Is the border effect an artefact of geographic aggregation?

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Abstract

The existence of a large border effect is considered as one of the main puzzles of international macroeconomics. We show that the border puzzle is an artefact of geographic concentration. In order to do so we combine international shipments with intra-national shipments data characterised by a high geographic grid. At this fine grid, intra-national shipments are highly localised and dropping sharply with distance. The use of a small geographical unit of reference to measure intra-national bilateral trade flows allows to estimating correctly the negative impact of distance on shipments. When we use sector disaggregated export flows of 50 Spanish provinces in year 2005 exhaustively split into inter-provincial and inter-national flows, we find that Spanish provinces trade as much with other countries as they do with other distant Spanish provinces; that is, there is no border effect. The results are robust to changes in the geographic unit of reference and to the level of industry aggregation.

JEL Codes: F14, F15
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1. Introduction

Since McCallum's (1995) seminal paper, a large body of literature has tried to explain why countries trade much more with themselves than with other partners. The notoriety of border effect is such that it has been argued to be “one of the six major puzzles in international macroeconomics” (Obstfeld and Rogoff, 2000). Researchers have followed different routes in order to solve the border puzzle. Firstly, some authors (Rauch, 2001; Combes et al., 2005) argue that it is reasonable to find large border effects, because information barriers increase gently the costs of doing business between partners that do not share nationality. Other authors point out that if there is a large elasticity of substitution between domestic and foreign goods, even small differences in costs may lead to large home-bias effects (Evans, 2003: Head and Reis, 2001). Anderson and van Wincoop (2003), contend that large border effects arise due to a misspecification of the gravity model used in the econometric analyses. Evans (2006) and Chaney (2008) argue that firm heterogeneity underlies the effect, while Rossi-Hansberg (2005) considers that intermediate goods and endogenous firm location may help to magnify initial small trade frictions along national borders. Yi (2009) also stresses the magnification effects due to vertical specialization. While each of these studies has managed to reduce the impact on the border effect, the puzzle remains unsolved and appears to been persistent across space and time (Eichengreen and Irwin, 1998; Schultz and Wolf, 2008).

A closely related literature has focused on intra-national border effects. Recent work by Hillberry and Hummels (2008) shows that most shipments in the US travel very short distances. In particular, shipments within 5-digit zip codes, which have a median radius of just 4 miles, are three times larger than shipments outside the zip codes. This pattern puts into question previous studies, such as Wolf (2000) and Hillberry and Hummels (2003), which conclude that US states trade *much* more with themselves than with other states. As Hillberry and Hummels (2008) show, once it is taken into account that the value of shipments within a state also falls sharply with distance, there is no need of an intra-national home bias to explain why states trade more with themselves than with other states. While the findings are suggestive it is far from clear that such findings relating to intra-national trade will necessarily translate to an international context. Indeed, a number of the mechanisms developed since McCallum seminal paper that are summarised above are predicated on the existence of national differences or greater preferences for domestically produced goods.

The contribution of our paper is to test whether the border effect puzzle can be explained as an artefact of aggregation. For that purpose we use a unique database that reports the value of Spanish small geographical units (provinces) shipments to other small geographical units and to other countries in year 2005. Previous research by Gil et al. (2005) use trade flows between Spanish large geographical units (regions) to the rest of Spain and to other countries over the period 1995-1998. They found that Spanish regions traded 20 times more with the rest of Spain than they did with other foreign countries, a result in line with McCallum´s work on Canada. We show that the Spanish border effect shrinks or even disappears once we allow data to show the high geographic concentration of intra-national shipments.[1] We also show that the result does not depend on the size of the exporting partner (region or province) or the level of aggregation of the trade flows; the result is driven by the size of the own country´s trading partners (rest of Spain, regions and provinces). These results are in line with recent research, such as Gorodnichenko and Tesar (2009), that have put into question the too large border effects found by previous studies.

The rest of the paper is organised as follows. Section 2 analyses the geographical concentration of shipments in Spain. Section 3 presents the empirical model and Section 4 the main results of the econometric analyses. The final section summarises the main conclusions of our paper.

