# TRADE POTENTIAL IN AN ENLARGED EUROPEAN UNION: A RECENT APPROACH[1]

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**Abstract**: This paper aims to evaluate the trade potential of manufactured products between the members of the EU25 in the threshold of its Eastern enlargement. We estimate, for 2002, a cross-section gravity model, whose coefficients will be used to project the "natural" trade relations between them. Relatively to previous evaluations of trade potential, we include in the gravity model a variable related to the countries' complementarities in terms of their Commodity Composition of Trade and we opt for a Poisson Pseudo-Maximum Likelihood Estimator. The latter is confronted with the OLS estimator normally used in this type of models.

**JEL Codes:** C31, C51, C52, F14, F15 and F17.
**Keywords:** European Union to 25 members, Trade Potential, Gravity Model, Poisson Pseudo-Maximum Likelihood Estimator, Commodities Composition of Trade in Manufactures.

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# Introduction

The process of enlargement of the European Union (EU), which took place on May 2004, was prepared by the Europe Agreements (EA) - a total of ten agreements signed between the EU and the Central and Eastern European Countries (CEEC) in the 1991-1996 period. These agreements led to the total liberalization of tariffs, by 2002, in the trade amongst the members of the future enlarged EU and also laid the foundations of the accession process by implying full convergence of the domestic system of the CEEC to the EU *acquis communautaire*, i.e., the comprehensive body of laws, rules and regulations that govern the Union. Both changes were expected to have produced relevant adjustments in trade between CEEC and the EU members even before the enlargement. As a consequence, several studies were undertaken in order to measure the trade potential of the countries that would belong to the enlarged EU[1].

This paper belongs to this group of studies as it aims to evaluate the trade potential of manufactured products between the EU25 members in the threshold of its Eastern enlargement, more precisely in 2002. This year corresponds to the beginning of a free trade area between the members of the future enlarged EU and, as such, should already capture the results of the trade liberalization process. Similarly to previous studies on the topic, we aim to evaluate the trade potential by making use of a gravity model. However, this paper is original as regards the evaluation of trade potential in two aspects. First, we include in the gravity model the Commodity Composition of Trade (CCT) of the countries involved, i.e. a measure of the complementarity between the export and import vectors of pairs of countries, as an additional explanatory variable. Second, having in consideration the latest academic debate as regards to the improvement of the gravity model specification, we opt for a Poisson Pseudo-Maximum Likelihood estimator and confront it with the OLS estimator normally used in this type of models.

When referring to the EU25 countries we include the current EU member States excluding Cyprus and Malta, for scale reasons, but we include Romania and Bulgaria, as Accession Countries that will become members in a near future. Three distinct groups of countries will be considered: the Cohesion Countries (CC), the Central and Eastern European Countries (CEEC) and the

remaining countries belonging to the EU25 (EU11). For the purpose of our study, we consider data disaggregated at the 6-digit level of the Comext database's Combined Nomenclature.

As a first approach to the purpose of this paper, we take into account the Commodity Composition of Trade of the countries involved. In spite of being used as a formal way of assessing prospective trade flows, we point to its limitations within the context of this paper and opt for the most widely diffused methodology for evaluating the trade potential, based on the gravity approach. We estimate, for 2002, a cross-section gravity model and make use of the coefficients obtained to project the "natural" trade relations between the EU25 countries. By focusing our attention on the residuals of the estimated difference between potential and verified bilateral trade relations, we identify the countries that might benefit from this EU enlargement.

The remaining of the paper will be organized as it follows. In section 1, we will focus on a descriptive approach to the recent evolution of the verified trade flows within the EU25 member States. In section 2, we measure the complementarity between the export and import vectors of pairs of EU25 trade partners. Additionally, in section 3, we estimate two gravity models, one making use of Poisson Pseudo-Maximum Likelihood estimator and the other with recourse to the classic OLS estimator, with their results being compared in detail. In section 4, we calculate the trade potential flows for each of the two estimators and section 5 concludes.

# 1. A Descriptive Approach to Verified Trade flows

In order to have an overview of the trading relationships in the threshold of the EU enlargement within the 25 countries considered in this study, as well as an indication of the evolution of this trade in the period that preceded the total abolition of tariffs, we will focus our attention on the verified trade flows from 1999 to 2002. This period was chosen as the European Commission only started to publish homogeneous trade data for Bulgaria and Romania in 1999.

Starting with a global comparison between the three considered groups of countries (EU11, CEEC and CC), it can be observed in Table 1 that in 2002 79.4% of the EU25 exports of manufactured products had as its destination one of the EU11 countries. Note that this value decreased from 80.9 % in 1999. In addition, the analogous figure for the CC did not display a

relevant change, as it barely increased from 11.6% in 1999 to 11.8% in 2002. The most significant observation is related to the remaining weight represented by the CEEC in the EU25 exports of manufactured products, which increased from 7.5% in 1999 to 8.7% in 2002, absorbing all the EU11 countries relative decrease.

**Table 1 about here.**

It can also be observed in Table 1 that the EU25 export flows increased around 24.3% from 1999 to 2002. However, some countries clearly displayed an above the average increase. This is the case of the CEEC that increased their exports to the EU25 by 58.8%, on average. In fact, ten out of the eleven higher increases occurred in the CEEC. As regards the EU11, this group of countries increased their exports to the EU25 by 21.2%, on average. Interestingly, all the seven lower increases occurred in EU11 countries, namely Sweden, United Kingdom, Finland, Italy, France, the Netherlands and Germany.

Taking now into consideration the relations between the three groups of countries, we start by focusing our attention on the EU11. At this respect, it can be observed that 78.9% of the export flows originated in the EU11 had the EU11 countries themselves as their destination in 2002. The remaining EU11 export flows were divided between the CC (12.5%) and the CEEC (8.5%). Although these weights are rather similar to those displayed in 1999, the CEEC's quota increased, as expected, by 1.1 p.p. As regards the previous global picture, some specific performances must be highlighted. Whereas Luxembourg, Belgium and the Netherlands' exports were highly concentrated in the EU11 countries (higher than 89%), the Austrian, Italian, German and Finish export flows were relatively highly concentrated in the CEEC (higher than 10%). The United Kingdom showed a relatively high concentration of its export flows on the CC, basically due to the Irish relevance in the British trade balance.

Turning our attention to the CEEC, it can be observed that 80% of their exports had the EU11 countries as their destination in 2002. The remaining export flows were divided between the CC (3.9%) and the CEEC themselves (16.1%). These values are rather similar to those displayed in 1999 although a slight decrease of the EU11 weight has to be mentioned. Taking each CEEC

separately, Romania displayed an explicitly high concentration in the EU11 countries as its exports' destination (higher than 86%), whereas Slovakia and Lithuania presented a relatively high weight in the CEEC (higher than 23%). On the other hand, the Bulgarian exports were relatively highly concentrated on the CC, as a consequence of the Greek preponderance in the Bulgarian trade balance.

Finally, taking into consideration the CC, it can be observed that 82.8% of the export flows originated in the CC had as their destination the EU11 countries in 2002. The remaining export flows were divided between the CEEC (4.3%) and the CC themselves (13%). The evolution between 1999 and 2002 shows a remarkable decrease of 2.16 p.p. in the EU11's quota, distributed rather similarly by the two other groups. It is worthwhile highlighting that whereas the Irish exports displayed the EU25-highest concentration in the EU11 countries (92.4%), the Greek export flows were relatively highly concentrated in the CEEC (18%). In addition, Portugal and Spain showed a relatively high concentration of their exports on the CC, although these figures are considerably explained by their reciprocal preponderance on their trade balance.

A concluding remark to be made is that in the period analyzed the CEEC was, as expected, the group that most remarkably increased their importance as importers and exporters in the EU25. Additionally, this increase is higher as regards the CEEC's exports than the CEEC's imports, as could also be expected from an asymmetric process of liberalization that favored the CEEC[2]. Finally, the dimension of the trade relations of the CEEC with the CC is still small, in relative terms, although showing an increasing trend in the period analyzed. Some countries belonging to these geographical spaces registered, however, considerable trade reorientation processes in the period analyzed. This was the case of the Lithuanian and the Portuguese exports pattern's shift from the EU11 to the CC, while Greece and Slovenia reoriented a significant part of their exports from the EU11 to the CEEC.

# 2 Commodity Composition of Trade

The analysis of the degree of commodity correspondence between the exports of a country and the imports of another country has been the adopted tool for the characterization of potential

trade flows[3]. This approach leads us to the concept of Commodity Composition of Trade, which is determined by means of a trade complementary measure between the export structure of the supplying country and the import structure of the demanding country and assumed to be positively related.

The average of a country's CCT values is assumed to provide some information regarding its export potential, since an exporting country with a supply vector that comprehensively fits the import needs of their counterparts is likely to have better export prospects than an exporter with a poorly matching export structure. This is especially true in the case of large importers and has been theoretically grounded[4] on the demand-related factors suggested by Linder's theory that envisages international trade as an extension across national frontiers of a country's own web of economic activity [see Linder (1961, pp. 88)]. Since exports are viewed as an extension of the domestic market in Linder's analysis, it follows that trade flows will be more intensive between countries with similar demand patterns.

