Revisiting the border effect in Europe and Spain:

New results using region-to-region intra-national and inter-national flows.

Nuria Gallego*

Carlos Llano*

First Draft.

Please, do not quote without permission

* Departamento de Análisis Económico: Teoría Económica e Historia Económica. Facultad de Ciencias Económicas y Empresariales. Universidad Autónoma de Madrid. Campus Cantoblanco. 28049 MADRID.

JEL Codes: F14, F15

Keywords: border effect, distance, interregional trade, region to region international trade

Abstract

The existence of a large border effect is considered as one of the main puzzles of international macroeconomics. The seminal paper by McCallum found that inter-provincial trade within Canada was -on average- 22 times larger than the trade of any Canadian province with any State from the United States of America. Although different authors have estimate internal and external border effects for the whole EU and some of their countries, no one have estimate to date the real border effect due to the lack of data on region-to-region international trade flows. In this paper, we develop a new dataset that captures international shipments by truck between the Spanish regions and other regions in the EU. Then, this novel dataset is used for estimating the internal and external border effect of 15 Spanish regions as regards to the regions of 11 European countries.

1. Introduction

The existence of a large border effect is considered as one of the main puzzles of international macroeconomics (Obstfeld and Rogoff, 2000). The seminal paper by McCallum (1995) found that inter-provincial trade within Canada was -on average- 22 times larger than the trade of any Canadian province with any State from the United States of America. Afterwards, different authors have tried to replicate this exercise in other countries like Japan (Okubo, 2004), USA (Wolf, 2000; Hillberry and Hummels, 2003), or the EU (Chen N. 2004; Nitsch 2002; Evans 2000a, b).

In the EU, some papers have estimated the relevance of the inter-national borders, quantifying how many times a European country trade more with itself than with any other (Head and Mayer, 2000; Minondo, 2001, Chen, 2004). Some others, have estimated *the external border effect* taking the regions (or provinces) of a country as a reference, and quantifying how many times these regions trade more with the rest of the country than with other countries as a whole (Gil et al, 2005; Gil et al, 2008; Requena and Llano, 2010, Ghemawat et al, 2011; Llano et al, 2011). In parallel, we also find estimates of the *internal border effect* (home bias), defined as how many times a region (province) within a EU country trade more with itself than with any other region (province) within the same country (Combes et al, 2005; Garmendia et al, 2011).

To the best of our knowledge, to date no one has been able to estimate the border effect in the pristine fashion for the EU countries, that is, estimating how many times a region from one country trades more with another region of the same country than with a third region from another country. This limitation is derived from the lack of data regarding region-to-region trade flows between different countries. Moreover, McCallum's approach, and most of the subsequent papers (Anderson and van Wincoop, 2003; Feenstra, 2002, 2004) just consider the interregional trade flows between to contiguous countries. Therefore, in their results the effect of crossing a national border was also mixed with the effect of being adjacent countries.

Due to the lack of data on region-to-region trade, the most ambitious attempts to measure the effect of international borders on the interregional trade structures are indirect, or have been restricted to the analysis of the singular performance of regions located around the borders of countries with an intense bilateral trade relation. To this regard, Lafourcade and Paluzie (20011), used a gravity model to study the trade performance of French and Spanish border regions relatively to non-border regions, over the past two decades. They found that, controlling for their size, proximity and location characteristics, border regions trade on average between 62% and 193% more with their neighbouring country than other regions, and twice as much if they are endowed with good cross border transport infrastructures. Despite European integration, however, this trade outperformance has fallen for the most peripheral regions within the EU. They also show that this trend was linked in part to a shift in the propensity of foreign investors to move their affiliates from the regions near their home market to the regions bordering the EU core. In addition, in a related work, Lafourcade and Paluzie (2008), investigate whether the European integration has changed the geography of trade within France, with a particular focus on the trends experienced by border regions. In this parallel investigation, they found that, once controlled for bilateral distance, origin- and destination-specific characteristics, French border regions trade on average 72% more with nearby countries than predicted by the gravity norm. They perform even better (114%) if they have good cross-border transport connections to the neighbouring country. However, this outperformance eroded drastically for the French border regions located at the periphery of Europe throughout integration. From a complementary perspective, Helble (2007) analysed the border effect between Germany and France. His results indicate that France trades about eight times more and Germany about three times more with itself than with other EU countries, respectively, compared to the predictions of the gravity equation. Regarding our paper, the main interest of Helble's article is the attempt to develop a method for improving the estimation of border effects using data on regional transportation flows.

Based on the development of a novel dataset capable of capturing region-to-region international trade, in this paper we estimate the internal and external border effect in the McCallum original way, confronting the intra-regional trade of the Spanish regions (Nuts 2) to the interregional trade within Spain and as regards to the regions of other 11 European countries. In order to do so, several specifications of the gravity model are tested. A first group of them, replicates the empirical model used by McCallum for a cross section sample of internal and external trade of the Canadian provinces (referred to 1988). Then, following Feenstra (2002, 2004) and Anderson and van Wincoop (2003), alternative specifications are developed, which controls for the interaction of the trading regions and the price vectors of the rest of the regions, by including the multilateral resistance terms. These specifications are tested with pooled data as well as fixed effects panel data.

The rest of the paper is organised as follows. Section 2 revisits the literature on border effect in Europe and Spain, and describes the alternative specifications of the gravity equation to be used in our analysis. Section 3 describes the methodology for estimating a region-to-region trade dataset for the Spanish case. Section 4 presents a descriptive analysis of our dataset on region-to-region trade flows within Spain and as regards to 11 European countries, as well as the main results of the econometric analyses. The final section summarises the main conclusions of our paper.

2. How to measure the border effect in Europe and Spain.

2.1. Previous literature.

In this section we briefly review the literature on border effect. The emphasis is put more on the results obtained in each area and the type of data used than in the econometric approach used for the estimation.

<< Table 1 about here >>

2.1.1. The border effect in North America and the OCDE

After the seminal contribution of McCallum (1995) Helliwell (1996, 1998); Hilberry (1998); and Anderson and Smith (1999) confirmed the national border effect between Canada and United State, using province-to-state data, and considering just one international border. Then, the border effect has been re-estimated by Anderson and van Winkoop (2003) as well as by Feenstra (2002, 2004) with some more refined specifications of the gravity model, which deals more carefully with the theoretical underpinnings of the gravity equation and the treatment of the effect that non observable price indexes of the system exert on each specific trading dyad.

Wei (1996) quantified the national border effect to the OCDE countries for the period 1982-1994. He introduced the intra-national flow of a country as the difference between its industrial production and its inter-national exports. In order to get a measure of the internal distance he assumed that the average distance travelled inside of the country is one-half of the distance from the economic center of that country to the border of its nearest neighbor. For the distance with other countries, he used the great-circle formula. He found that the OCDE's countries trade in average 10 times more with themselves than with other countries and only 2.6 when common language and contiguity effects are taken into account.

Helliwell (1997) use the same dataset of Wei (1996) for the year 1990. He considered a more completed specification of the border effects and included a more elaborated variable of common language and a different remoteness measure. In his work he found a national border effect of roughly 12 times larger for the internal trade of OCDE countries than the trade that they have with other countries.

2.1.2. Border effect in Europe

Nitsch (2000a) measured the impact of national borders on the international trade between the European Union countries for the period of 1979-1990. For his estimation, Nitsch used an alternative approach to the ad hoc measure (proposed by Wei, 1996 and Wolf, 1997). He elaborated the average distances within a country as a function of country size. He found that in average all EU countries have an intra-national trade about 10 times larger than their international trade with any other EU partner of similar size and proximity. Then he analyzed the evolution of the home bias over the time, considering two different samples: for the period 1979-1990 (not including Spain and Portugal); and for the period 1983-1990 (with Spain and Portugal included). His results showed that the border for the first sample dropped gradually from roughly factor 9 to 7, while for the second dropped from 12 to 11.

Then, Head and Mayer (2000) estimated the border effect for 3-digic industries in the European Union. They also consider the impact of different internal measures on the value associated to the border effect. Their results cover a wide variation in the border effect across the industries. For the average industry in 1985, they found that European purchased trends 14 times more from the domestic country than from other European country, with equal size and distance. Then, also Head and Mayer (2002) demonstrated that the border effect is conditioned by the method used to measure the internal distance of a country. In this paper they develop a correct measure of distance to inter-national and intra-national trade. They find the border effect and adjacency effects have been reduced, but they have not disappeared.