2. The geographical concentration of shipments

To analyse the border effect in Spain we use a new database, *C-Intereg*, that combines fine grid intra-national shipments data with international shipments data (Llano, 2008a, 2008b).[2] It

[1] Head and Mayer (2002) also argue that the border effect may arise due to an overstatement of internal distances. However, contrary to our paper, they do not have data on intra-national shipments.

[2] The C-intereg database (see www.c-intereg.es) combines the most accurate data on Spanish transport flows of goods by transport modes (road, rail, ship, plane, pipe and electric network) with additional information used to estimate specific export price vectors, province of origin, transport mode and type of product . The methodology also includes a process for correcting problems in the original transport flows database that arise from multi-modal transport flows and international transit flows hidden in the interregional flows. After this first screening process, an initial estimate of interregional trade flows in tons and current euros is obtained, based on a combination of transport magnitudes and price information. Finally, a process of harmonization is applied to produce flows magnitudes in tons and euros that are consistent with total output magnitudes from the Spanish Industrial Survey, the National Accounts and the international trade figures from Customs. This final process of harmonization allows offering international trade flows with origin (destination) in any of the Spanish provinces and destination (origin) in any country of the world, compatible with the internal trade estimates and the official

offers the value of total shipments from Spanish provinces (Eurostat NUTS III) to other Spanish provinces and to 24 OECD countries, disaggregated by 13 manufacturing industries, in year 2005.[3] Spain is divided into 50 provinces, the smallest administrative units; their average area is similar to an US 3-digit zip code.[4]

We use a kernel regression estimator to provide a nonparametric estimate of the relationship between distance and the value of Spanish intra-national and international shipments.[5] As can be seen in Figure 1, there is a sharp reduction in the value of shipments with distance: from a maximum of 34,000 thousand Euros at very short distances the average value falls to 1,477 thousand Euros when distance rises to 2,700 kilometres. Between 2,700 kilometres and 5,300 kilometres there is no effect of distance on the average value of shipments. Finally, the average value rises in the 5,300-10,000 kilometres range, which is a surprising finding at first sight. However, this strange pattern is explained by the mix composition of countries included in this distance range: Australia, Korea, Japan, Mexico and the USA. Despite the larger distance, Spain exports a large volume of goods to the US (due to the size of its market) and to Mexico (due to cultural links) leading to a positive relationship between the value of shipments and trade in this distance range. In fact, when we exclude Mexico and the US from the sample, the kernel regression (Figure 1b) gives a smoother relationship between the value of shipments and distance.

It is important to highlight the fact that the fall in trade as distance rises happens for both intra-national and international shipments. In particular, the intra-national shipments are encompassed in the 54-1,203 kilometres range, a segment in which we also observe a sharp negative relationship between the value of shipments and distance. In order to confirm the negative relationship between value and distance for intra-national shipments, Figure 2 estimates the kernel regression only with intra-national shipments data. The figure confirms

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output figures at the provincial and the sector level. This procedure brings the trade flows to a position close to the paradigm of trade in continuous space.

[3] The OECD countries are Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Sweden, the United Kingdom and the United States. The industries are Food, beverages and tobacco; Textiles; Leather and footwear; Wood; Paper, printing and publishing; Chemicals; Rubber and plastics; Other non-metallic minerals; Basic and fabricated metals; Machinery; Electrical and Optical Equipment; Transport equipment; Other manufacturing.

[4] The average area of a US 3-digit zip code is 13763 square kilometres and the average area of a Spanish province is 10116 square kilometres (excluding Ceuta and Melilla, two autonomous city-provinces in Africa).

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

that the value of intra-national shipments also drops with distance. We can see, as well, that the slope of the curve is not constant throughout the range. As was mentioned before, other factors, such as provinces' GDP, may influence this relationship.[6]

The kernel regressions show that at the intra-national level the value of shipments is highly localised. As a result of that, if we aggregate geographically the Spanish intra-national shipments and do not take into account their localised pattern, we may overstate the distance travelled by goods sold in the domestic market. This overstatement may lead, in turn, to create an artificial border effect. In particular, if distance (and other controls for trade impediments) cannot explain why Spanish firms sell more goods in the domestic market than in foreign markets, then the border effect will be capturing these differences. The next section examines this possibility.