In this paper, we take into consideration the two trade indexes that have been alternatively used as methods of measuring the degree of complementarity between the trade structures of different countries, namely the Cosine Measure (COS), introduced by Linnemann (1966) and the Export-Import Similarity Index (EIS), set up by Finger and Kreinin (1979) and later upgraded by Linnemann and Beers (1988). Both are a relative index and thus immune to the absolute magnitudes of values. Their formulae are as follows.

$$COS_{ij} = \frac{\sum_k x_{ik} . m_{jk}}{\sqrt{\sum_k x_{ik}^2 . \sum_k m_{jk}^2}} \qquad (1) \qquad EIS_{ij} = \sum_k \min\left[\frac{x_{ik}}{\sum_k x_{ik}}, \frac{m_{jk}}{\sum_k m_{jk}}\right] \qquad (2)$$

where $x_{ik}$ equals multilateral exports of commodity *k* by country *i* to the rest of the world and $m_{jk}$ equals multilateral imports of commodity *k* by country *j* from the rest of the world. Note that either the export vector of the country i ($x_{ik}$) or the import vector of the country j ($m_{jk}$) are composed by n elements (k = (1, … , n)).

Despite the fact that both variables are strongly correlated[5] and that, to some extent, they display similar results, we opt for the EIS-measure, due to its relatively narrower variance[6]. The obtained results can be observed in Table 2.

**Table 2 about here.**

As expected, the biggest five economies of the EU25, namely Germany, France, United Kingdom, Spain and Italy, jointly with Belgium and the Netherlands, emerge as the most prepared to face the EU25 Internal Market as a whole, in terms of trade specialization, as they presented a relatively high average EIS-value (higher than 0.48) in 2002. The cases of the Czech Republic, Poland, Hungary, Slovakia and Slovenia as exporters, all of them displaying an EIS-value over 0.34, must also be highlighted. Their average EIS-measure shows that these five CEEC have better export possibilities than Finland, Luxembourg, Greece or Ireland. On the other hand, Bulgaria, Romania and the three Baltic countries appear to have a relatively inadequate trade specialization to tackle the challenge of the EU25 Internal Market. Furthermore, the CC patterns of specialization also appear to be worse than the average of the EU, being Spain the only exception.

Some obvious limits may be, nonetheless, pointed out as regards the adoption of the CCT as an indicator of trade potential. First, it is basically a static characteristic. Additionally, countries with large and diversified export bases tend to exhibit a high degree of complementarity between their exports and the imports of their trade counterparts when compared with non-diversified economies. The Irish case confirms the latter. Indeed, despite the well-known success of Ireland as an exporting economy in the recent years, it displays low values in terms of its EIS-measure, as it can be observed in Table 2. This outcome is a result of the high concentration of its export structure in a low number of products[7], which implies that exports cannot extensively match dispersed import structures of trade.

In the following section, we focus on the evaluation of the trade potential by making use of the gravity approach, as mentioned in the introduction. Nonetheless, the CCT will be also taken into consideration as an additional explanatory variable of actual bilateral trade in such modeling, given that a high degree of complementarity between a country's export structure and the

respective import structure of its counterparts is expected to be positively related to bilateral trade. This same option was also taken in a few gravity model studies, namely by Linnemann and Beers (1988), Beers and Linnemann (1992), Arnon *et al*. (1996), Beers and Biessen (1996) and Lamotte (2002).

# 3. The Gravity Model

In its simplest form, the trade-related gravity model explains the volume of bilateral trade between two countries (either the export or the import flow) based on each country's "economic mass", generally measured by GDP and population, and on the geographical distance between their "economic centers of gravity". Other trade-promoting and trade-restraining variables that capture different aspects of bilateral relations are also usually included into these models. This basic model has been subsequently improved in terms of the refinement of the explanatory variables considered in the analysis and, more recently, as regards to its econometric specification. These contributions not only brought the original equation closer to more realistic situations, but also succeeded in the elimination of strong distortions of the traditional specification of this type of regression.

We will start by enumerating the explanatory variables introduced in the model. After this characterization, two alternative models will be discussed and compared in subsection 3.2. Their specifications and results will be introduced in detail in subsections 3.3 and 3.4, respectively.

## 3.1 The Explanatory Variables

We will consider as the dependent variable of our model either the export or the import flows, and accordingly, we will identify the variables corresponding to each model by X and M, respectively.

On what concerns the independent variables introduced in the several regressions that were run, they aimed to cover consensual aspects of this type of literature. As regards the economic mass variables, they included the GDP (*MGDP, XGDP*) of both countries involved in the bilateral trade flow, their land area (*MLAND, XLAND*) and their population (*MPOP, XPOP*). The intensity of bilateral trade variables incorporates absolute and relative distance variables between both countries (*DIST, RDIST*), their foreign exchange reserves (*MFER, XFER*), their respective EIS-

measure (*EIS*), their nominal bilateral exchange rate (*EXR*) and the magnitude of the reciprocal flow to the one that it is being tested in the respective regression as the dependant variable (*RECI*). Finally, they also comprise dummy variables for countries sharing adjacency (*NEIGH*), the same language (*IDIOM*), a country representing a significant share of population in its counterpart (*ETHN*), EU15 belonging (*EU15*), the euro as their common currency (*EURO*), landlockedness for either the importing or the exporting country (*MLOCK*, *XLOCK*) and a dummy testing for a specific German bias (*GERMAN*). The respective specification of each one of these variables can be observed in the Appendix. All the above variables are expected to promote trade flows between two countries with the exception of DIST, XPOP, MLOCK, XLOCK, MLAND and XLAND, which are expected to be negatively correlated with trade, and RDIST, whose sign is theoretically ambiguous for reasons that will be explained further on.

Amongst the above-mentioned variables, there are some that have not been broadly used in the literature of the gravity model. For instances, the foreign exchange reserves variable (*FER*) represents the stock of successful trade flows in previous years, whereas the reciprocity variable (*RECI*) points out to the possibility of one-way trade flow being influenced by its inverse flow, as it creates time-certainty-related, psychic-cultural-related and market familiarity-related links that reduces the trading costs and, subsequently, benefit both flows. Additionally, the ethnic minority variable (*ETHN*) represents the existence in one of the countries of an ethnic minority of the other country involved in the trading exchange representing at least 5% of total population, and last the German dummy (*GERMAN*) is introduced following several authors that consider this kind of variable in every gravity model testing the CEEC's trade relations, such as Beers and Biessen (1996).

It is worth mentioning that the COS-variable was also included in the regression as an alternative to the EIS-measure, but it proved to be statistically less significant than the latter, enforcing the previous conclusions regarding the EIS-COS measures comparison.

The GDP variable is calculated at market exchange prices (MES), following the argument of authors such as Gros and Gonciarz (1996) or Frankel (1997) that the proper measure of a country's trade potential should be based on the international value of goods and services and not

on how well off its inhabitants are, as would be the case if it were calculated in terms of purchasing power parities (PPP)[8]. Note that the inclusion of a *per capita* GDP variable is implicitly carried out in our regression, as the joint presence of the GDP and the population variables display the *per capita* effect.

The inclusion of two distance variables (absolute and relative) and their respective expected signs deserve a more detailed explanation. The absolute distance variable is included as a measure to the resistance to trade that several transportation costs represent (namely time-uncertainty, psychic-cultural and market unfamiliarity-related costs[9]) and it is assumed to be negatively related to trade flows. The most popular absolute distance variable is the distance between capitals, as a proxy for the economic center of a country. Although the measurement of distances between capitals may not be the best of choices (for instance, when capitals are very close, as in the case involving Austria and Slovakia), Boisso and Ferrantino (1996) found very little difference between the gravity equation results of measuring the distance between the most populous cities or between the geographical centers. In view of this, we opted to proxy absolute distance by the geodesic distance between capitals[10], measured as the surface distance between two points of latitude and longitude (great circle distance[11]). The fact that this measure of absolute distance does not take sufficient account of a series of trade impediments that surely matter, such as real transport costs, complex orography, tariff and non-tariff barriers, waiting times at borders[12], transport infrastructure quality[13] or differences between maritime, road or train costs, constitutes an additional problem, which could not be solved out owing to a data availability problem.

Nonetheless, since Polak (1996), it has also been considered that the absolute distance between two economies is not the only variable that influences bilateral trade volume, with emphasis being also put on their geographical location. The hypothesis is that two countries located far away from the economic center tend to rely, to a larger extent, on trade with each other. Omitting countries' relative location may thus lead to an underestimate of trade flows that take place between countries geographically isolated from the trade-economic center and inversely to an overestimate in the case of centrally located countries. Accordingly, Polak proposed the inclusion

of a measure of relative distance between a country and its counterparts as a complement of the distance variable.