Chen (2004) focuses in the estimate and explanation of border effects among a set of European Union countries and manufacturing industries. In fact she included in the gravity equation the bilateral flows of 7 countries, disaggregated in 78 industries for the year 1996. She found that controlling for the relative prices (multilateral resistance), the size of the border effect decreases. She got a border effect that suggests an intra-national trade roughly 6 times larger than the inter-national trade, equal the rest of variables.

As a final example, we refer to Helble (2007), who estimated the border effect for France and Germany. For his research he combines Inter-national trade and Intra-national Transport Flows, and he avoid the use of intra-national trade flows. His results suggest that France trades roughly 8 times more with itself than with other EU countries, and Germany does about 3 times.

2.1.3. Border effect of Spain in relate with European countries

Regarding the border effect in Spain, Gil et al. (2005) examined the magnitude of the "home bias" in Spanish trade, using bilateral trade between each of the 17 Spanish regions and 27 OECD countries for the period 1995-1998. In their estimates of the border effects they use a panel data, which allowed considering the unobservable individuals effect. The result showed that intra-national Spanish trade exceeds 22 times the inter-national trade, only controlling for size and distance. And for the augmented gravity equation the "home bias" of Spain is around 14 larger, even with respect to contiguous countries and members of the European Union.

Afterwards, three papers revisited the Spanish border effect also using region-to-country trade flows. Requena and Llano (2010) estimated the internal and external border effect at the Nuts 2 level, using industry specific flows. With a similar dataset, Ghemawat et al. (2010) focused on the Cataluña's inter-national border effect, defined in terms of the intensity of inter-regional trade relative to international trade, once controlling for distance and economic size. For this analysis the authors considered the total flow of Cataluña with the rest of Spain, the intra-regional trade of Cataluña, and the international trade that this region keeps with 22 ODCD countries. The results for the national border effects in Cataluña dropped from a factor of 80 in 1995 to factor of 29 in 2005. Instead, when this analysis is repeated just considering the international trade of Cataluña with the adjacent France, the national border effect decrease down to 23 in 2005. Finally, Llano et al (2011), revisited the border effect in Spain using Nuts 2 and Nuts 3 datasets, finding that the size of the border depends largely on the spatial unit used. One of the limits of this final paper is that although they are able of varying the spatial scale of the Spanish units (from Nuts 2 regions to Nuts 3 provinces), they have to fix the spatial scale of the partner (always a country).

2.2. The empirical model.

Like most of the articles cited in the previous section, the backbone of our investigation is the gravity equation, where the intensity of trade between any two locations (regions or countries) is related to their economic size and inversely related to the geographical distance between them. Also departing from previous literature, it is worthy to start describing the specific border effects that we want to measure: on the one hand, the label *"regional border effect"* will be used for denoting how many times a region in Spain trades more with itself than with another Spanish region. Instead, the *"national border effect"* will measure how many times a Spanish region trades more with another Spanish region than with another region in the rest of Europe.

In a first step, we replicate the McCallun (1995) specification. By doing so, we will have, for the first time, the real flavor of the border effect in an EU country when homogeneous spatial units are used at both sides of the national border (region-to-region instead of region-to-country). Like in McCallum seminal paper, we define a cross section specification, which will be referred to year 2006, in order to increase the number of observations and to avoid potential bias due to the recent economic downturn (data for 2007 seems to be affected by this distorting effect). The McCallum's simplest specification just controls for the origin and destination GDPs and for the bilateral distance:

$$\ln T_{ij}^{eu} = \beta_0 + \beta_1 Nat\_Border_{ij} + \beta_2 lnY_i + \beta_3 lnY_j + \beta_4 lndist_{ij} + \epsilon_{ij} \qquad [1]$$

where T_{ij} is the export flow from the region *"i"* in country *"e"* to the region *"j"* in country *"u"* at year "t". Note that:

- if e=u=Spain and i=j, equation [1] will capture intraregional trade flows for an Spanish region *"i"*.
- if e=u=Spain and i≠j, equation [1] will capture interregional trade flows for a pair of regions within Spain *"i-j"*.
- if e≠u, equation [1] will capture interregional flows between Spain and another European country in the sample. This flow will be a Spanish export if *e=Spain*, and a Spanish import if *u=Spain*.

The variable *Nat_Border* is a dummy that takes the value one when the interregional flow takes place within Spain (*u=e=Spain*), and zero otherwise. The variables lnY_i and lnY_j represent, respectively, the logarithm of the nominal gross domestic product (GDP) of the exporting and the importing region. And finally, the variable $lndist_{ij}$ is the logarithm of distance between the region *"i"* and the region *"j"*.

The second specification introduces new variables for controlling for additional effects:

$$\ln T_{ij}^{ue} = \beta_0 + \beta_1 Nat\_Border_{ij}^{eu} + \beta_2 Reg\_Border_{ij}^{eu} + \beta_3 lnY_i + \beta_4 lnY_j + \beta_5 lndist_{ij} + \beta_6 Home\_Contig_{ij}^{eu} + \beta_7 Foreign\_Contig_{ij}^{eu} + \varepsilon_{ij} \qquad [2]$$

First, we want to control for the expected larger levels of trade occurring within each region than between a Spanish region and any other within the country. This effect, that we lavel *the regional border effect*, is in line with the concept of "regional home bias" (Wolf, 1997, 2000a,b) or the "internal border" measured by other authors in similar contexts (Llano and Requena, 2010). In order to control for these effect, a new dummy variable Reg_Border_{ij} is introduced, which takes value "one" when the origin and the destination region are the same (intrarregional flows "i=j"), and "zero" otherwise.

Then, in order to control for the contiguity effect two additional variables are included. On the one hand, like McCallum and others, it is convenient to control for interregional trade flows taking place between contiguous regions located in the same country. The variable of *Home_Contig*$_{ij}$ is a dummy that takes value "one" when the trading regions "i" and "j" belongs to Spain and share a common border, and takes value "zero" otherwise. In addition, we want also to control for augmented concentration of trade between border-regions of different countries. This attempt is in the line of the results found in different papers (Lafourcade and Paluzie, 2011, 2008; Gallego and Llano, 2011) that have demonstrated that border-regions located in countries like France, Spain or Portugal tends to capture larger shares of bilateral trade and FDI flows than the average. In order to do so, a dummy variable *Foreign_Contig*$_{ij}$ is introduced in equation [2], which takes value "one" when the two partner regions "i" and "j" belongs to different countries (Spain-France-Portugal) and share a common border, and "zero" otherwise.

The third specification -defined in equation [3]- explores the time-dimension of our dataset, defining pooled and panel data specifications for the period 2004-2007. In order to control for the possible events affecting the trade along the years, but without affecting the causal effect of the independent variable on the dependent one, we add time dummies variables. In addition, following Anderson and van Wincoop (2003), and most of the subsequent literature on the use of gravity equation for trade, we include the multilateral resistance terms with the aim of controlling for the effect that the non-observable price index of the competing origins and destinations exert on the bilateral flow of each trading dyad. In the line of Feenstra (2002, 2004) and others, the multilateral resistance terms are introduced as origin and destination fixed effects.

$$\ln T_{ijt}^{eu} = \beta_0 + \beta_1 Nat\_Border_{ijt}^{eu} + \beta_2 Reg\_Border_{ijt}^{eu} + \beta_3 lnY_{it} + \beta_4 lnY_{jt} + \beta_5 lndist_{ij} + \beta_6 Home\_Contig_{ijt}^{eu} + \beta_7 Foreign\_Contig_{ijt}^{eu} + \lambda_t + \mu_i + \mu_j + \varepsilon_{ijt} \quad [3]$$

Where variable λ_t is the year fixed effect (one dummy variable per year). The terms μ_i and μ_j correspond, respectively, to the multilateral resistance fixed effects for each origin and destination region. These variables are introduced as a dummy for each origin and destination, both at the country level as well as the regional level. Thus, for countries fixed effects, we introduce a dummy for each country of origin/destination, which takes value "one" if the as country of origin is *"e"* or the country of destination is *"u"*), and zero otherwise. Similarly, for the specification with regional fixed effects, a set of dummy variables are introduced that takes value "one" when the origin region is "i" and destination region is "j", and zero otherwise.