3. Empirical model

We estimate the border effect using a gravity model. The estimating equation takes the following form:

$$\begin{aligned} \ln X_{ijk} &= \beta_0 + \beta_1 Border + \beta_2 \ln Y_{ik} + \beta_3 \ln Y_j + \beta_4 \ln \text{distance}_{ij} \\ &\quad + \beta_5 \text{Contiguity}_{ij} + \beta_6 EUEFTA_{ij} + \beta_7 \text{wv}_k + P_{i,k} + P_{j,k} \end{aligned} \qquad (1)$$

where X_{ijk} are exports from province i to a trading partner j of industry k goods. *Border* is a dummy variable that takes the value of 1 if the shipment is intra-national and zero if the shipment is international; Y_{ik} is production of industry k in province i (source: INE); Y_j denotes trading partner's GDP (source: WDI-online); *dist* denotes distance between territories (source: see footnote)[7]. The nature of other trade impediments is captured using a dummy

[6] For example, Barcelona, the Spanish province with the second highest GDP, due to its geographical position is relatively distant from other provinces. However, even when this province is distant from others it will receive a large volume of intra-national shipments due to its economic importance.

[7] For inter-provincial flows and exports to continental Europe distance refers to the actual average distance travelled by heavy trucks. For non-continental European countries we use great circle distances, which are calculated as follows. First, we transform the latitude φ j and the longitude λ into radians (x π /360). Second, the formula used to calculate the distance between the pair of cities is $\Delta_{ij} \equiv \lambda_j - \lambda_i$, $d_{ij} = \arccos\lfloor \sin\varphi_i \sin\varphi_j + \cos\varphi_i \cos\varphi_j \cos\Delta_{ij} \rfloor z$, with z= 6367 for km. Third, we calculate the population-weighted average distance between the cities of the trading partners using the same formula

variable, *Contiguity*, that takes values of one if the Spanish exporting province is adjacent to a country, zero otherwise, and a dummy variable *EUEFTA* that takes value of one if trading partners belong to the EU25 or EFTA, zero otherwise. The variable wv_k is the ratio between weight in tons and value in Euros of exports in industry k, averaged across all trading partners, introduced to take into account differences in transport costs across industries (source: C-intereg). Following Anderson and van Wincoop (2003), in order to control for multilateral resistances, we include two industry-country and industry-province fixed effects (P_i^k, P_j^k). Finally, due to the existence of zeros in our database, as in Eichengreen and Irwin (1998) and Chen (2004), we express the dependent variable as (1+Ln X_{ijk}) and estimate the model by a Tobit procedure. [8]

The definition of a Spanish trading partner plays a key role in our exercise. While the number of international trading partners will be constant and equal to 24 countries in all the estimations, the size of the Spanish trading partners will change. We will estimate Eq. (1) using three samples. In the first sample, we aggregate all Spanish trading partners in one, the rest of Spain, so each exporting province has 25 trading partners (25 OECD countries, included the rest of Spain). This is the same level of geographical aggregation used by Gil et al (2005) in the period 1995-1998. We call this sample "SPAIN". Our second sample consider the 17 Spanish regions as trading partners, so an exporting province located in a multi-province region has 40 trading partners (16 regions and 24 OECD countries). We call that sample "REGION". In the third sample we use the smallest geographic unit that we have as Spanish trading partner, 50 provinces. In this sample, that we call "PROVINCE", an exporting province has 73 trading partners (49 provinces and 24 OECD countries). Notice that the construction of the variable *distance* (and also the variable *adjacency*) changes as we choose different definitions of Spanish trading partner. We expect a narrow definition of Spanish trading partners to control adequately for the fact that intra-national shipments are highly localised. Trading with large partners will tend to upward bias the border effect since the border effect will be capturing part of the non-linear relationship between distance and shipments.

$D_{r,r'} = \sum_{i \in r} w_i \left(\sum_{j \in r'} w_j d_{ij} \right)$, $w_i = pop_i / pop_r$. Latitude and longitude data were obtained from www.infoplease.com and city populations was obtained from www.citypopulation.de.

[8] We use the McDonald and Moffitt (1980) procedure to recover the elasticity at sample means.