To define the relative distance, we follow Javorcik's methodology (2001). Unlike Polak, who uses a location index equal to the sum of all bilateral distances weighted by partners' GDPs, this author proposes to measure all distances with respect to the "trade center", previously defined. In the case of this paper, this variable is measured by the geodesic distance between the midpoint of each trading-country pair and the European Economic Center (EEC) for 2001[14], found to be located on the *Ostbayern* (Bavarian Forest, Germany), quite near to the Czech and the Austrian borders.

The effects of the location of a pair of countries relative to the "trade center" on their goods exchange are nonetheless ambiguous, as mentioned by Javorcik (2001, pp. 6-7). On one hand, countries at the periphery may trade less in absolute terms than economies of the same size located closer to the center. On the other hand, the share of their bilateral trade flows in their total trade may increase the further away they are from the center[15].

### 3.2 Discussion of the Two Estimators Alternatively Applied

As mentioned in the previous subsection, two estimators will be alternatively applied to the gravity model.

Firstly, the traditional approach considers a multiplicative form for the gravity equation that leads to the following expression for the trade flow from country *i* to country *j*, $T_{ij}$,

$$T_{ij} = e^{\beta' x_{ij}} \phi_{ij}$$

where $x_{ij}$ is a vector with the natural logarithm of the variables that explain the trade flows, $\beta$ a vector of unknown coefficients and $\phi_{ij}$ is an error term which verifies $E[\phi_{ij} \mid x_{ij}] = 1$, such that,

$$E[T_{ij} \mid x_{ij}] = e^{\beta' x_{ij}}, \qquad (3)$$

The usual procedure consists of estimating the regression model,

$$\log T_{ij} = \beta' x_{ij} + \eta_{ij}, \qquad (4)$$

with $\eta_{ij} = \log \phi_{ij}$ being the residual variable.

However, Santos Silva and Tenreyro (2003, 2005) pointed out to the fact that this procedure is not totally adequate as it leads to several econometric inaccuracies that we will subsequently elucidate. First, notice that, even if $E[\eta_{ij} \mid x_{ij}] = 0,$ by means of (4) we are able to estimate $\exp(E[\log T_{ij} \mid x_{ij}])$. However, this is, in general, not the same as $E[T_{ij} \mid x_{ij}]$. This observation has been referred in the literature as the Jensen's inequality. Wooldridge (2003) advises the correction of the OLS estimate of $\exp(E[\log T_{ij} \mid x_{ij}])$ by use of a scale factor that can be easily deduced when $\phi_{ij}$ is conditionally distributed as lognormal with constant variance. For other distributions, the author proposes a simple OLS regression to approximate this factor. However, this procedure is only effective if the $\beta$ coefficients are consistently estimated, which is not always the case. Indeed, if $\phi_{ij}$ is heteroskedastic, with variance depending on the regressors, which is very likely to happen in practice, then, and following the reasoning of Santos Silva and Tenreyro (2003, 2005) most likely $E[\eta_{ij} \mid x_{ij}] \neq 0$, implying that the OLS of equation (4) is not consistent to be used as an estimate to the $\beta$ parameters and, consequently, of the expected trade flow represented by (3). This result was patent in the simulations ran by the referred authors, having been detected a severe bias of the usual OLS estimators when that type of heteroskedasticity was present.

To avoid the above mentioned problems, Santos Silva and Tenreyro (2003, 2005) propose to consistently estimate (3) by making use of the Poisson Pseudo-Maximum Likelihood estimator (PML) using the robust Eicker-White estimator for the covariance matrix. This is the approach we follow in this paper though we also use OLS to estimate equation (4) for the sake of comparison.

### 3.3 Model Specification

We assume that the bilateral trade flow is given by the following equation,

$$T_{ij} = \exp(\beta_0 + \beta_1.\ln(DIST_{ij}) + \beta_2.\ln(MGDP_j) + \beta_3.\ln(XGDP_i) + \beta_4.\ln(MPOP_j) + \\ + \beta_5.\ln(XPOP_i) + \beta_6.NEIGH_{ij} + \beta_7.IDIOM_{ij} + \beta_8.ETHN_{ij} + \beta_9.\ln(EIS_{ij}) + \\ + \beta_{10}.\ln(RDIST_{ij}) + \beta_{11}.EU15_{ij} + \beta_{12}.\ln(MLAND_j) + \beta_{13}.\ln(XLAND_i) + \\ + \beta_{14}.\ln(EXR_{ij}) + \beta_{15}.\ln(MFER_j) + \beta_{16}.\ln(XFER_i) + \beta_{17}.EURO_{ij} + \\ + \beta_{18}.\ln(RECI_{ji}) + \beta_{19}.GERMAN_{ij} + \beta_{20}.MLOCK_j + \beta_{21}.XLOCK_i).\phi_{ij} \quad (5)$$

where $T_{ij}$ represents the trade flow, either exports from country *i* to country *j* or imports from country *i* to country *j*. We estimate (5) directly by PML and by OLS after applying to both sides the logarithm transformation in order to obtain a linear model. Our data consists of a cross-section series of 600 bilateral trading pairs involving all the EU25 members in 2002. None of the observations represent problematic zero-trade flows.

### 3.4 Econometric Results Obtained

Table 3 reports the results obtained with the Poisson Pseudo-Maximum Likelihood estimator (PML). For the sake of comparison, we also include the results obtained with the OLS estimator. TSP 4.5 was used for all the calculations. Note that a list of the variables' definitions can be obtained in the appendix and that, in the tables, the prefix L applied to the name of a variable refers to its natural logarithm. We estimate a General Model, which includes all the variables described in the previous section, and a Restricted Model, which includes the variables that proved to be statistically significant in the former model.

As regards the PML results presented in Table 3, the RESET test detects no evidence of misspecification of the functional form of the model at the 5% level and the R-squared is very high. The following variables are denoted to have positively influenced both foreign trade flows involving the EU25 members during the 2002 period: the EIS-variable (though only at 12% for the exports), reciprocal flow, exporter's GDP, importer's GDP, euro sharing, German bias, nominal bilateral exchange rate, ethnic minority and relative distance. Additionally, the variables importer's population, official language sharing and a relevant ethnic minority positively influenced the import flows, while the variable importing country's foreign exchange reserves positively

influenced the export flows. The variables that negatively influenced the EU25 internal trade flows, in the same period, were the absolute distance and the exporting country' s size.

**Table 3 about here.**

All the coefficients present the expected sign and their magnitudes are similar to those found in other studies, with the exception of the coefficients for the income variables of the exporting and importing countries. On one hand, we observe that the latter present a magnitude lower than one, depicting a tendency of trade to rise less than proportionately with economic size[16], also found in similar studies. On the other hand, this value is lower than that usually obtained when making use of the OLS methodology, which is closer to one[17]. Our results also point to the income coefficient being a little larger for the exporting than for the importing country, while Frankel (1997, pp. 140) obtained the reciprocal, although the author makes use of a gravity model with a broader geographical scope than ours.

The relative distance variable is positive and significant, and we can therefore admit that two countries not located near the "trade center" tend to be more reliant on trade with each other than a pair of countries located close to this center, as the latter have more alternatives to their trade activities.

In addition, comparing the results of the equation for the export flows with those for the import flows, one verifies that they are not totally coincident. This is due to the fact that exports and imports are computed differently and the difference between *cif* (for imports) and *fob* (for exports) may vary according to each specific flow[18].

Turning our attention to the alternative OLS results presented in Table 4, the most striking feature is that the RESET test shows evidence of misspecification of the regression model, implying that the OLS estimates are less reliable than the PML's. This was the expected outcome given the econometric implications of the Jensen's inequality, referred to in Section 3.2. Moreover, applying the test of Park to assess the validity of the log-linear OLS model as suggested by Santos Silva and Tenreyro (2003, 2005), we obtain tests statistics with p-values equal to 0.00, with either

imports or exports as the dependant variable, showing evidence of lack of consistency of the OLS estimator.

**Table 4 about here.**

All the OLS estimates are comparable to the PML's except for the intercept. As expected there are differences between both results that are worth pointing. A relevant one is the fact that, while with the PML estimator the relative distance variable is statistically significant, this is not the case with the OLS. As a consequence, the estimates displayed by the coefficients of the absolute distance variable are larger (in absolute terms) with the latter. Additionally, the PML estimator results in a higher statistical significance for the variables related to the exporting country's land area, the relevant presence of an ethnic minority and the common official language when compared to the OLS estimator outcomes. On the contrary, the statistical significance of the estimates displayed by both the importer's and exporter's population, both the importing and exporting country's landlockedness and the EIS-measure variables are lower for the PML estimator when compared to the OLS regression results. Moreover, the findings show that the exporter's population and the importing country's landlockedness variables are statistically significant with the OLS but not with the PML estimator, whereas the presence of an ethnic minority, common official language, adjacency and German dummy variables are significant with the PML but not with the OLS estimator.