3. The data

3.1. A region-to-region international trade dataset for Spain.

On the outset, it should be said that there is no official data on region-to-region international trade flows for any country in the EU. Gallego and Llano (2011) describes a methodology for estimating region-to-region international trade flows ($\hat{T}_{ij}^{eugR}$) between Spain and 11 European countries, by combining region-to-region freight statistics on Spanish trucks (F_{ij}^{eugR}), as well as international price indexes ($\hat{P}_{i.}^{eugR}$) for each region-country-variety deduced from official trade data. In this section we briefly summarize the methodology described in detail in that paper.

Let us start considering two countries *e* and *u*, with *I* and *J* number of regions respectively. Considering the complete set of regions, all types of trade flows could be expressed by T_{ijt}^{eu}. Each aggregated flow can be decomposed in volumes (*Q*) and unit prices (*P*) of a set of *k* tradable varieties. These commodities could travel using 5 alternative transport modes: road (R), train (T), ship (S), airplane (A) and others (O). Next, we focus on element $T_{ij}^{eukR} = \left(Q_{ij}^{eukR} * P_{ij}^{eukR}\right)$, which captures the international exports of variety *k* delivered *by road* with origin in region *i* from country *e* to region *j* in country *u*. Again, this flow can be decomposed depending on the nationality of the truck offering the transportation service (freight flow), which can be classified as an intra-national or an inter-national (cross-country) type of service (equation [4]).

$$T_{ij}^{eukR} = \left(Q_{ij}^{euk\_National\_Trucks} * P_{ij}^{eukR}\right) + \left(Q_{ij}^{euk\_International\_Trucks} * P_{ij}^{eukR}\right) \quad [4]$$

For the Spanish case, the Spanish Permanent Survey on Commodity Transport by Road (SPSCTR), collected by the Ministerio de Fomento, offers data on intra-national and inter-national transport flows by road. Like its counterparts in the rest of the EU, this survey provides, for each year *t* and type of product (*G=24;* see detail in the Annex), a rich set of variables covering origin and destination flows (in Tons and in Tons*km), both for intraregional, interregional and international shipments. Exceptionally, we were able of using an extended dataset, which specify the region-to-region dimension of intra-national and inter-national flows with a large number of European countries. It is important to highlight that the survey just cover the *volumes* transported by heavy trucks with base in Spain ($Q_{ij}^{euk\_National\_Trucks}$ from equation 1), that is around 60% of the international trade flows using the road. Consequently, all the international exports and imports with origin/destination in a Spanish region, which were delivered by an international truck ("cross-country transport") are not covered by the survey.

Departing from this conceptual decomposition of the flows by quantities, prices and transport modes, and considering the partial information available on region-to-region international deliveries (Spanish carriers transporting goods by road), we need to estimate *"international price vectors"* in order to translate the *transport flows* (in tons) into *trade flows* (in current euros). As it is described in detail in (Gallego and Llano, 2011), departing from a very detailed international trade dataset (*K=17.000 varieties*), we compute region-country-product specific prices for the products considered in the freight statistics (*G=24 products*). With the goal of obtaining "implicit price vectors" for each region-country-product transported by road, which have to take into account the "quality" specialisation of the internal "variety-mix" within each product g ($\{k_1, k_2, \dots\} \epsilon\, g_1$), the "value/volume" ratios are calculated by computing weighted average of the "variety price" (k) included in each product (g). The process also included a set of filters to control for outliers.

The outcome of this procedure is a unique dataset with information on several variables regarding region-to-region flows for international flows departing/arriving to the Spanish regions (Nuts 2). Each flow can be described by equation [5]:

$$\hat{T}_{ij}^{eugR} = \left(F_{ij}^{eug\_National\_Trucks} * \hat{P}_{ij}^{eugR}\right) \qquad [5]$$

The *estimated* trade flows $\hat{T}_{ij}^{eugR}$ of products g traveling by Spanish trucks from region i in country e to region j in country u, were obtained by the combination of estimated trade prices $\hat{P}_{i.}^{eugR}$ (or $\hat{P}_{.j}^{eugR}$ for imports, being u=*Spain*) and actual *freight flows* in tons, F_{ij}^{eugR}, delivered by Spanish trucks. Note that if *e*= *Spain*, equation [5] will capture Spanish exports to regions in our sample of 11 European countries, while if *u*= *Spain* it will capture Spanish imports from them. In both cases just the goods transported by Spanish trucks are considered. Due to the characteristic of our road flow dataset, we exclude flows where a Spanish island-region is a partner (I=15 for Spain). After the final screening, the region-to-region dataset includes bilateral exports and imports of the Spanish regions against the regions (Nuts 2) of 11 European countries[1], disaggregated by G=24 manufacturing products (the list of countries and products is reported in the Annex).

<< Table 1 about here >>

One of the great potentials of this dataset is that it could be directly connected with the same type of intra and interregional trade flows within Spain (Llano et al, 2009; Ghemawat et al., 2010). Thus, the dataset obtained get closed to what Fujita et al (1999) described as *"the seamless world paradigm"*, where trade flows are analysed almost in a *continuous space framework*.

3.2. Other data.

Regarding the distance variable, we use the mean *actual distance* covered by the Spanish trucks in the operations between each pair of trading regions. This data is also reported by the SPSCTR. This variable has the virtuosity of capturing the *real distance* travelled by trucks between actual origins and destinations, and is superior to the one used by other authors where the intra-national or the inter-national (or both) distances were based on a priori estimates based on the great circle distance between the main cities weighted by their population. In theory, with our actual distance, we will be able to take into consideration region-to-region links between countries that are not directly explained by the GDP or the population (market potential), but also by specific regional links induced by social and business networks or upstream-downstream inter-sectorial relations. These links could be driven by specific factor endowments (first geography, historical accident…) rather than by the simplest accumulation of population and economic activity. In addition, the survey also

[1] Note that although the paper refers to the EU, the sample of countries considered do not specifically fulfil any administrative category, and indeed include countries like Switzerland or Andorra, considered in this paper as single-region countries.

includes the actual distance travelled by trucks on intraregional deliveries. This fact allow us to avoid the critical issue of choosing alternative ad hoc intraregional distance, which indeed affect the results on border effects (Head and Mayer, 2002).

Finally, we built a dataset covering the main indicators available for the European regions (GDP, Population, Employment, etc.). This dataset was built upon the existing information published by the Eurostat at the Nuts 2 level for the selected countries.

3. Results

3.2. A descriptive analyses

Before proceeding to the econometric analysis of the dataset, it is convenient to briefly analyse the new dataset obtained, as well as its most novel spatial dimension, namely, the region-to-region breakdown of international flows.

The first goal will be to test to what extend the dataset obtained is coherent with the official trade statistics. This comparison should be set at the common level of disaggregation for both sources, that is, the usual breakdown for product (*g*)-region (*i, j*)-country (*e, u*), both for volumes (Tons) and monetary values (Euros).

With this aim, **Table 2** shows the correlation coefficients obtained for the comparison, *vis a vis*, of different pairs of equivalent vectors containing international trade flows, considering 8 possible categories: both for outflows and inflows of the 15 Spanish regions considered here (Nuts 2, except the islands), we compare the vectors of aggregate volumes ($\sum_g Q_{ijt}^{eugR}$; $\sum_g F_{ijt}^{eugR}$), the ones for aggregate monetary flows ($\sum_g T_{ijt}^{eugR}$; $\sum_g \hat{T}_{ijt}^{eugR}$), as well as the commodity specific flows in quantities (Q_{ijt}^{eugR}; F_{ijt}^{eugR}) and in current euros (T_{ijt}^{eugR}; $\hat{T}_{ijt}^{eugR}$). Note that in all cases, the vectors contain bilateral flows for 4 consecutive years (2004-2007). In order to make this point clearer, every vector that includes flows for all the years appears with the *t* suffix.

<< Table 2 about here >>

The results in **Table 2** show high levels of correlation between all pairs of vectors, both for imports and exports, and for the two possible units of measurement (Tons and Euros). In general, the highest coefficients are observed in outflows when comparing quantities. The smaller coefficients found in the monetary flows are explained by the difficulty of measuring "aggregated prices for products (*g)*" departing from disaggregated variety unit-values (*k*). However, the high and significant correlation coefficients found also in these cases, indicate a good performance of the methodology used for estimating such price vectors, as well as the effectiveness of the filters proposed for eliminating outliers.

Next, we want to identify the main interregional aggregated flows, together with the interregional domestic Spanish flows. Thus, we will emphasize, in the line of other papers (Ghemawat et al, 2010; Llano et al, 2010; Hewings et al, 1998), the relevance of domestic trade in absolute terms.