4. Main Results

Table 1 reports the results of estimating Eq (1) using the three samples based on the definition of Spanish trading partner. The first two columns use the sample SPAIN. The first regression estimates the basic gravity model, which includes only exporter's production, importer's GDP, distance and the border dummy as explanatory variables. When we aggregate intra-national shipments as the rest of Spain, the coefficient associated to the border effect in the basic gravity model is 1.89; that is, a Spanish province trades around 6.7 times more with the rest of Spain than with other countries. The second regression estimates the augmented gravity model, by adding extra control variables: contiguity between the Spanish province and a country, common membership of a regional trade agreement (EU or EFTA) and industry-specific weight-to-value variable. In the sample SPAIN the variable EUEFTA takes the value of one for intra-national shipments. Hence, the border effect measures how many times a Spanish province trades more with the rest of Spain than with another country which belongs to the European Union or to EFTA. The border coefficient of the augmented model is similar to that estimated with the basic model: 1.92. In both regressions the coefficient on other independent variables has the expected sign: positive for economic size of trading partners (exporter's production and importer's GDP) and forces that enhance trade (adjacency and membership of EU or EFTA); on the other hand, negative for physical distance between partners and for products whose weight-to-value is large. All coefficients, except for contiguity, are statistically significant.

The next two columns (3)-(4) present the results of estimating Eq. (1) using the sample REGIONS (Spanish provinces having regions as Spanish trading partners). Again, for a correct interpretation of the border coefficients, it is important to remember that the dummy EUEFTA takes the value of one for all intra-national shipments. In both specifications the border coefficients are statistically significant and equal to 1.02 and 0.85, respectively. The first thing that we notice is that the magnitude of the border effect is smaller than the one obtained using the sample SPAIN. According to the result of the basic model, Spanish provinces trade 2.8 times more with other Spanish regions than with other countries; according to the result of the augmented model, Spanish provinces trade 2.4 more with other Spanish regions that with EUEFTA countries. The coefficients of the other explanatory variables exhibit the expected sign; however neither Contiguity nor EUEFTA are statistically significant.

Next, we present the results of estimating Eq. (1) using the sample PROVINCES, that is, other provinces as a trading partners. Both in the basic and the augmented specification the border coefficient is positive but it is not statistically significant, suggesting the possibility that the border effect is zero. The coefficients of the other explanatory variables, except for Contiguity and EUEFTA, exhibit the expected sign and are statistically significant. Hence, we can conclude that the border effect tend to become smaller, and even may disappear, when the definition of Spanish trading partner changes from a highly aggregated geographical unit (Rest of Spain) to a much smaller units such as regions or provinces. These results point out that the border effect is an artifact of the geographic aggregation of intra-national shipments, and stems from an overstatement of the distance travelled by goods sold domestically.

Table 2 reports the industry-specific border coefficients for 13 manufacturing sectors. For any of the three samples, SPAIN (column 1), REGIONS (column 2) or PROVINCES (column 3), there are large differences in the border coefficients across industries. If we focus on the first sample (SPAIN - Column 1), we can observe that while four sectors report very large border effects (non-metallic mineral products, paper & print, chemical products and metallic products), there are five sectors with no border effect (textile & apparel, leather & shoes, electric & electronic products, transport equipment and other manufactures). In addition, the border coefficients tend to become smaller as we use smaller geographic units to define Spanish trading partners, supporting our hypothesis that intra-national trade is very geographically concentrated so distant provinces tend to trade with each other as much as distant provinces and countries.

Robustness analyses

We perform different sensitivity analyses in order to test the robustness of our results. The first robustness test uses aggregated export flows in order to check whether our results are driven by the use of industry-level disaggregated data. In order to control for disaggregation, in this analysis the number of sectors is reduced from 13 to 1. As can be seen in Table 3, the sample SPAIN (Columns 1 and 2) reports very large border coefficients: 13.6 and 14.1 in the basic and the augmented specification, respectively. We interpret these results cautiously since the distance coefficient, although negative, is not statistically significant; in addition to that, we obtain a very large EUEFTA coefficient.[9] Using the sample REGIONS in columns 3