# 4. Trade Potential

To evaluate the trade potential in manufactured products between the members of the EU25, this paper makes use of the coefficients obtained applying the PML estimator to cross-section data for exports in 2002, after the exclusion of the non-significant variables. By focusing our attention on relation between potential and verified bilateral trade relations, the estimated coefficients allow us to project the "natural" trade relations and, consequently, we are able to identify which countries might statistically benefit from this Eastern enlargement.

As referred, the trade potential calculations are based on parameters that were previously obtained taking into consideration the EU25 countries. This procedure, also followed by other

authors such as Baldwin (1994) or Nilsson (2000) implicitly assumes that the trade behavior of the CEEC is not different from that of the EU25 members. Supporting this idea is the fact that the CEEC dummy included in the Poisson-based cross-section regression of the previous section was statistically insignificant.

Table 4 displays the results obtained as a ratio between the potential and the verified exports. A ratio higher than one represents a potential flow higher than its respective verified flow. Note that a higher-than-unity ratio for the exporting country is usually interpreted as a positive sign in the sense that its exports display space to grow in the future, but it also means that the country's exports have not been able to complete all the trading space available providing that it behaves according to the average of the EU25, in the period of these calculations (2002).

**Table 5 about here.**

Focusing on the results obtained with the PML estimator, some aspects must be highlighted. Starting with the CEEC, we conclude that the CEEC export flows to the EU25 have no longer space to grow, as their potential exports are lower than the verified flows. This result is not in consonance with previous similar studies. For instance, Wang and Winters (1992) and Baldwin (1994) foresaw a huge expansion of trade between the CEECs and both the OECD and the EU, whereas Nilsson (2000) showed that in the 1995-96 period there was scope for some trade expansion as actual trade underscored potential trade for several pairs of countries. More recently, Africano and Teles (2001), Egger (2002), Packauskaite *et al*. (2002) and Africano (2004) tried to revive those studies by making use of a plain OLS estimator with more up-to-date trade data[19], and concluded that CEEC full-membership would bring about further trade adjustments between the newcomers and the "old" countries[20]. It should however be taken into consideration the fact that our period is not only more recent than that taken into account in the other mentioned studies but also that it coincides with the full tariff liberalization of the EU25 space. Additionally, the estimating methodology used influences the results, as we will put into evidence with the comparison with the OLS-based outcomes.

An advantage of distinguishing between the two country groupings present in the EU space previous to the Eastern enlargement (EU11 and CC) that must be necessarily mentioned is that it allows to conclude that, in spite of the previously mentioned result, obtained for the EU25 as a whole, market opportunities for CEEC exports' expansion are obvious as regards the CC. Indeed, bilateral potential exports between these two groups of countries were 53 % above the verified exports. More specifically, eight out of ten CEEC show scope to grow relatively to the CC market, with the respective ratios being considerably significant for Poland (1.50), Hungary (1.50), Romania (1.60) and, mostly, Slovakia (2.38). Slovenia should be highlighted as the only country presenting potential exports higher than verified exports relatively to the three groups of countries in 2002. Notwithstanding, the CC market displays a clear advantage, with a ratio of 3.89. Additionally, we must also mention Romania and Latvia, which display better opportunities not only relatively to the CC but also to the CEEC markets.

Turning now our attention to the EU11, the potential export flows of this group of countries appears to be rather similar to the verified one relatively to the EU as a whole and relatively to each one of the specific groups of countries considered with the exception of the CC market. As a result, we conclude that the EU11 had no space to expand its trade flows to either the EU11 or the CEEC markets, in 2002. These figures correspond to what one should expect from the abolition of tariff barriers on trade between the CEEC and the remaining EU25 countries, fulfilled in January 2002. However, taking a closer view of each one of the EU11 countries, we observe that Denmark, Luxembourg, the United Kingdom, Austria and the Netherlands displayed the highest above-one ratios, relatively to the CEEC market (1.72, 1.66, 1.47, 1.36 and 1.32, respectively). All of them, except the Netherlands, also showed the highest ratios as regards the EU11 market. Finally, the Belgian exports displays considerable space to grow on what concerns the CC market (1.51), while Finland is the only EU11 country in which the ratios were below the unity in all the three groups considered.

As regards the CC, the potential exports do not differ considerably from the verified flows. The most relevant figure is the one referring to its exports to the CEEC market (0.96), which tells us that these CC exports exceeded, in 2002, their potential value, a situation that contrasts with the

already referred reciprocal CEEC exports to the CC (53% below its potential). However, at the country level, we observe that Greece presents a high above-one ratio in all the three markets, whereas Portugal displays considerable space to grow on what concerns the CEEC and with most of the CC. In the case of the Portuguese exports to Spain, and despite the fact that they increased remarkably between 1999 and 2002, its potential figures still remain higher than the verified ones, implying further scope to grow. On the contrary, the Irish ratio emerges far below unity as regards the three markets considered.

The results obtained in this section point to the existence of special biases between certain countries, not explained by all the independent variables introduced in the gravity model tested, resulting in their verified trade being, on average, above their respective expected values. These biases, as shown by Caetano and Galego (2005) by making use of a Hausman-Taylor fixed-effects AR(1) to panel data, are strongly related to certain groups of countries that used to belong to a common State, such as the Czech and Slovakian Republics (ex-Czechoslovakia) and, especially, the Baltic countries (ex-USSR). Indeed, sharing the same State established a great bulk of unquantifiable links that clearly promote trade between these countries after secession. However, similar biases exist in the case of the British exports to Ireland, the Belgian exports to Luxembourg, the Finnish exports to Hungary or the Irish exports to Belgium.

A last comment focuses on the comparison between the differences observed in terms of the trade potential results when making use of both the OLS and the PML estimators. Table 4 also presents the results for the OLS estimator as regards the EU25 as importer and the main conclusion to be retained is that, despite the high correlation between the two series of trade potential calculated (0.72), there are, as expected, considerable differences in the results obtained with two estimators. Six countries show opposing results in terms of the expanding capacities of their market, namely Portugal, Lithuania, Latvia, Poland, Italy and Bulgaria. Additionally, the CC appear to have exhausted their trade possibilities to the EU25 market given the OLS estimation, whereas the PML estimator provides the contradictory information. Nevertheless, one must keep in mind that there is evidence against the consistency of OLS. In fact, the estimated trade flows obtained with OLS in our study were usually above of the observed ones, while usually the

opposite is the verified. The correction proposed by Wooldridge (2003) was too penalizing and we decided not to include it in our estimations.

### 4.1 CEEC-CC Bilateral Trade Relations

As previously observed, the CEEC as a whole only appeared to have good opportunities to increase their exports relatively to the CC markets in 2002, presenting a ratio of potential over verified exports of 1.53. In contrast, as regards the reciprocal ratio, the potential level is slightly lower than the verified one (0.96). Thus, the global picture is clearly favorable for the CEEC in terms of space to grow towards the CC in the future, although including different individual situations. In this section we deepen the previous analysis by focusing our attention on the bilateral net balance between these two groups of countries, in terms of both the observed trade balance and the potential trade balance values. For that purpose, we also calculate the potential imports by means of the estimated coefficients of the Restricted Model with the import flows as the dependent variable. Table 6 displays the results obtained.

**Table 6 about here.**

Whereas the verified trade deficit of the CEEC with the CC, in 2002, accounted for € 653 millions, the potential trade balance pointed out precisely on the opposite way, with the CEEC presenting a trading surplus that accounted for € 58 millions. Taking a deeper view into these values, the CEEC trade deficit with Ireland would have been expected to convert itself in a trade surplus, evolving from a verified trade deficit of € 315 millions to a potential trade surplus of € 210 millions. Moreover, the CEEC trade deficit with Spain would have been expected to decrease from € 776 to € 247 millions, whereas the CEEC trade surplus with Greece would have been expected to increase from € 44 to € 144 millions. Consequently, it can be stated that these three economies may be seriously harmed in the context of the EU enlargement, although Spain would still displays a trade surplus with the CEEC.

Portugal is the only CC economy that might benefit from this enlargement in terms of the adjustment of its bilateral trade balance with the CEEC. In fact, the Portuguese trade deficit with the CEEC might be expected to convert itself into a trade surplus, evolving from a verified trade

deficit of € 394 millions to a potential trade surplus of € 18 millions. This would be mostly achieved by improving its bilateral trade balances with Poland, the Czech Republic and, in a minor scale, with the three Baltic countries.

Finally, turning our attention to each CEEC country, the Czech Republic and Hungary would have been expected to worsen their trading balances with the CC, evolving from a trade surplus to a trade deficit, whereas Bulgaria and Poland would have been expected to improve these indicators, evolving, on the contrary, from a trade deficit to a trade surplus. Furthermore, Slovakia and Slovenia would have been expected to decrease their trade deficits, whereas Romania would have been expected to increase its trade surplus.