Before doing that, it is important to highlight that there is a classic discussion around what should be considered as the *"main flows"*. To this regard, the literature has defined location and specialisation coefficients, export and import concentration indexes, etc. For the sake of briefness, we will define a comprehensive index based on the one suggested by Streit (1969), which offer a condense measure of the bilateral intensity of trade between any two pair of regions. This index was computed using aggregate flows pooling the observations for all the period. For clarity, the scripts for products (*g*) and time (*t*) are not included in equation (11).

$$ST^{eu}_{ijAverage(2004-07)} = \frac{1}{4}\left[\frac{\hat{T}_{ij}}{\sum_{i=1}\hat{T}_{ij}} + \frac{\hat{T}_{ij}}{\sum_{j=1}\hat{T}_{ij}} + \frac{\hat{T}_{ji}}{\sum_{j=1}\hat{T}_{ji}} + \frac{\hat{T}_{ji}}{\sum_{i=1}\hat{T}_{ji}}\right] \qquad [6]$$

<< Figure 1 about here >>

Here, it is worth mentioning the novelty of the maps plotted in **Figure 1**, as well as the interesting spatial patterns *discovered* by the new region-to-region dimension of our dataset. For conciseness, we just show three panels representing the spatial distribution of total flows (exports+impots) of three important trading regions in Spain, whose trading landscapes show indeed strong differences. First of all, it is important to highlight clear differences in the degree of spatial concentration of the trading partners (and the relative intensities) of the two border regions chosen (Cataluña and País Vasco) faced to the capital region (Madrid), which is located in the very centre of the country. To this regard, the spatial concentration of Cataluña's trade with the European regions located along the Mediterranean axis (within France and Italy), as well as the strong concentration of Basque flows in the regions located along the Cantabric Coast-Axis (in France), seems to be mainly conditioned by the "accessibility". By contrast, the lower level of spatial concentration observed in Madrid's international trade (but not in the interregional within Spain), points out to alternative drivers, such as intra-firm trade, or more complex logistics connections associated with the role of multinationals or intermediate products. Note that despite this hypothesis, some other factor could explain such different pattern: for example, one may want to consider a higher relevance of the "airplane transport mode" for exports/imports departing from Madrid region compared to the other two regions (Gallego and Llano, 2011), with higher road accessibility with regards to the EU countries. Another potential explanation could be connected with the presence of intra-firm trade, which is more likely to occur between capital regions in Europe (i.e. an stronger allocation of multinationals in the capital cities in sectors such as retail, drugs or edition, could induce larger concentrations of trade flows between Madrid-Paris-Lisbon-Brussels-Berlin-Rome…, than with less remote regions).

In addition, following some recent works (Hillberry and Hummels, 2008; Minondo et al, 2011), we offer here a first view of the distribution of trade depending on the distance travelled by the trucks, both in the domestic and international deliveries (always considering the region-to-region dimension). Like them, we use a kernel regression to provide a nonparametric estimate of the relationship between distance and the intensity of the Spanish regional trade flows[2]. One novelty of our approach is the capacity of plotting in the same graph the kernel distribution of the consecutive years. By doing that, we will have a first intuition on the Spanish trade propensity with further locations. This measure will be also a first insight on the dynamic evolution of the border effect between the Spanish regions and the regions located in the 11 European countries considered in our sample.

[2] We use the Gaussian kernel estimator in STATA, calculated on n=100 points, and allowing the estimator to calculate the optimal bandwidth.

<< **Figure 2 about here** >>

Figure 2 plots the distribution of domestic and international flows (exports+imports) for each region against the rest of the regions within Spain and the 11 European countries considered. Note that the trade flows are corrected by the GDPs of each exporting/importing flow. Therefore, the kernel distribution on the "corrected trade" on "the actual distance travelled by the Spanish trucks" is close to plotting a gravity equation. It is also worth mentioning that, even when intra-regional trade flows are not included, the highest concentration of the trade flows (in current monetary units) for each year occurs in the shortest distance, observing a downward shape of the intensity in the first 700 km. This result is in line with the results obtained in previous papers (Llano et al., 2011), which also analysed all the Spanish flows (domestic and international), but considering all the flows (and not just the deliveries by Spanish trucks) but did not have the region-to-region breakdown.

3.3. The econometric analyses

In this section we analyse the results obtained for each one of the specifications described in section 2.2 and the novel dataset described above. As said, the goal is re-estimating the internal and external border effect for the Spanish case at the regional level (Nuts 2) as regards to equivalent regions located in 11 European countries.

Following other papers (Anderson and van Winkoop, 2003; Feenstra 2002, 2004), in order to get a first point of reference, we replicate McCallum's simplest model, by estimating our equation [1] in a cross section context for year 2006. Before doing that, it is important to remark some important difference between our dataset and the one used by these authors:

1) our sample accounts for intraregional trade flows and intraregional distance for the Spanish regions, while the dataset used by McCallum do not;
2) our distance[3] variable measures the actual distance travelled by the trucks in their deliveries of commodities for the intra-national and inter-national flows. On the

[3]Despite of the fact we could calculate the average distance per pair in an annually frequency, we would rather do an average of the distances for each pair of partner in all the period (2004:2007). We do that to get a better

contrary, the distance used by McCallum –and the papers published hereafter- was the linear distance between the main cities in each province and state, or weighted ;

3) in our sample we consider 11 different "national-borders", two of them are between Spain and two contiguous countries (France and Portugal). By contrast, McCallum, and all the subsequent articles replicating his work with similar datasets, just considered 1 "international border", that is, the one between Canada and the United States.

In addition to this basic specification, we also report the results for the extended model described in equation [2], where, also for a cross section sample (2006), some additionally effects are considered. In this case, the two contiguity dummies as well as the "regional border effect" are considered.

<< Table 4 about here >>

Table 3 shows the results obtained for different versions of equation [1] and equation [2]. The results shown in columns (1) and (2) correspond to the equation [1] when just intra-national trade flows for Spain are considered alone. These specifications are equivalent to the reference exercise conducted by other authors (McCallum, 1995; Anderson and van Winkoop, 2003; Feenstra, 2004) considering interregional trade for Canada or for the US separately. This choice is also coherent with the strongest relevance of the dataset used (based on shipments by Spanish trucks) for the internal trade flows rather than for the international deliveries. Focusing on the results, it is worth mentioning that all the coefficients are significant and have he expected signs. The coefficients obtained for the gdp´s are smaller than one, a fact that contrasts with the results obtained by McCallum, who obtained values larger than one. The coefficient obtained for the distance variable in column (1), which is the most similar specification to the McCallum´s one, is -1.3, which is close to McCallum's value (-1.52).

We now focus on the results in column (2), where the *regional border effect* has been added. For this specification, the coefficient for the distance variable is slightly smaller (-1.06) than in the first specification. The positive and significant coefficient obtained for variable

---

measure of the distances when there are few observations for some partner, and there is not any inconvenient or relevant advantage to have a variant distance.

Reg_Border suggests that on average, in 2006, a Spanish region trades 3.5 times (exp(1.26)=3.52) more with itself than with another Spanish region.

Columns (3) and (4) also correspond to equation [1], which has been applied in this case to the inter-national trade flows between the 15 Spanish regions and the regions of the 11 European countries considered, for the year 2006. The results in column (3)[4] reports the estimates obtained when the national border effect (*Nat_Border*) is included alone. Now, the coefficients for the rest of the variables (gdp's and distance) are also significant and coherent with theory, but capturing an important reduction in their absolute values: the coefficient for distance decrease to -0.902 while the ones for the GDP's fall to 0.512 for the exporting region and to 0.604 for the importing one. The coefficient obtained for the *Nat_Border* variable is significant and positive, with a value that suggest that, on average, a Spanish region trades 15 times more with another region in the country [exp(2.71)=15.0] than with another region from the 11 European countries considered in the sample, once that the size of the regions and the distance between them are controlled for. In order to have a point of reference from other articles, it is interesting to compare this ratio (15) with the (22) obtained by McCallum using 1988 data for Canada and the US. Note also that the negative coefficient obtained by McCallum for the distance is higher (-1.42) than ours (-0.9). This difference could be also related to the way in which both distances were measured.

Although this results have to be taken into account carefully due to all the remarkable differences between datasets and the geographical areas considered, it is important to emphasize that according to them, the level of integration (at least when imports and exports are considered together) between the Spanish regions and the main European countries is very high, since the border effect appears to be even lower than the one obtained for Canada and the US in 1988, two contiguous countries with very little differences in terms of language, culture and history.