[9] Even when we drop the border variable the coefficient on distance remains statistically not significant.

and 4, which allows capturing better the geographical concentration of exports, the border coefficients become much more smaller (3.15 and 2.71 in the basic and augmented specification, respectively), and are statistically significant. Finally, using the sample PROVINCES in column 5 (basic model) we obtain a border coefficient that is not statistically different from zero, while in column 6 (augmented model) the border coefficient is statistically different from zero and equal to 1.58; that is, regions trade 4.95 times more with each other than with another EUEFTA country. The findings are consistent with those provided in Table 1 and point out that our conclusions are not driven by the use of industry-disaggregated data.

In the second exercise we test whether our results are robust to changes in the exporting geographic unit. In the new sample, instead of provinces, we select regions as the exporting geographic unit; in this sample, the number of geographic units is reduced from 50 to 17. As shown in Table 4, when we use the sample SPAIN (columns 1 -2), the border coefficient is 4.19 in the basic specification and 4.32 in the augmented specification, suggesting that regions trade around 66-75 times more with the rest of Spain than with another country. This is ten times larger than the border effect obtained when we use a smaller geographic unit of origin (provinces) in Table 1, column 1. If regions, other things being equal, trade more with closer regions than with distant regions, we should expect a larger border effect when we analyse exports of a region to the rest of Spain than when we do so using exports from one region to another region. When we use the sample REGIONS (columns 4 and 5) the border effect is positive and statistically significant but, as expected, the magnitude decreases: a Spanish region trades 8 times more with another Spanish region than with a country that belong to the EUEFTA. We also estimate industry-specific border coefficients using regions as geographic unit for the exporters. Column (3) reports the 13 border coefficients for the sample REST OF SPAIN. The range of variation is quite small compared to the border coefficients obtained in Table 2. Here the border coefficients vary between 2.44 for leather & shoes and 5.76 for paper & print products. When we use the sample REGIONS (column 6) all border coefficients become smaller, and in three industries the border coefficients are not statistically different from zero (textile & apparel, leather & shoes and mechanical machinery). Therefore, the border effect also falls when we use a more aggregated geographical unit. However, such a reduction in the border effect is not as large compared to the sample that uses provinces as geographic unit of reference.

In the third exercise, in order to control for a non-linear relationship between exports and distance, we perform a B-spline transformation of this latter variable. Based on the sample PROVINCES, we determine two knots, percentile 33 and percentile 66, in order to distribute the distance observations in three segments. Then, we use a B-spline square function to transform the distance observation in its B-spline components. As in previous analysis, the border coefficients is reduced when we move from a more aggregated partner sample to a less aggregated partner sample (Table 5)[10]. Nevertheless, the border coefficients are larger than those presented in Table 1.

As our sample encompasses countries that are relatively close to Spain (EUEFTA countries) with countries that are relatively far from Spain (Australia, Japan, Korea, Mexico and United States), we analyse whether our results are robust to a more homogeneous sample in terms of distance. In particular we restrict the sample to continental EU+EFTA countries. Within this sample distance refers to the actual average distance travelled by heavy trucks. As shown in Table 6, our results hold: as we disaggregate partners, the border effect is reduced and, even, becomes statistically not different from zero.

Finally, we perform a last exercise in order to check whether our dataset is different from the one used by Gil-Pareja et al. (2005) in estimating the border effect in Spain. They used data on total shipments, not only manufactures, from Spanish regions to the rest of Spain and to 26 OECD countries over the period 1995-1998. They used random effects model rather than fixed effects to estimate the gravity equation in Eq (1). We use our database to estimate the border effect for Spain, using the same Spanish trading partner (the rest of Spain), the same period and the same gravity specification. Our border estimate is equal to 2.58, which is almost equal to 2.61, the one reported by Gil-Pareja et al. (2005).