# 5. Conclusions

As regards the gravity approach used in previous papers to estimate the trade potential, based on the OLS estimator, we concluded in favor of the PML superiority, not only because of the Jensen's inequality and inconsistency of OLS when heteroskedasticity is present, but also in particular in terms of the RESET test results. Additionally, some results obtained with the OLS estimator clearly differ from the results displayed by the PML estimator. We have, consequently, shown that previous OLS results might be biased in terms of the variables' individual coefficients and, consequently, of the potential trade.

Furthermore, the results have also shown that the behavior of the bilateral trade flows related to the EU25 members follows the normal rules of gravitation. The PML estimator allows us to set the statistical significance of the relative distance variable, even when a geographically reduced space, as the EU, is considered. As a consequence, the estimates displayed by the coefficients of the absolute distance variable decrease, allowing us to infer that the estimation of the absolute distance coefficient is overestimated when the relative distance effect is not included in the model, as suggested by Polak (1996).

It can be also concluded that the trade liberalization between the EU members and the CEEC in the period that preceded 2002 has caused the subsequent trade adjustment to progress greatly. The trade potential figures indicate that, as expected, CEEC exports progressively

conquered the EU11 market relatively to their potential trade. However, conclusion does not hold in the case of the CC, given that the CEEC exports to the latter would have been expected to be 53% higher than those verified in 2002. This observation points to the existence of growth space for the CEEC products relatively to the CC markets, in the future.

The possible expansion of the EU members into the CEEC markets is not confirmed, neither in terms of the 25 countries nor when one disaggregates by groups of countries, in spite of the fact that market openness was slower in the case of the CEEC. However, it should be taken into consideration that tariff barriers between the CEEC and the EU members were abolished 2002, precisely the year we have chosen for our analysis. If one considers the bilateral trade balance, the CC countries appear to be in a rather unfavorable position at this respect, with the exception of Portugal. Indeed, Portugal is the only CC that would have been expected to improve its bilateral trade position with the CEEC, mostly by improving its bilateral trade balances with Poland, the Czech Republic and, in a minor scale, with the three Baltic countries.

# Appendix

## *Countries Included in the Data Set*

Austria (AU), Belgium (BE), Bulgaria (BU), The Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IR), Italy (IT), Latvia (LV), Lithuania (LH), Luxembourg (LU), The Netherlands (NE), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SV), Spain (SP), Sweden (SW) and the United Kingdom (UK).

## *Variables*

If an L precedes the following variables throughout this paper, this indicates that the logarithm has been applied to the variable in question.

## *Dependant Variables:*

**M** - *Nominal Import (cif) .flows of manufactured products* (covering Comext's 2-digit Combined Nomenclature yearly data from 1999 to 2002, Codes 16 to 98), measured in thousands of euro.

**X** - *Nominal Export (fob) flows of manufactured products* (covering Comext's 2-digit Combined Nomenclature yearly data from 1999 to 2002, Codes 16 to 98), measured in thousands of euro.

## *Independent Variables:*

**DIST** - *Absolute Distance*, expressed in kilometers, is the geodesic distance between capitals (in the case of The Netherlands, Amsterdam substitutes Den Haag), measured as the surface distance between two points of latitude and longitude (great circle distance). Values obtained from *www.wcrl.ars.usda.gov/cec/java/lat-long.htm*.

**RDIST** - *Relative Distance*, expressed in kilometers, is the geodesic (great circle) distance between the midpoint of each trading-country pair and the European Trade Center (ETC) for each considered year, according to Javorcik, 2001.

**MGDP/XGDP** – *Importer/Exporter country's Nominal Gross Domestic Product at Market Prices*, expressed in thousands of euro. Yearly data obtained from the Eurostat's *New Cronos* Database on Nov. 24th, 2003.

**MPOP/XPOP** – *Importer/Exporter country's Population*, expressed in thousands of people at the end of the period. Data obtained from the Eurostat's *New Cronos* Database on November 24th, 2003.

**NEIGH** - *Neighboring Dummy Variable* is equal to one if two trading partners share a land or sea border, zero otherwise. From CIA's *World Factbook 2003* on *www.cia.gov/cia/publications/factbook/index.html*.

**IDIOM** - *Common Language Dummy Variable* is equal to one if two trading partners share a same official language, zero otherwise. From CIA's *Factbook 2003* on *www.cia.gov/cia/publications/factbook/index.html*.

**ETHN** - *Ethnic Dummy Variable* is equal to one if there is in one of the countries an ethnic minority of the other country that represents more than 5% of total population of the latter, zero otherwise. From the CIA's *The World Factbook 2003*.

**EIS** - *EIS Variable* varies from zero to one as a complementarity measure of trading structures. Authors' calculations based on the *European Commission's Comext Database* (covering 6-digit CN yearly data of manufactured products for 2002).

**EU15** - *EU15 Dummy Variable* is equal to one if both of the countries involved in the trade flow belong to the EU15, zero otherwise.

**EURO** - *Euro Dummy Variable* is equal to one if both countries involved in the trade flow share the euro as a common currency, zero otherwise.

**MLAND/XLAND** – *Importer/Exporter country's Land Area*, expressed in squared kilometers. From the CIA's *The World Factbook 2003*.

**EXR** - *Nominal Bilateral Exchange Rate*. Data obtained accordingly to authors' calculations based on yearly averages for the course of exchange of the exporter country's currency against the euro divided by the course of exchange of the importer country's currency also against the euro. Those courses of exchange previously obtained from Eurostat's *New Cronos* Database on November 24th, 2003.

**MFER/XFER** – *Importer/Exporter country's Foreign Exchange Reserves*, expressed in millions of euro. Yearly data obtained at the end of the period accordingly to Eurostat's *New Cronos* Database on Nov. 24th, 2003.

**RECI** - *Reciprocity*, defined as the opposite trade flow of the dependant variable (covering yearly data from the Comext's 2-digit CN from 1999 to 2002), measured in thousands of euro.

**GERMAN** - *German Dummy Variable*, is equal to one if one of the countries involved in the trade flow is Germany, zero otherwise.

**MLOCK/XLOCK** - *Landlockedness Dummy Variable for the Importer/Exporter country*, is equal to one if the importing country has no direct connection to sea, zero otherwise.