The results in column (4) corresponds to the same equation than the ones in column (3), but including the regional border effect (*Reg_Border*). The inclusion of this variable hardly

[4] We have included alternative specifications in order to deal with the likely econometric problems. We have employed the instrumented logarithm of PPS GDP of the origin and destination regions using the logarithm of the population of the origin and destination region, respectively. Also we have used the population variable as proxy of size instead of the PPS GDPs. The results are very similar to the original specification, for that they are not reported.

change the coefficient associated to the *national border*, however it produces new decreases in the coefficients of the other variables. For instance, the distance went down from -0.9 to -0.74. In conclusion, the regional border matters, as does the national border. For this specification it is estimated that a Spanish region tends to trade -on average- 8 times more [exp(2.13)=8.4] with itself than whit another region (in Spain or in the rest of the 11 European countries), after controlling for the GDP and for the distance, but without controlling for any kind of adjacency effect.

The results in column (5) correspond to equation [2], which includes the contiguity variables. Focusing on the parameter of the national border (2.7), this shows a similar magnitude in comparison to the estimates obtained for the previous specifications. However, the distance coefficient has reduced its size down to -0.481. The *regional border effect* is 3.27, suggesting that –on average- a Spanish region trades 26 times [exp(3.27)=26.3] more with itself than with another non-congituous region, after controlling for the economic size and distance. Relative to the contiguity effect, the event of sharing a border has a positive effect on the trade. The coefficient obtained for *Home_contig* suggests that the trade between two adjacent Spanish regions is 4.7 times [exp(1.56)=4.75] larger than between any non-contiguous regions in the sample. Similarly, the coefficient obtained for *Foreign_contig* suggests that the intensity of trade between a Spanish border-region with a contiguous border-region in another country (France or Portugal) is 3.8 times [exp(1.33)=3.78] larger than with another non-adjacent region. In conclusion, the enhancing effect for Spanish regions of being contiguous of another Spanish region is slightly larger than being a border-region with France or Portugal. This result suggests that international borders exert higher impedance to trade than internal borders.

<< Table 4 about here >>

Table 4 show the results obtained for equation [3], where the dataset is fully explored, considering the whole period (2004-2007). In this occasion we try to measure the regional and national border effect in a larger sample controlling by the year fixed effects, by the origin/destination country fixed effects and finally by origin/destination region fixed effect (*multilateral resistance terms*).

Column (6) contains the estimate for the pooled data, regardless of any individual or temporary fixed effect. The significant levels and signs obtained for all the coefficients are in line with the expected ones, and the ones obtained for the specification (5), which only considered one year (2006).

By the introduction of time fixed effects we want to correct for possible bias motivated by the omission of some relevant variables occurred during the period, which affect the intensity of trade in all the regions. Column (7) shows the results of this specification, whose coefficients are similar to the ones obtained for the pooled data. The coefficients associated with temporary variables are statistically significant but with low economic relevance. The explanatory power of the model does not vary too much.

Columns (8-11) correspond to the specifications that take into account the multilateral resistance terms. In that sense, according to Anderson and van Winkoop (2003) and Feenstra (2002, 2004) they are the only ones that avoids the bias induced by the omission of variables capturing the competing effect of non-observable prices in the whole system. Columns (8) and (9) include a dummy by origin-country and other by destination-country. By doing so, we intend to capture the effect of prices (multilateral resistance) at the spatial level that is usually considered in other articles. The only difference between the specifications (8) and (9) is that the later includes the temporary effects. However, the coefficients are very similar in both specifications. The explanatory power of these two estimates is slightly larger (around 62 per cent) than the two previous ones. With regard to the *Nat_Border* variable, the national border effect has decreased down from a value of 2.63 in column (7) to a value of 1.97 [exp (1.97) = 7.17] in columns (8) and (9). This value suggests that a Spanish region trades around 7 times more with another Spanish region than with another European region. Also for specification (8), the coefficient obtained for the internal border effect (*Reg_Border)*, suggests that a typical Spanish region trades 29 times [exp (3.376) = 29.253] more with itself than with any other region in the sample.

Columns (10) and (11) count with the same variables than the previous two, but they include fixed effects for each origin and destination region, in this way we consider the effect on differences in prices at the regional level rather than at the country level. In contrast to the previous results, there is a significant change in the coefficient of *Nat_Border* with the introduction of the year fixed effect, while distance and the contiguity variables remain almost invariant. Note that thanks to the variability of the GDPs over the period we can have these variables in our model, while it should be removed for a cross section estimate. We have a low, positive and significant value associated to the national border effect in the specification (10), which indicates that when the multilateral resistance terms are considered the coefficient for *Nat_Border* decrease down to 1.12. This value suggests that a Spanish region trades roughly 3 times more [exp(1.12)= 3.06] with a non-adjacent Spanish region than with a non-adjacent European region. Another strange result from this specification is that the coefficient for the gdp of the exporting region becomes negative and non-significant. These results clearly contrast with the previous ones, and require further investigation. Finally, regarding the results for specification (11), which also considers the multilateral resistance terms at the regional level as well as the time fixed effects, we obtain a very large national border of 3.09, which suggest that a Spanish region trades 36 times [exp(3.6)=36.59] more with a non-adjacent Spanish region than with a non-adjacent European region, other things equal. With regard to the regional border effect, the coefficient obtained for *Reg_Border* (3.09), indicates that a Spanish region trades 22 times [exp(3.09)=21.97] more with itself than with any other non-adjacent region, ceteris paribus. Regarding the contiguity variable *Home_Contig* (adjacency between Spanish regions) we also obtain a positive sign and a significant value, somewhat lower than the estimates from column (9) and (10). This parameter suggests that trade between two adjacent Spanish regions is 169% [exp (0.99)-1=1.69] larger than between non-contiguous regions. In relation to *Foreign_Contig*, the coefficient is also positive and significant, with a value of 1.008, which indicates that a Spanish border-region trades 172% [exp(1.00)-1=1.72] more with an international contiguous region (from France or Portugal) than with a non-adjacent one. In this regression distance has a negative and significant value – 0.51, quite similar to the pool specification (6) and the time fixed effect specification (7).

Putting all these results together, it is worthy to compare them not just with the results obtained for US and Canada (using equivalent region-to-region flows) but also to previous estimates for the Spanish case (using region-to-country flows). For example, in Requena and Llano (2010), the internal and external border effect was computed in a pooled sample (1995 and 2000). The datasets used by them was clearly different, since it includes all the transport modes and several checking's with official data on trade and production, which indeed affect the value of the intraregional/interregional trade flows within the country[5]. Like in our paper, Requena and Llano (2010) found that the *internal border effect* is larger than the *external border effect*. They found that, for the *internal border effect*, a typical Spanish region trades with itself about 17 (30 for manufactures) times more than with other non-adjacent Spanish region. For the *external border effect*, they found that, ceteris paribus, a typical Spanish region trade with another non-adjacent Spanish region 13 (10 for manufactures) times more than with a non-adjacent country. The value for the external border found by Requena and Llano (2010) (13 in general, and 10 for manufactures) is higher than the one obtained in our closest specification (8), where it accounts for an external border of 7. However, it is worth mentioning that in the former paper, the external trade was computed between each region-against the Rest of the Country-against 24 OCDE countries, while in the current paper it is computes for each region-against each Spanish region (region-to-region) and against the regions of 11 European countries. Therefore, it seems plausible that the external border effect decreases for the Spanish regions, when just the closest countries (European versus OCDE), the region-to-region dimension (versus region to country), and the preferred transport mode for shortest distance (road versus all), is just considered in our current sample. Also taking into account all the singularities of both datasets, it is also interesting to consider their results for the *internal border effect* and to compare them with the ones shown in our specification (8). They found an internal border effect of 17 (30 for manufactures) while we obtained another of 29. Since our sample excludes products included in categories 9 and 24 (energy and miscellaneous), it can be argued that the industry composition of our dataset is somewhere in between the “all products” and the “just manufactures” estimates obtained by Requena and Llano (2010). This point of reference suggests that our new results are different than the ones based on more aggregated data, but are also consistent with the general trends observed before.