5. Conclusions

During the last decades a large number of studies have tried to explain why countries trade more with themselves than with other countries. We show that the border effect in Spain is an artefact of geographical aggregation. Based on a geographic fine grid data, we find that intra-

[10] We obtain similar results if, as in Hillberry and Hummels (2008), we introduce distance and the square of distance as independent variables.

national shipments are highly localised, with value dropping sharply with distance. If intra-national shipments data are aggregated this localised pattern is lost, which leads to an overestimation of the distance travelled by goods sold domestically and to the creation of an artificial border effect. Our econometric estimations confirm this fact. While a sizable border effect exists for Spain when intra-national data are aggregated, the border effect shrinks or disappears when we allow data to show the localised nature of intra-national shipments.

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.

Chaney, T. (2008). "Distorted Gravity: The Intensive and Extensive Margins of International Trade", *American Economic Review*, 98(4), 1707-1721.

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.

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.

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

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.

Llano, C. (2004). “The interregional trade in the context of a multirregional input-output model for Spain”, *Estudios de Economía Aplicada*, **22**, 3, 539-576.

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

McDonald, J.F. and Moffitt, R.A. (1980). “The Uses of Tobit Analysis”, *The Review of Economics and Statistics*, **62**, 2, 318-321.

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.

Rauch, J.E. (2001). “Business and Social Networks in International Trade”, *Journal of Economic Literature*, **39**, 4, 1177-1203.

Rossi-Hansberg, E. (2005). “A Spatial Theory of Trade”. *American Economic Review,* 95(5): 1464–1491.

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

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.

Figure 1a. Kernel regression: value on distance, year 2005

(intra-national and international shipments)

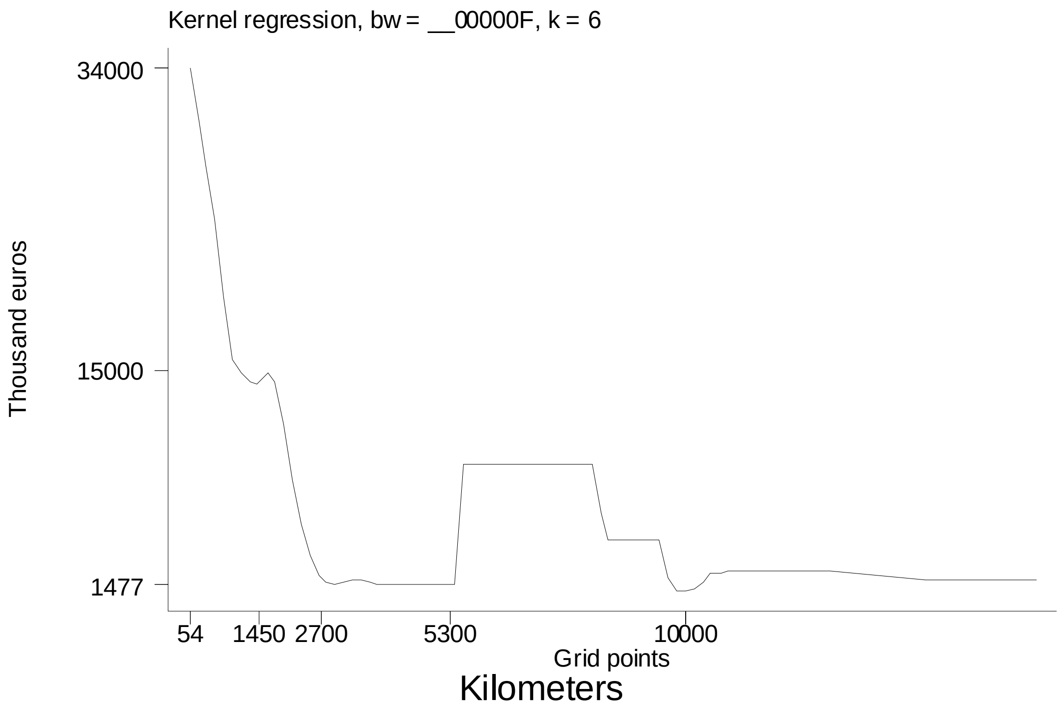

Figure 1b. Kernel regression: value on distance excluding USA and Mexico, year 2005

(intra-national and international shipments)