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# Statistical Tables

**Table 1 – Exports to the EU25 and EU11, CEEC and CC (in € billions)**

| Exporting country | Evolution from 1999 to 2002 | | | | 1999 | | | | 2002 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Increase (%) | Share Increase | | | Total EU25 Trade | Share | | | Total EU25 Trade | Share | | |
| | | EU11 (pp) | CEEC (pp) | CC (pp) | | EU11 (%) | CEEC (%) | CC (%) | | EU11 (%) | CEEC (%) | CC (%) |
| **EU25** | 24.3 | -1.51 | 1.25 | 0.26 | 1 324 | 80.9 | 7.5 | 11.6 | 1 645 | 79.4 | 8.7 | 11.8 |
| **EU11** | 21.2 | -1.51 | 1.16 | 0.34 | 1 111 | 80.5 | 7.4 | 12.2 | 1 346 | 78.9 | 8.5 | 12.5 |
| **CEEC** | 58.8 | -1.01 | 0.58 | 0.43 | 86.4 | 81.0 | 15.5 | 3.5 | 137.2 | 80.0 | 16.1 | 3.9 |
| **CC** | 27.6 | -2.16 | 1.13 | 1.03 | 127.0 | 84.9 | 3.1 | 11.9 | 161.9 | 82.8 | 4.3 | 13.0 |
| **Romania** | 83.6 | -1.34 | 0.67 | 0.67 | 6.0 | 87.4 | 7.8 | 4.7 | 11.1 | 86.1 | 8.5 | 5.4 |
| **Luxemb.** | 72.0 | -1.12 | -0.29 | 1.40 | 5.0 | 91.9 | 3.4 | 4.7 | 8.6 | 90.8 | 3.1 | 6.1 |
| **Lithuania** | 68.5 | -5.18 | 0.66 | 4.52 | 2.0 | 74.7 | 22.8 | 2.5 | 3.4 | 69.5 | 23.5 | 7.0 |
| **Poland** | 66.7 | -2.62 | 1.46 | 1.16 | 18.9 | 84.1 | 12.8 | 3.1 | 31.4 | 81.5 | 14.3 | 4.2 |
| **Czech R.** | 62.1 | 1.00 | -1.34 | 0.34 | 20.5 | 76.7 | 20.1 | 3.2 | 33.3 | 77.7 | 18.8 | 3.5 |
| **Slovakia** | 59.6 | 1.13 | -1.89 | 0.76 | 8.6 | 66.7 | 31.8 | 1.5 | 13.7 | 67.9 | 29.9 | 2.2 |
| **Bulgaria** | 57.9 | 5.46 | 0.55 | -6.01 | 2.3 | 72.5 | 9.6 | 17.9 | 3.7 | 78.0 | 10.1 | 11.9 |
| **Estonia** | 54.6 | -0.79 | -0.98 | 1.76 | 2.1 | 84.4 | 13.6 | 2.0 | 3.3 | 83.7 | 12.6 | 3.7 |
| **Hungary** | 48.1 | -1.83 | 2.22 | -0.39 | 18.4 | 86.5 | 9.7 | 3.8 | 27.3 | 84.7 | 12.0 | 3.4 |
| **Latvia** | 39.0 | -1.02 | 1.16 | -0.14 | 1.6 | 83.9 | 12.6 | 3.5 | 2.2 | 82.9 | 13.8 | 3.4 |
| **Slovenia** | 33.5 | -3.36 | 3.00 | 0.36 | 5.9 | 86.5 | 11.4 | 2.0 | 7.9 | 83.2 | 14.4 | 2.4 |
| **Belgium** | 32.4 | 0.09 | 0.19 | -0.29 | 103.6 | 89.8 | 3.0 | 7.2 | 137.2 | 89.9 | 3.2 | 6.9 |
| **Ireland** | 31.5 | -0.79 | 0.10 | 0.69 | 40.0 | 93.2 | 1.9 | 4.8 | 52.6 | 92.4 | 2.0 | 5.5 |
| **Denmark** | 31.4 | -1.92 | 0.58 | 1.34 | 22.0 | 86.9 | 6.9 | 6.2 | 28.8 | 85.0 | 7.5 | 7.5 |
| **Austria** | 30.9 | 0.15 | -0.14 | 0.00 | 38.0 | 77.7 | 16.8 | 5.5 | 49.8 | 77.8 | 16.6 | 5.5 |
| **Greece** | 28.7 | -5.57 | 3.89 | 1.67 | 4.5 | 80.8 | 14.1 | 5.1 | 5.8 | 75.3 | 18.0 | 6.7 |
| **Portugal** | 27.3 | -5.35 | 0.94 | 4.41 | 17.8 | 79.9 | 1.8 | 18.3 | 22.6 | 74.5 | 2.7 | 22.7 |
| **Spain** | 25.1 | -2.14 | 1.68 | 0.46 | 64.7 | 81.5 | 3.5 | 15.0 | 80.9 | 79.3 | 5.2 | 15.5 |
| **Germany** | 23.4 | -2.03 | 1.52 | 0.51 | 312.6 | 78.2 | 11.4 | 10.3 | 385.8 | 76.2 | 13.0 | 10.8 |
| **Netherl.** | 22.3 | -0.65 | 0.39 | 0.26 | 133.3 | 89.9 | 2.6 | 7.4 | 163.0 | 89.3 | 3.0 | 7.7 |
| **France** | 16.9 | -2.01 | 1.31 | 0.70 | 166.1 | 77.6 | 4.9 | 17.5 | 194.2 | 75.6 | 6.2 | 18.2 |
| **Italy** | 16.8 | -3.43 | 3.14 | 0.29 | 120.9 | 74.4 | 10.1 | 15.5 | 141.3 | 70.9 | 13.3 | 15.8 |
| **Finland** | 15.6 | 0.70 | 0.12 | -0.83 | 23.5 | 80.1 | 11.7 | 8.2 | 27.2 | 80.8 | 11.9 | 7.3 |
| **Utd. Kg.** | 14.4 | -2.94 | 0.58 | 2.36 | 138.8 | 75.8 | 3.7 | 20.5 | 158.9 | 72.9 | 4.3 | 22.8 |
| **Sweden** | 9.7 | 0.39 | 1.17 | -1.56 | 46.6 | 85.2 | 6.7 | 8.2 | 51.1 | 85.6 | 7.8 | 6.6 |

Source: Authors' calculations based on the European Commission's Comext Database.

**Table 2 – EIS average, the two maximum and the two minimum values for intra-EU25 trade (2002)**

| Exporter | EU25 Avg. | EU11 Avg. | CEEC Avg. | CC Avg. | Maximum | Minimum |
|---|---|---|---|---|---|---|
| **Germany** | 0.571 | 0.596 | 0.554 | 0.543 | AU (0.658) – FR (0.645) | IR (0.483) – LU (0.481) |
| **France** | 0.541 | 0.573 | 0.502 | 0.549 | SP (0.623) – DE (0.615) | LU (0.448) – RO (0.443) |
| **Utd King.** | 0.525 | 0.562 | 0.484 | 0.525 | FR (0.596) – DE (0.591) | RO (0.434) – LU (0.433) |
| **Spain** | 0.515 | 0.530 | 0.484 | 0.549 | PT (0.621) – IT (0.579) | RO (0.427) – LU (0.418) |
| **Belgium** | 0.501 | 0.533 | 0.466 | 0.501 | IT (0.556) – SP (0.554) | HU (0.423) – RO (0.396) |
| **Italy** | 0.500 | 0.505 | 0.497 | 0.493 | AU (0.558) – FR (0.549) | IR (0.426) – LU (0.382) |
| **Netherlands** | 0.499 | 0.535 | 0.461 | 0.498 | DE (0.544) – UK (0.534) | LH (0.425) – RO (0.407) |
| **Austria** | 0.461 | 0.470 | 0.464 | 0.425 | CZ (0.528) – DE (0.516) | GR (0.377) – IR (0.371) |
| **Sweden** | 0.450 | 0.470 | 0.440 | 0.425 | FI (0.526) – AU (0.501) | IR (0.375) – LU (0.358) |
| **Czech Rep.** | 0.444 | 0.445 | 0.454 | 0.416 | SK (0.530) – AU (0.523) | LU (0.368) – IR (0.347) |
| **Denmark** | 0.424 | 0.444 | 0.406 | 0.412 | AU (0.489) – SW (0.469) | RO (0.378) – LU (0.377) |
| **Poland** | 0.400 | 0.399 | 0.404 | 0.392 | AU (0.465) – DE (0.443) | IR (0.330) – LU (0.311) |
| **Hungary** | 0.388 | 0.405 | 0.377 | 0.369 | DE (0.452) – AU (0.445) | RO (0.312) – LU (0.310) |
| **Slovakia** | 0.361 | 0.371 | 0.356 | 0.345 | AU (0.416) – SL (0.415) | RO (0.287) – IR (0.285) |
| **Portugal** | 0.355 | 0.370 | 0.335 | 0.363 | SP (0.413) – AU (0.406) | IR (0.299) – RO (0.292) |
| **Slovenia** | 0.350 | 0.347 | 0.360 | 0.335 | AU (0.403) – SK (0.390) | IR (0.284) – LU (0.268) |
| **Finland** | 0.324 | 0.333 | 0.321 | 0.306 | DK (0.386) – EE (0.366) | LU (0.287) – RO (0.281) |
| **Greece** | 0.306 | 0.305 | 0.303 | 0.319 | LV (0.341) – DK (0.331) | BE (0.277) – HU (0.265) |
| **Lithuania** | 0.283 | 0.285 | 0.282 | 0.280 | LV (0.324) – EE (0.323) | HU (0.239) – RO (0.233) |
| **Bulgaria** | 0.277 | 0.286 | 0.270 | 0.271 | SV (0.314) – DK (0.306) | HU (0.237) – IR (0.236) |
| **Romania** | 0.266 | 0.276 | 0.258 | 0.260 | SV (0.312) – DE (0.298) | LH (0.232) – IR (0.211) |
| **Estonia** | 0.256 | 0.265 | 0.253 | 0.236 | DK (0.324) – AU (0.312) | RO (0.225) – BE (0.222) |
| **Ireland** | 0.236 | 0.255 | 0.205 | 0.262 | NE (0.331) – BE (0.313) | SV (0.195) – EE (0.188) |
| **Luxembourg** | 0.236 | 0.254 | 0.220 | 0.222 | DK (0.266) – AU (0.261) | BE (0.207) – RO (0.201) |
| **Latvia** | 0.222 | 0.224 | 0.222 | 0.217 | DK (0.250) – EE (0.249) | IR (0.193) – HU (0.192) |

Source: Authors' calculations based on the European Commission's Comext Database (6-digit Combined Nomencl.).