4. Conclusions

This work pretends to quantify the national and the regional border effects in Spain, taking into account the intra-national and the inter-national trade at the regional level (NUTS 2), using a region-to-region trade dataset for Spain against 11 European countries. Until now

[5] Helliwell (1996), Wolf (2000), Hillberry and Hummels (2003), Millimet and Osang (2007) and Combes et al. (2005) find an internal border effect between 2 and 6 in Canada, USA and France. Djankov and Freund (2000), Poncet (2003) and Daumal and Zignago (2008) find an internal border effect between 11 and 20 in ex-former USSR, China and Brazil.

the lack of information of inter-regional flows, both inside of a country and with the regions of foreign countries, has hampered the estimation of the "border effect" in the pristine way, as it was obtained for Canada and the US by McCallum (1995) or Anderson and van Winkoop (2003). Until now, in Europe, the national border effect has been just computed using country-to-country or region-to-country flows, what can suppose a loss of relevant information due to the aggregation and the use of non-spatial-homogeneous-units. Also the way in which the distance has been computed, both for intraregional trade, and as regards to the region-to-country dyads, could also introduce bias on previous estimates of the border effect.

In this paper we have exploited a dataset that considers interregional trade flows shipped by Spanish trucks, which includes intra-national and inter-national flows (Llano and Gallego, 2011). This dataset also considers the distance associated with the shipment of the flows. Departing from this novel dataset we have estimated some classical specifications of the gravity model, found in the literature for computing the national border between Canada and the US, where province-to-state data was available. In addition, due to our richer dataset, we were also able to compute the internal border effect for the Spanish regions and to control for different levels of national and regional contiguity effects, as well as for time varying effects.

Our estimate for the cross-section McCallum's basic specification, suggests that on average a Spanish region trades 15 times more with another Spanish region than with a region from the 11 European countries considered. This value is smaller than the one obtained by McCallum (22) for the interregional trade between Canadian provinces and US states. Then, the border effect is computed again using more reined specifications (Anderson and van Wincoop, 2003) and using panel data (2004-2007) and time and origin/destination fixed effects. The results obtained suggest that when we include the origin country and destination country fixed effects, we get lower values for the national border effect. These results changes drastically when we control for the regional multilateral resistance, with the use of fixed effect for origin/destination regions, obtaining a very large national border effect of about 36 times. Due to the large variability of the results obtained with different specifications, more research is needed on this issue.

Based on these first results (this version should be considered as a first draft) we expect to analyse more in detail the variability of the results depending on the specifications used, covering the following issues:

- As a robust check, the region-to-region dataset will be aggregated to the typical region-to-country layout. Then we will replicate the specifications used in other papers for the Spanish case (Gil et al, 2005; Requena and Llano, 2010; Llano et al, 2011). This exercise will give as a flavour of what part of our results for the national border effect are explained by the new dataset (region-to-region dimension) or by difference in the type of data used (the fact of not considering all the trade flows but just the shipments by Spanish trucks; the countries included as partners; the period chosen).
- As a robust check, we will analyse the same dataset but considering the "zero" flows (Poisson or Tobit specifications), alternative specifications and the possibility of "selection bias in the sample".
- We expect to explore the evolution of the border effect in time, in general, and for some selected countries.

Future extensions of this paper will explore the difference in the performance of the border effect for each Spanish region, and type of flow (exports versus imports). Another natural extension will come from exploring the industry specific border effect, as well as its behaviour when lower spatial units are considered (Nuts 3). Thus, in line with other papers (Llano et al, 2011), we will be able to analyse in detail if the distance decade has a linear/exponential relationship with the volume of trade, as well as on the two components, intensive and extensive margins, considered by Hillbery and Hummels (2008).

5. References

Anderson, J.E. and Van Wincoop, E. (2003). "Gravity with Gravitas: A Solution to the Border Puzzle", *American Economic Review*, **93**, 1, 170-192.

Anderson, M., and S. Simth (1999). Do National Borders Really matter? Canada-US Regionat Trade Reconsidered. *Review of International Economics* 7 (2): 219-227.

Chen, N. (2004). "Intra-National Versus International Trade in the European Union: Why Do National Borders Matter?", *Journal of International Economics*, **63**, 1, 93-118.

Combes, P. P., Lafourcade, M. and Mayer, T. (2005) "The trade-creating effects of business and social networks: evidence from France", *Journal of International Economics*, **66**: 1–29.

Daumal M, Zignago S (2008) Border effects of Brazilian states. Working Papers 2008-11, CEPII Research Center

Deardorff AV (1998). "Determinants of bilateral trade: does gravity work in a neoclassic world?" In
J. Frankel JA (ed) *The Regionalization of the World Eeconomy*. University of Chicago Press, Chicago

Djankov S, Freund C (2000). “Disintegration and trade flows: evidence from the Former Soviet Union”, Policy Research Working Paper Series 2378. *The World Bank*

Eichengreen, B. and Irwin, D. (1998). “The Role of History in Bilateral Trade Flows”, in Frankel, J. (ed.), *The Regionalizatrion of the World Economy*, University of Chicago Press, Chicago.

Evans, C.L. (2003). "The Economic Significance of National Border Effects", *American Economic Review*, **93**, 4, 1291-1312.

Feenstra R (2002). “Border effect and the gravity equation: consistent methods for estimation”, *Scottish Journal of Political Economy*, 49(5), 1021–1035

Fujita M., Krugman P., Venables AJ. (1999). “The spatial economy”, The MIT Press, Cambridge, MA

Gallego N. and Llano C. (2011). “Towards a region-to-region international trade database for the EU: methodology of estimation and first results for the Spanish case”, Working paper. Paper presented in the NARSC 2011. Miami.

Ghemawat, P., Llano. C., Requena, F., (2010). “Competitiveness and interregional as well as and international trade: The case of Catalonia”, *International Journal of Industrial Organization* 28 (2010) 415–422

Gil-Pareja, S., Llorca-Vivero, R., Martínez Serrano J.A. and Oliver-Alonso, J. (2005). "The Border Effect in Spain", *The World Economy*, **28**, 11, 1617-1631.

Gorodnichenko, Y. and Tesar, L. (2009). "Border effect or country effect? Seattle may not be sor far from Vancouver after all", *American Economic Journal: Macroeconomics*, **1**, 1, 219-241.

Head, K. and Mayer, T. (2000). "Non-Europe: the causes and magnitudes of market fragmentation in the EU", *WeltwirtschaftlichesArchiv*, **136**, 2, 285-314.

Head, K. and Mayer, T. (2002). "Illusory Border Effects: Distance mismeasurement inflates estimates of home bias in trade", *CEPII Working Paper 2002-01*.

Heinemeyer, H., Chulze, M.-H. and Wolf, N. (2008), “Endogenous Borders? The Effects of New Borders on Trade in Central Europe 1885-1933”, CESifo Working Paper No. 2246

Helble (2007). “Border Effect Estimates for France and Germany”, *Review of World Economics*, Vol. 143 (3)

Helliwell, JF (1996). “Do national borders matter for Quebec’s trade?”, *Canadian Journal of Economics*, 29(3), 507–522.

Helliwell, JF (1997). “National Borders, Trade and Migration”, *Pacific Economic Review* 3 (3): 507-522

Helliwell JF (1998). “How much do national borders matter?” *Brookings Institution Press, Washington, DC.*

Helliwell JF, Verdier G (2001) Measuring internal trade distances: a new method applied to estimate provincial border effects in Canada. *Canadian Journal of Economics,* 35(3):517–530.

Helliwell, J.F. and Verdier, G. (2001). "Measuring internal trade distances: a new method applied to estimate provincial border effects in Canada", *Canadian Journal of Economics*, **34**, 4, 1024-1041.

Helpman, E., Melitz, M and Rubinstein, Y. (2008). "Estimating Trade Flows: Trading Partners and Trading Volumes", *Quarterly Journal of Economics*, **123**, 2, 441-487.

Hillberry, RH (1998). “Regional Trade and “the Medicine Line”: The National Border Effect in US Commodity Flow Data”, *Journal of Borderland Studies* 13: 1-17.

Hillberry, RH (2002). “Aggregation bias compositional change, and the border effect”, *Canadian Journal of Economics,* **35**(3), 517–530.

Hillberry RH, Hummels D (2003). “Intranational home bias: some explanations”, *Review of Economics and Statistics*, **85**(4), 1089–1092.

Hillberry RH, Hummels D (2008). “Trade responses to geographic frictions: a decomposition using microdata”, *European Economic Review*, **52**(3), 527–550.

Hillberry, R. and Hummels, D. (2003). “Intra-National Home Bias: Some Explanations”, *The Review of Economics and Statistics,* **85**, 4, 1089-1092

Hillberry, R. and Hummels, D. (2008). “Trade responses to geographic frictions: A decomposition using micro-data", *European Economic Review*, **52**, 3, 527-550.