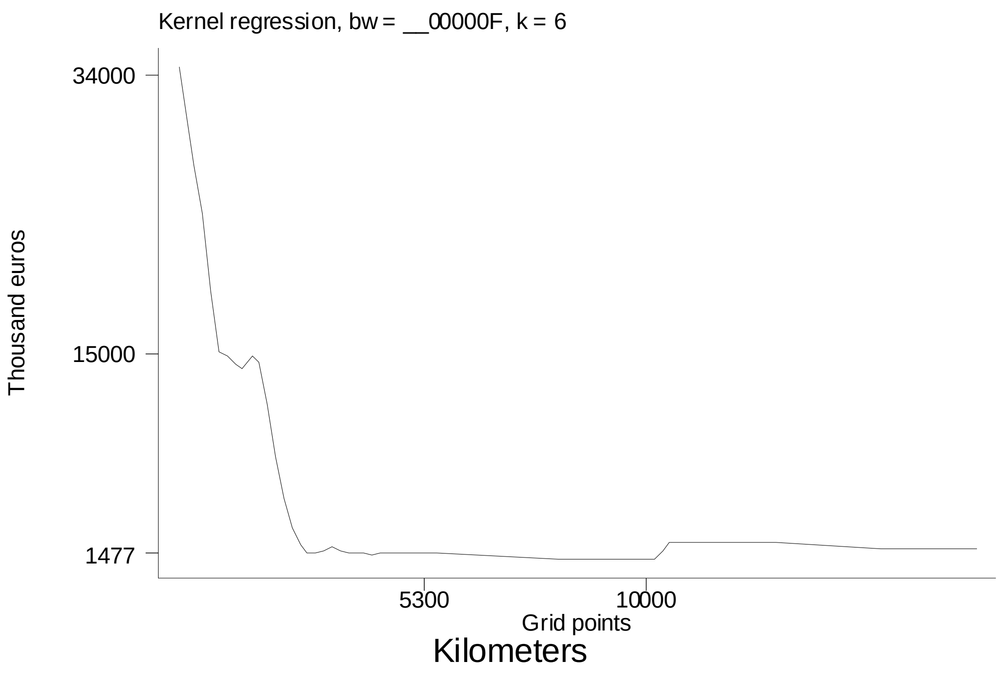

Figure 2. Kernel regression: value on distance (only intra-national shipments), year 2005