**Table 3 – Poisson Pseudo-Maximum Likelihood (PML) estimates for intra-EU25 trade (2002)**

| | General Model | | Restricted Model | |
|---|---|---|---|---|
| | **Dependant Var. X** | **Dependant Var. M** | **Dependant Var. X** | **Dependant Var. M** |
| Constant | -18.736*** | -17.6412*** | -18.4019*** | -17.6227*** |
| | (-7.26283) | (-7.27035) | (-13.0505) | (-12.4508) |
| LDIST | -0.337018*** | -0.270706*** | -0.441408*** | -0.322552*** |
| | (-3.31491) | (-3.09831) | (-5.4088) | (-4.10292) |
| LMGDP | 0.269215*** | 0.181507** | 0.307544*** | 0.184102*** |
| | (2.64439) | (2.01136) | (4.98535) | (3.16690) |
| LXGDP | 0.498553*** | 0.439408*** | 0.442143*** | 0.418642*** |
| | (3.87811) | (3.79270) | (6.19258) | (6.65616) |
| LMPOP | 0.12685 | 0.158543* | | 0.175075*** |
| | (1.37801) | (1.85082) | | (3.62237) |
| LXPOP | -0.057822 | -0.044971 | | |
| | (-0.503834) | (-0.39947) | | |
| NEIGH | 0.151293 | 0.137989* | | |
| | (1.58352) | (1.67747) | | |
| IDIOM | 0.221457* | 0.212488* | | 0.198424* |
| | (1.7733) | (1.92029) | | (1.65518) |
| ETHN | 0.271855* | 0.238274 | 0.318123** | 0.310777** |
| | (1.78897) | (1.42768) | (2.40213) | (2.07938) |
| LEIS | 0.52913* | 0.651708** | 0.451670 | 0.680473** |
| | (1.75333) | (1.97667) | (1.55311) | (2.42116) |
| LRDIST | 0.116161 | 0.121409** | 0.109688* | 0.147054*** |
| | (1.52164) | (2.23295) | (1.71474) | (2.76876) |
| EU15 | -0.055832 | -0.010530 | | |
| | (-0.343602) | (-0.063486) | | |
| LMLAND | -0.051770 | -0.003249 | | |
| | (-0.912069) | (-0.069399) | | |
| LXLAND | -0.138929*** | -0.189737*** | -0.128179*** | -0.189872*** |
| | (-2.84313) | (-4.50325) | (-3.47459) | (-5.64397) |
| LEXR | 0.041439*** | 0.031731* | 0.034045** | 0.030682** |
| | (2.86926) | (2.45226) | (2.29039) | (2.56173) |
| LMFER | 0.048148 | 0.013151 | 0.054423* | |
| | (1.39576) | (0.422315) | (1.69438) | |
| LXFER | 0.021765 | 0.021403 | | |
| | (0.617454) | (0.676813) | | |
| EURO | 0.298997*** | 0.219226** | 0.319264*** | 0.225944*** |
| | (2.73052) | (2.31787) | (3.58296) | (2.63202) |
| LRECI | 0.380547*** | 0.462756*** | 0.432754*** | 0.485194*** |
| | (5.43345) | (6.97512) | (6.01113) | (7.80820) |
| GERMAN | 0.220845*** | 0.186441*** | 0.212841*** | 0.176540*** |
| | (3.10131) | (2.79304) | (3.07473) | (2.89966) |
| MLOCK | -0.030987 | -0.089654 | | |
| | (-0.3867) | (-1.36754) | | |
| XLOCK | -0.158833 | -0.094517 | | |
| | (-1.32379) | (-0.96769) | | |
| **R-Squared** | 0.92 | 0.94 | 0.92 | 0.94 |
| **RESET test** (p-value) | 0.070 | 0.288 | 0.434 | 0.626 |
| **Wald test** (p-value) | | | 0.072 | 0.591 |
| **N** | 600 | 600 | 600 | 600 |

Dependant Variable is the natural logarithm of Exports or Imports from country i to country j.
The t-statistics are found in brackets. Standard Errors are heteroskedastic-consistent.
***, **, * denote statistically significant at respectively 1%, 5% and 10%.
LR=Likelihood Ratio to test the restricted against the general model.

**Table 4 – Ordinary Least Squares (OLS) estimates for intra-EU25 trade (2002)**

| | General Model | | Restricted Model | |
|---|---|---|---|---|
| | **Dependant Var. LX** | **Dependant Var. LM** | **Dependant Var. LX** | **Dependant Var. LM** |
| Constant | -3.32219* | -3.20184* | -2.48932** | -1.1985 |
| | (-1.91051) | (-1.72124) | (-2.38093) | (-1.00206) |
| LDIST | -0.649995*** | -0.720337*** | -0.704120*** | -0.788215*** |
| | (-7.54613) | (-7.77577) | (-9.86614) | (-10.2105) |
| LMGDP | 0.223224*** | 0.231156*** | 0.214285*** | 0.202146*** |
| | (3.30046) | (3.13614) | (4.07586) | (3.3928) |
| LXGDP | 0.572042*** | 0.623611*** | 0.544496*** | 0.590117*** |
| | (8.29868) | (8.06065) | (10.7251) | (9.66352) |
| LMPOP | 0.247486*** | 0.192179*** | 0.224093*** | 0.273989*** |
| | (3.87019) | (2.84430) | (4.73461) | (5.36374) |
| LXPOP | -0.252844*** | -0.205167*** | -0.168532*** | -0.208932*** |
| | (-4.41791) | (-3.41222) | (-3.99399) | (-4.62748) |
| NEIGH | 0.115016 | 0.089625 | | |
| | (1.23460) | (0.912933) | | |
| IDIOM | 0.091676 | -0.001186 | | |
| | (0.556799) | (-0.007354) | | |
| ETHN | 0.121642 | 0.229815 | | |
| | (0.647943) | (1.08408) | | |
| LEIS | 0.570067*** | 0.844693*** | 0.579002*** | 1.05985*** |
| | (2.62137) | (3.71938) | (3.40757) | (5.95687) |
| LRDIST | 0.030520 | 0.047958 | | |
| | (0.575881) | (0.960616) | | |
| EU15 | -0.003812 | -0.010831 | | |
| | (-0.03295) | (-0.081849) | | |
| LMLAND | -0.062079 | 0.013901 | | |
| | (-1.39169) | (0.287505) | | |
| LXLAND | 0.060163 | -0.008834 | | |
| | (1.54669) | (-0.215160) | | |
| LEXR | 0.017786* | 0.036231*** | 0.018672* | 0.037758*** |
| | (1.76152) | (3.15685) | (1.85619) | (3.31135) |
| LMFER | 0.058856*** | 0.032910 | 0.044534** | |
| | (2.88005) | (1.26054) | (2.30233) | |
| LXFER | 0.019773 | 0.014919 | | |
| | (0.935819) | (0.632965) | | |
| EURO | 0.270295*** | 0.313778*** | 0.271128*** | 0.309836*** |
| | (3.03998) | (3.20156) | (3.51711) | (4.11237) |
| LRECI | 0.434217*** | 0.409605*** | 0.447982*** | 0.407116*** |
| | (8.97828) | (7.98325) | (9.80001) | (8.41817) |
| GERMAN | 0.107144 | 0.077024 | | |
| | (1.37668) | (1.00601) | | |
| MLOCK | -0.243926*** | -0.364728*** | -0.240298*** | -0.425338*** |
| | (-3.41527) | (-4.64919) | (-3.57851) | (-5.64305) |
| XLOCK | 0.103605 | 0.238959*** | | |
| | (1.35824) | (3.20884) | | |
| **R-Squared** | 0.93 | 0.92 | 0.92 | 0.92 |
| **RESET test** (p-value) | 0.033 | 0.002 | 0.002 | 0.000 |
| **Wald test** (p-value) | | | 0.122 | 0.135 |
| **N** | 600 | 600 | 600 | 600 |

Dependant Variable is the natural logarithm of Exports or Imports from country i to country j.
The t-statistics are found in brackets. Standard Errors are heteroskedastic-consistent.
***, **, * denote statistically significant at respectively 1%, 5% and 10%.
LR=Likelihood Ratio to test the restricted against the general model.