Lafourcade M., Paluzie E. (2008). “European Integration, FDI and the Internal Geography of Trade: Evidence from Western European Border Regions”. DOCUMENTS DE TREBALL DE LA FACULTAT DE CIÈNCIES ECONÒMIQUES I EMPRESARIALS. Col·lecció d’Economia

Lafourcade, Miren and Paluzie, Elisenda(2011) “European Integration, Foreign Direct Investment (FDI), and the Geography of French Trade”, *Regional Studies*, **45**: 4, 419 — 439.

Llano-Verduras C.; Minondo A., Requena-Silvente F. (2011). “Is the Border Effect an Artefact of Geographical Aggregation?” *The World Economy*, 34, 10, 1771–1787.

McCallum, J. (1995). “National Borders Matter: Canada-U.S. Regional Trade Patterns”, *American Economic Review*, **85**, 3, 615-623.

Millimet D, Osang Th (2007). “Do state borders matter for U.S. intranational trade? The role of history and internal migration”, *Canadian Journal of Economics*, **40**(1):93–126

Minondo A. (2207). “The disappearance of the border barrier in some European Union countries’ bilateral trade”, *Applied Economics*, **39**, 119-124.

Nitsch, V. (2002). “Border effects and border regions: lessons from the German unification”. Banakgesellschaft, Berlin.

Nitsch, V. (2000). "National borders and international trade: evidence from the European Union", *Canadian Journal of Economics*, **33**, 4, 1091-1105.

Nitsch, V. and Wolf, N. (2009). "Tear down this wall: on the persistence of borders in trade", *CEPR Working Paper 7545*.

Obstfeld, M. and Rogoff, K. (2000). “The Six Major Puzzles in International Macroeconomics. Is there a Common Cause?”, *NBER Working Paper 7777*, National Bureau of Economic Research, Cambridge, MA.

Okubo, T., (2004) “The border effect in the Japanese market: a gravity model analysis". *Japan International Economics*, **18**:1–11

Poncet, S., (2003). “Measuring Chinese domestic and international integration”, *China Economic Review*, **14**(1):1–21.

Shultze, M.S. and N. Wolf (2008), “On the origins of border effects: insights from the Habsburg Empire”, *Journal of Economic Geography*, 1-20.

Silva, J. and Tenreyro, S. (2006). "The log of gravity", *Review of Economics and Statistics*, **88**, 4, 641-658.

Wei, S. (1996). "Intra-National Versus International Trade: How Stubborn are Nations in Global Integration?", *NBER Working Paper 5531*.

Wolf, H.C. (1997). “Patterns of Intra- and Inter-State Trade. NBER Working Paper 5939. National Bureau of Economic Research, Cambridge, Mass.

Wolf, H.C. (2000). "Intranational home bias in trade", *Review of Economics and Statistics*, **82**, 4, 555-563.

Yi, Kei-Mu (2009). "Can Multi-Stage Production Explain the Border Effect", *American Economic Reveiw*, forthcoming.

TABLES

Table 1. Selected papers on External Border Effect for North America, OCDE, Europe and Spain, classified by the type of data and the spatial unit considered.

Papers	Countries	Sectoral analysis	Time period considered	External Border Effect
		Region-to-Region		
1995. McCallum	Canada-United State	No	1988	22
1996. Helliwell	Canada-United State	No	1988-1990	22
1998. Hillbery	Canada-United State	No	1993	20
2002 Head & Mayer	United State (Wolf, 1997,2000)	Yes	1997	11
		Country-to-Country		
1996. Wei	OCDE	No	1982-1994	10-2.6
1997 Helliwell	OCDE	No	1996	13
2000 $Nitsch_a$	EU-10	No	1979-1990 1983-1990	7-10
2000 Head & Mayer	EU-9 EU-12	Yes Yes	1976-1995 1993-1995	30-11 4.2
2004. Chen	EU-7	Yes	1996	6
		Region-to-country		
1999. Anderson & Smith	Canada-United State	No		12
2005. Gil et al.	Spain (17 regions), Rest of Spain(*) and OECD-27	No	1995-1998	21
2003. Minondo	País Vasco, Rest of Spain(*), 201 countries	No	1993-1999	20-26
2007. Helble	France, EU-14 Germany, EU-14	No	2002	8 3
2010.Requena &Llano	Spain (17 regions) OECD-28	No Yes	1995 & 2000	13 4-156
2010. Ghemawat et al.	Cataluña, Rest of Spain(*), OECD	Yes	1995-2006	55
2011. Llano et al.	Spain (17 regions; 50 Provinces, OECD)	No	2000 & 2005	55

(*) Rest of Spain is considering as a country. This term considers the total export of one Spanish region to the rest of the Spanish region. This kind of aggregation of the regional export is elaborated to measure the external border region-to-country with other countries.

Table 2. Correlation between pairs of vectors on international trade.
Region to country level (Nuts 2-1). Flows in volume and monetary units. 2004 - 2007

Trade (AEAT) vs Freight (EPTMC)	Units	EXPORT	IMPORT
$\sum_g T_{ijt}^{eugR}$; $\sum_g \hat{T}_{ijt}^{eugR}$	Euros	0.8868*	0.8066*
T_{ijt}^{eugR} ; $\hat{T}_{ijt}^{eugR}$	Euros	0.7667*	0.6984*
$\sum_G Q_{ijt}^{eugR}$; $\sum_G F_{ijt}^{eugR}$	Tons	0.9243*	0.9147*
Q_{ijt}^{eugR} ; F_{ijt}^{eugR}	Tons	0.9243*	0.7390*

* Significance at the 1 -percent level.
Countries included: AD, BE, CH, DE, DK, FR, IT, LU, NL,PT and UK.
All the Spanish regions but: ES63 (Ceuta), ES64 (Melilla) y ES70 (Canarias)

Table 3: Estimations based on the Gravity Equations [1] and [2].

Region-to-region trade flows Period: 2006

	INTRA-NATIONAL		INTRA AND INTER-NATIONAL		
Variables / Specifications	(1)	(2)	(3)	(4)	(5)
$Ln(Y_i)$	0.699[a]	0.682[a]	0.512[a]	0.498[a]	0.485[a]
	(0.071)	(0.072)	(0.042)	(0.040)	(0.038)
$Ln(Y_j)$	0.929[a]	0.906[a]	0.604[a]	0.591[a]	0.578[a]
	(0.082)	(0.078)	(0.037)	(0.036)	(0.036)
$Ln(dist_{ij})$	-1.305[a]	-1.061[a]	-0.902[a]	-0.746[a]	-0.481[a]
	(0.092)	(0.179)	(0.092)	(0.102)	(0.112)
Nat_Border			2.717[a]	2.779[a]	2.707[a]
			(0.148)	(0.146)	(0.140)
Reg_Border		1.267[b]		2.138[a]	3.270[a]
		(0.556)		(0.327)	(0.384)
Home_Contig					1.560[a]
					(0.172)
Foreign_Contig					1.332[a]
					(0.319)
Observations	249	249	1,652	1,652	1,652
R-squared	0.626	0.630	0.598	0.607	0.626

Robust standard errors are given in parentheses. ; [a] denotes significance at 1% level, [b] at 5% level and [c] at 10%. GDP is measured in term of Purchasing Power Standard.
Columns (1) and (2) show the results for equation [1], only for the exporting flows with origin and destination in Spain. The rest of the specifications consider the intra-national trade as well as the international trade (exports + imports) with the regions of the 11 European countries.

