y_i}{y_j}$	1.02^{a}	1.03^{a}	1	1	0.40^{a}	0.40^{a}	1	1	0.70^{a}	0.80^{a}	1	1
	(0.024)	(0.024)			(0.036)	(0.086)			(0.016)	(0.017)		
$\ln \frac{I_{i,t/93}}{I_{j,t/93}}$	-0.43^{a}	-0.41^{a}	-0.43^{a}	-0.41^{a}	0.45^{a}	0.40^{b}	0.40^{b}	0.36^{b}	0.12^{ns}	0.08^{ns}	0.14^{ns}	0.10^{ns}
	(0.122)	(0.122)	(0.122)	(0.122)	(0.158)	(0.160)	(0.163)	(0.166)	(0.102)	(0.103)	(0.105)	(0.105)
$\ln \frac{w_{i,93}}{w_{j,93}}$	0.04^{ns}	-0.08^{ns}	0.05^{ns}	-0.06^{ns}	-0.30^{a}	-0.30^{a}	-0.36^{a}	-0.35^{a}	-0.01^{ns}	-0.09^{a}	-0.15^{a}	-0.24^{a}
	(0.063)	(0.066)	(0.062)	(0.064)	(0.074)	(0.076)	(0.076)	(0.077)	(0.012)	(0.013)	(0.009)	(0.009)
$\ln \frac{d_{ij}}{d_{jj}}$ $[\theta = 1]$	-1.46^{a}		-1.45^{a}		-0.72^{a}		-0.80^{a}		-1.05^{a}		-1.28^{a}	
	(0.065)		(0.062)		(0.059)		(0.055)		(0.042)		(0.041)	
$\ln \frac{d_{ij}}{d_{jj}}$ $[\theta = -1.45]$		-1.30^{a}		-1.28^{a}		-0.53^{a}		-0.65^{a}		-0.97^{a}		-1.21^{a}
		(0.057)		(0.054)		(0.066)		(0.061)		(0.041)		(0.039)
Constant	-3.64^{a}	-2.45^{a}	-3.64^{a}	-2.48^{a}	-5.56^{a}	-5.19^{a}	-3.91^{a}	-3.29^{a}	-3.80^{a}	-2.88^{a}	-3.52^{a}	-2.28^{a}
	(0.245)	(0.286)	(0.247)	(0.290)	(0.263)	(0.338)	(0.226)	(0.287)	(0.160)	(0.188)	(0.090)	(0.126)
Number of observations	3621	3621	3621	3621	3791	3791	3791	3791	7412	7412	7412	7412
Border effect	**38.09**	**11.59**	**38.09**	**11.94**	**259.82**	**179.47**	**49.90**	**26.84**	**44.70**	**17.81**	**33.78**	**9.78**

[a], [b] and [c] indicate 1%, 5% and 10% significance level of estimated coefficients.

♯ regressions with country pair dummies.