**Table 5 – Ratio of Potential to Verified Exports in terms of the PML estimator for intra-EU25 trade (2002)**

| Exporter | EU25 as Importer | EU11 as Importer | CEEC as Importer | CC as Importer | Maximum | Minimum | EU25 as Importer (OLS) |
|---|---|---|---|---|---|---|---|
| **EU25** | **1.00** | 1.01 | 1.00 | 0.95 | - | - | 1.07 |
| **EU11** | **1.01** | 1.02 | 1.03 | 0.91 | - | - | 1.10 |
| **CEEC** | **0.97** | 0.97 | 0.83 | 1.53 | - | - | 0.81 |
| **CC** | **1.02** | 1.02 | 0.96 | 1.06 | - | - | 0.96 |
| **Greece** | **3.14** | 3.42 | 1.43 | 4.62 | LU (19.65) – IR (6.56) | RO (0.97) – BU (0.65) | 2.28 |
| **Denmark** | **1.56** | 1.57 | 1.72 | 1.21 | LU (4.49) – AU (3.00) | FI (0.76) – SW (0.75) | 1.60 |
| **Luxemb.** | **1.49** | 1.50 | 1.66 | 1.27 | IR (6.00) – SK (3.46) | LH (0.81) – IT (0.79) | 1.46 |
| **Austria** | **1.35** | 1.35 | 1.36 | 1.27 | IR (3.95) – SK (3.68) | RO (0.79) – UK (0.68) | 1.51 |
| **Slovenia** | **1.31** | 1.27 | 1.15 | 3.89 | IR (6.64) – FI (4.13) | AU (0.91) – LH (0.37) | 1.06 |
| **Portugal** | **1.23** | 1.07 | 1.48 | 1.74 | LU (5.32) – LV (3.66) | UK (0.83) – BE (0.69) | 0.99 |
| **Lithuania** | **1.18** | 1.30 | 0.89 | 0.85 | SV (19.7) – GR (19.4) | EE (0.30) – LV (0.26) | 0.84 |
| **Spain** | **1.17** | 1.27 | 0.85 | 0.79 | IR (4.53) – FI (3.51) | PO (0.62) – SK (0.56) | 1.17 |
| **Utd. Kg.** | **1.14** | 1.25 | 1.47 | 0.73 | LV (6.08) – EE (2.99) | DK (0.99) – IR (0.47) | 1.40 |
| **France** | **1.14** | 1.21 | 0.78 | 0.95 | IR (2.99) – FI (2.29) | PL (0.79) – RO (0.79) | 1.50 |
| **Poland** | **1.07** | 1.09 | 0.83 | 1.50 | FI (3.31) – IR (3.05) | LV (0.63) – RO (0.57) | 0.93 |
| **Latvia** | **1.06** | 0.98 | 1.55 | 1.28 | BU (10.1) – RO (7.63) | SW (0.59) – UK (0.23) | 0.77 |
| **Italy** | **1.03** | 1.11 | 0.72 | 0.93 | IR (3.76) – LU (3.19) | EE (0.56) – RO (0.47) | 0.99 |
| **Bulgaria** | **1.01** | 0.94 | 1.32 | 1.19 | LU (6.98) – FI (5.99) | LV (0.55) – BE (0.31) | 0.66 |
| **Belgium** | **1.00** | 0.96 | 1.10 | 1.51 | IR (6.96) – BU (2.92) | GR (0.56) – LU (0.30) | 1.15 |
| **Romania** | **0.97** | 0.86 | 1.67 | 1.60 | FI (15.8) – LV (7.91) | UK (0.78) – IT (0.56) | 0.56 |
| **Czech R.** | **0.90** | 0.95 | 0.62 | 1.29 | DK (2.52) – IR (2.38) | SK (0.40) – RO (0.34) | 0.89 |
| **Netherl.** | **0.89** | 0.86 | 1.32 | 1.06 | IR (2.43) – LH (1.98) | BE (0.69) – IT (0.68) | 0.97 |
| **Estonia** | **0.88** | 0.89 | 0.85 | 0.94 | BU (22.7) – SV (11.0) | UK (0.46) – LV (0.27) | 0.68 |
| **Germany** | **0.88** | 0.86 | 1.05 | 0.84 | IR (2.22) – FI (1.76) | UK (0.71) – SP (0.62) | 0.83 |
| **Slovakia** | **0.87** | 0.96 | 0.56 | 2.38 | IR (5.29) – LU (3.60) | CZ (0.44) – RO (0.38) | 0.73 |
| **Hungary** | **0.87** | 0.82 | 1.05 | 1.50 | FI (3.19) – PT (2.71) | RO (0.51) – BE (0.47) | 0.70 |
| **Finland** | **0.76** | 0.79 | 0.64 | 0.65 | LU (5.31) – IR (1.79) | HU (0.39) – UK (0.37) | 0.76 |
| **Sweden** | **0.76** | 0.74 | 1.03 | 0.71 | IR (2.18) – LU (1.79) | SP (0.47) – BE (0.36) | 0.84 |
| **Ireland** | **0.47** | 0.46 | 0.65 | 0.50 | LV (1.99) – LU (1.32) | IT (0.33) – BE (0.09) | 0.49 |

Source: Authors' calculations based on the European Commission's Comext Database.

**Table 6 – Comparison between Potential Trade Balance (in bold) and Verified Trade Balance (in brackets) as regards trade CEEC-CC bilateral trade in 2002 (Mio Euro)**

| Between | CC | Greece | Ireland | Portugal | Spain |
|---|---|---|---|---|---|
| **CEEC** | **58** (*-653)* | **114** (*44)* | **210** (*-315)* | **-18** (*394)* | **-247** (*-776)*) |
| **Bulgaria** | **32** (*-286)* | **19** (*-269)* | **7** (*-9)* | **2** (*-13)* | **4** (*4)* |
| **Czech Rep.** | **-78** (*175)* | **1** (*130)* | **36** (*-77)* | **-17** (*106)* | **-98** (*16)* |
| **Estonia** | **12** (*36)* | **1** (*-3)* | **6** (*-9)* | **1** (*18)* | **4** (*30)* |
| **Hungary** | **-27** (*55)* | **15** (*71)* | **30** (*1)* | **-7** (*-20)* | **-65** (*2)* |
| **Latvia** | **16** (*-2)* | **2** (*1)* | **6** (*10)* | **2** (*13)* | **6** (*-26)* |
| **Lithuania** | **16** (*47)* | **2** (*-6)* | **8** (*9)* | **2** (*36)* | **4** (*8)* |
| **Poland** | **56** (*-234)* | **14** (*62)* | **64** (*-161)* | **-2** (*231)* | **-20** (*-365)* |
| **Romania** | **124** (*19)* | **58** (*13)* | **25** (*-33)* | **11** (*1)* | **31** (*39)* |
| **Slovakia** | **-45** (*-248)* | **4** (*36)* | **15** (*-23)* | **-5** (*-10)* | **-60** (*-271)* |
| **Slovenia** | **-48** (*-214)* | **-3** (*9)* | **12** (*-23)* | **-4** (*13)* | **-53** (*-213)* |

Source: Authors' own calculations following previous PML estimator coefficients.

# Notes

[1] See, for instance, Biessen (1991), Wang and Winters (1992), Hamilton and Winters (1992), Rosati (1992), Winters and Wang (1994), Baldwin (1994), Gros and Gonciarz (1996), Nilsson (2000), Africano and Teles (2001), Packauskaite *et al.* (2002), Egger (2002), Africano (2004) or Caetano and Galego (2005).

[2] The CEEC had to liberalise market access for manufactured goods over a (maximum) period of ten years, while in the case of the EU it was only five years.

[3] See, for example, Abdalla (1997), Linnemann and Beers (1988), and Beers and Linnemann (1992).

[4] See, for instance, Kösekahyaoğlu (1994).

[5] The R-squared of the regression relating both measures achieved 0.645 for the available data.

[6] $COS_{ij}$ and $COS_{ji}$ variances represent 0.0178 and 0.0033, respectively, whereas $EIS_{ij}$ and $EIS_{ji}$ variances represent 0.0119 and 0.0006, respectively.

[7] The "Machinery and Mechanical Appliances", "Organic Chemicals" and "Electrical Machinery and Electrical Equipment" 2-digit Comext sectors represented around 61% of the Irish total manufacturing exports in 2002.

[8] Nonetheless, Baldwin (1994), Bayoumi and Eichengreen (1995), Beers and Biessen (1996), Boisso and Ferrantino (1996), Piani and Kume (2000) and Paas (2002), among others, make use of income at PPP.

[9] Frankel (1997, pp. 73), Bougheas *et al.* (1999), and Martínez-Zarzoso and Nowak-Lehmann (2001), confirm that monetary costs are not necessarily the most important component of costs associated with distance.

[10] Some authors, such as Christie (2002), substitute the capital with a major city that seems to be closer to the country's economic centre of gravity (a triangle linking Frankfurt, München and Berlin instead of the latter in the German case). At this respect, we opted to use Amsterdam instead of The Hague as the Dutch capital.

[11] Also known as "*as the crow flies*", which is technically defined as the great-circle distance between the two latitude-longitude combinations.

[12] Christie (2002) attempted to take account of border waiting times by making use of a transport time matrix between the main transport nodes of the CEEC but concluded that that this specific variable does not clearly outperform the traditional distance measure.

[13] See Garman *et al.* (1998), Limão and Venables (1999) and Bougheas *et al.* (1999). Moreover, for an inclusion of infrastructure facilities endowment (namely in terms of road, train, maritime and air infrastructures) in a gravity model, see Martínez-Zarzoso and Nowak-Lehmann (2001).

[14] Other authors such as Schumacher (2001, pp. 28) and Gray (2001) presented different formulas for calculating geodesic distances by making use of latitude and longitude coordinates.

[15] In order to solve this indeterminacy, Javorcik (2001) proposes a gravity model based on bilateral trade shares rather than on absolute bilateral flows.

[16] Note that these results are not strictly comparable to those of Santos Silva and Tenreyro (2003, 2005), as the latter refers to GDP and GDP *per capita* as explanatory variables, whereas ours involve GDP and POP. As a consequence, the coefficients displayed in both models are not the same.

[17] See, for instance, Bikker (1987), Arnon *et al.* (1996) and Frankel (1997).

[18] Similar results were also obtained by Arnon *et al.* (1996).

[19] 1998-99 Comext-data, 1986-1997 OECD-data, 1995-2000 OECD-data and 2000 OECD-data, respectively.

[20] It must be noted that the geographical scope of the studies by Africano and Teles (2001) and Caetano and Galego (2005) are the only that completely match ours.