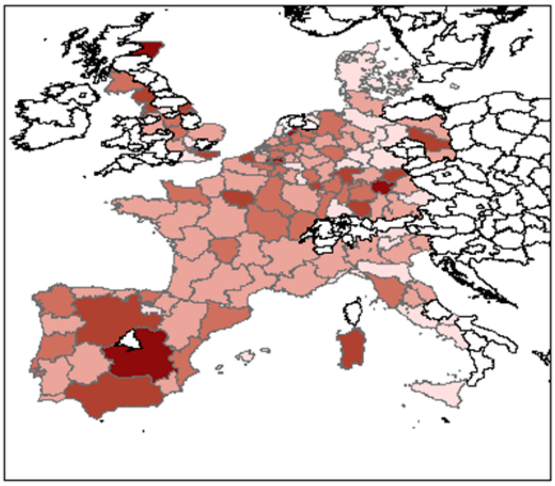
Table 4. Estimations of the Gravity Equations [3]. Period: 2004-2007

Variables/Specifications	(6)	(7)	(8)	(9)	(10)	(11)
$Ln(Y_i)$	0.520[a]	0.516[a]	0.530[a]	0.525[a]	-0.131	1.825[b]
	(0.018)	(0.019)	(0.018)	(0.018)	(0.390)	(0.807)
Ln(Yj)	0.562[a]	0.561[a]	0.571[a]	0.565[a]	1.730[a]	3.563[a]
	(0.018)	(0.018)	(0.019)	(0.019)	(0.409)	(0.761)
$Ln(dist_{ij})$	-0.506[a]	-0.502[a]	-0.451[a]	-0.449[a]	-0.511[a]	-0.512[a]
	(0.056)	(0.056)	(0.062)	(0.062)	(0.074)	(0.0740)
Nat_Border	2.633[a]	2.634[a]	1.972[a]	1.970[a]	1.123[c]	3.604[a]
	(0.070)	(0.070)	(0.362)	(0.359)	(0.631)	(1.062)
Reg_Border	3.186[a]	3.199[a]	3.376[a]	3.332[a]	3.095[a]	3.093[a]
	(0.198)	(0.197)	(0.219)	(0.218)	(0.314)	(0.313)
Home_Contig	1.470[a]	1.474[a]	1.555[a]	1.552[a]	0.998[a]	0.996[a]
	(0.091)	(0.090)	(0.098)	(0.098)	(0.102)	(0.102)
Foreign_Contig	1.077[a]	1.080[a]	1.161[a]	1.162[a]	1.009[a]	1.008[a]
	(0.163)	(0.163)	(0.149)	(0.149)	(0.133)	(0.134)
2004		-0.148[a]		-0.153[a]		0.715[a]
		(0.044)		(0.048)		(0.269)
2005		-0.135[a]		-0.134[a]		0.485[b]
		(0.043)		(0.042)		(0.193)
2006		-0.195[a]		-0.188[a]		0.125
		(0.041)		(0.041)		(0.097)
Fixed by year	no	yes	no	yes	no	yes
Fixed by o/d_country	no	no	yes	yes	no	no
Fixed by o/d region	no	no	no	no	yes	yes
Observations	6,345	6,345	6,345	6,345	6,345	6,345
Adjusted R-squared	0.605	0.606	0.618	0.620	0.690	0.691

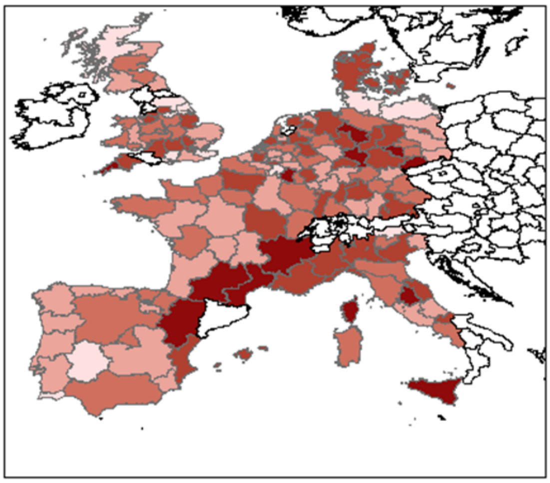
Robust standard errors are given in parentheses. ; [a]denotes significance at 1% level, [b] at 5% level and [c] at level 10%.
GDP is measured in term of Purchasing Power Standard

FIGURES

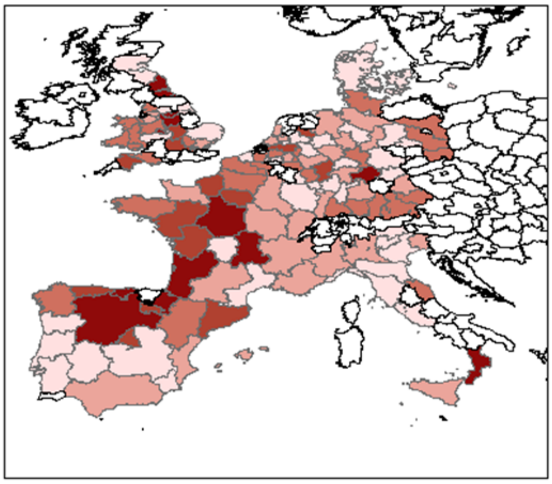
Figure 1: Main intra-national and inter-national trade flows from selected regions by road (€). Streit Index. Average flows for period 2004-07.



Madrid region



Cataluña



País Vasco

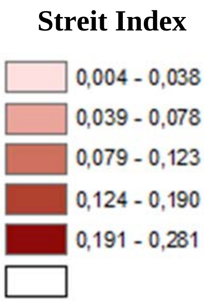
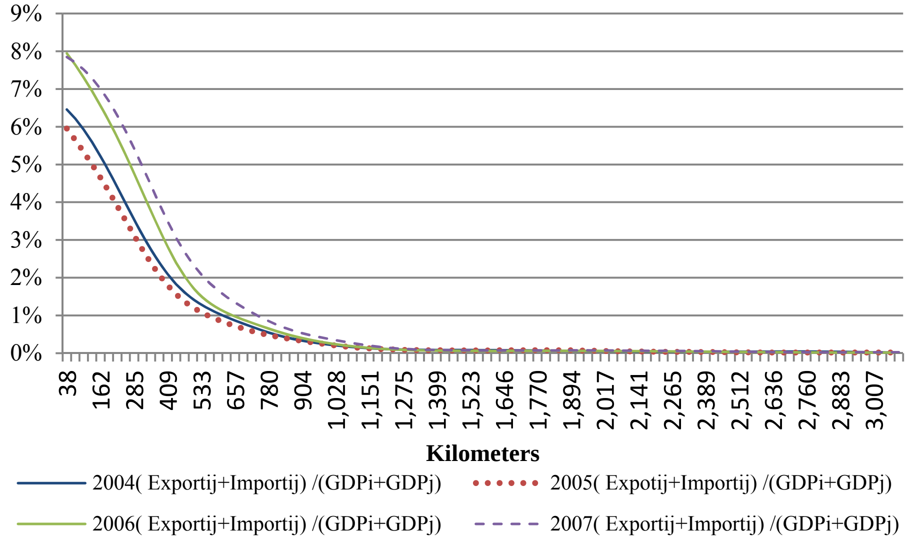


Figure 2: Kernel regression: Intra-national & Inter-national trade relative to the GDP (NUTS-2 region-to-region) on distance. Intra-regional trade excluded. Euros. 2004-07.



ANNEX

Table 4: Countries and regions included in the sample. 2004 to 2007.

Countries	NUTS 0
Andorra	AD
Belgium	BE
Switzerland	CH
Germany	DE
Denmark	DK
Spain	ES
France	FR
Italy	IT
Luxembourg	LU
Netherland	NL
Portugal	PT
United Kingdom	UK

Spanish Regions	NUTS 2
Andalucía	ES61
Aragón	ES24
Asturias	ES12
Baleares	ES53
Canarias	ES70
Cantabria	ES13
Castilla y León	ES41
Castilla La Mancha	ES42
Cataluña	ES51
Comunidad Valenciana	ES52
Extremadura	ES43
Galicia	ES11
Comunidad de Madrid	ES30
Región de Murcia	ES62
Navarra	ES22
País Vasco	ES21
La Rioja	ES23

Table 5: Products (G) included in the sample. Based on the NST classification.

Code	Descripcion	Code	Descripcion
1	Cereals	16	Natural or manufactured fertilizers
2	Potatoes, other fresh vegetables or freezed, fresh fruit.	17	Coal chemicals, tar
3	Live animals, sugar beets	18	Chemicals, except Coal chemicals and tar
4	Wood and cork	19	Pulp and waste
5	Textiles and residuals, other raw materials of animal or vegetable origin	20	Vehicles and transport equipment, machinery, engines, whether or not assembled and parts
6	Food and fodder	21	Metalware
7	Oil	22	Glass, glassware, ceramic products
8	Solid mineral fuels	23	Leather, textiles, clothing, miscellaneous manufactured articles
9	Crude oil	24	Various ítems
10	Petroleum products		
11	Iron ore, scrap, blast furnace dust		
12	Minerals and non-ferrous residuals		
13	Iron products		
14	Cement, lime, manufactured building materials		
15	Raw or manufactured minerals		

Sourse: Permanent Survey on Road Transport of Good, Ministerio de Fomento.