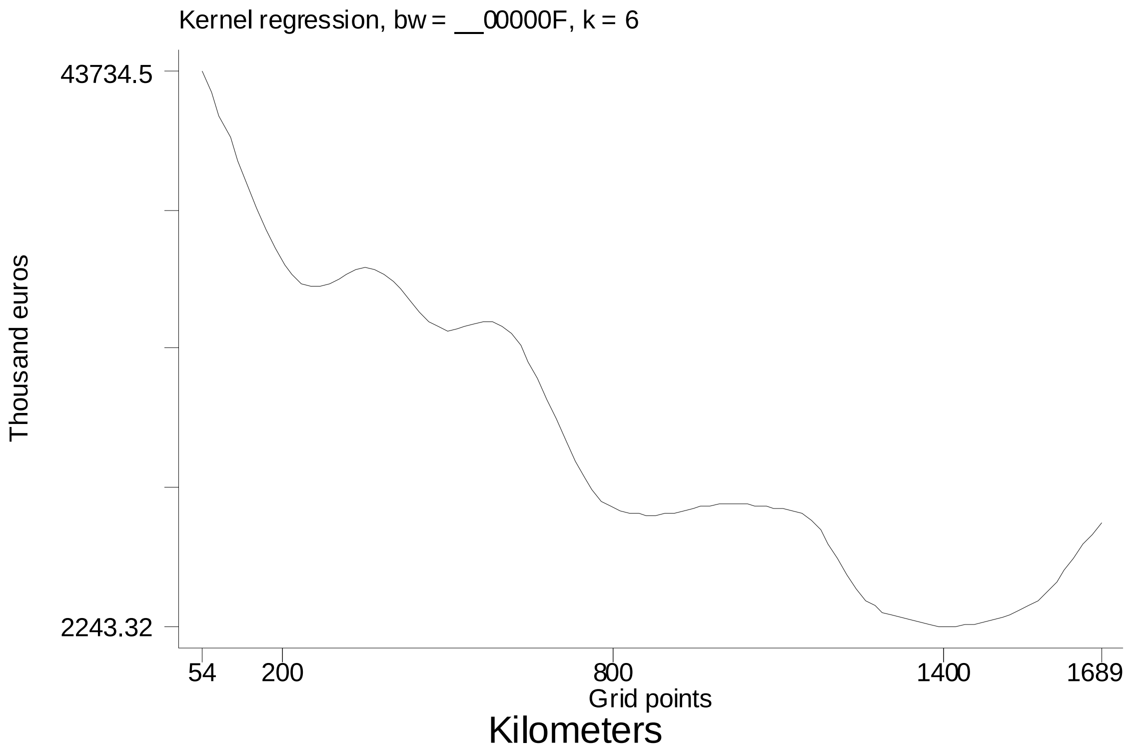

Table 1. Main results. Geographic unit of origin is province. Disaggregated export flows for 13 manufacturing industries. Year 2005.

	Sample REST OF SPAIN		Sample REGIONS		Sample PROVINCES	
	(1)	(2)	(3)	(4)	(5)	(6)
Origin						
Provinces	50	50	50	50	50	50
Destination						
Provinces	-	-	-	-	50	50
Regions	-	-	16	16	-	-
Rest of Spain	1	1	-	-	-	-
Countries	24	24	24	24	24	24
Sectors	13	13	13	13	13	13
Observations	16250	16250	26000	26000	47450	47450
Gross output ik	0.967 ***	1.117 ***	0.931 ***	0.932 ***	0.746 ***	0.766***
	(25.54)	(25.35)	(25.27)	(22.72)	(28.60)	(28.25)
GDP j	0.923 ***	0.991 ***	0.821 ***	0.837 ***	0.719 ***	0.714***
	(26.46)	(23.36)	(24.80)	(22.31)	(30.74)	(27.80)
Distance ij	-1.456 ***	-1.267 ***	-1.266 ***	-1.251 ***	-1.131 ***	-1.138***
	(26.72)	(14.96)	(35.00)	(30.85)	(64.89)	(63.06)
Contiguity ij		0.288		0.020		-0.256**
		(1.59)		(0.11)		(2.00)
EUEFTA ij		0.600 ***		0.151		-0.073
		(2.87)		(0.88)		(0.57)
Weight-to-value k		-0.954 ***		0.014		-0.293**
		(6.47)		(0.10)		(2.53)
Border	1.896 ***	1.916 ***	1.023 ***	0.853 ***	0.040	0.020
	(8.27)	(8.07)	(6.50)	(6.48)	(0.39)	(28.08)
Pseudo R2	0.300	0.301	0.196	0.197	0.193	0.193

Note: Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. Heterokedasticity-robust t-statistics in parenthesis with *** denoting significance at the 1-percent level and ** significance at the 5-percent level.

Table 2. Industry-specific border effect. Geographic unit of origin is province. Disaggregated export flows for 13 manufacturing industries. Year 2005.

	Sample REST OF SPAIN (1)		Sample REGIONS (2)		Sample PROVINCES (3)	
Origin						
Provinces	50		50		50	
Destination						
Provinces	-		-		50	
Regions	-		16		-	
Rest of Spain	1		-		-	
Countries	24		24		24	
Sectors	13		13		13	
Observations	16250		26000		47450	
Gross output ik	1.520	***	1.224	***	0.871	***
	(24.16)		(22.07)		(26.01)	
GDP j	1.002	***	0.847	***	0.709	***
	(23.66)		(21.57)		(27.56)	
Distance ij	-1.240	***	-1.251	***	-1.145	***
	(14.66)		(30.87)		(63.39)	
Contiguity ij	0.331	*	0.205		-0.263	**
	(1.83)		(0.14)		(2.07)	
EUEFTA ij	0.662	***	0.172		-0.092	
	(3.19)		(1.00)		(0.72)	
Weight-to-value k	-4.446	***	-3.704	***	-2.073	***
	(14.99)		(14.00)		(11.23)	
B_food & drinks	0.690	**	0.960	***	0.035	
	(2.17)		(6.18)		(0.33)	
B_textile & apparel	-1.785	***	-2.230	***	-1.661	***
	(4.30)		(6.48)		(5.18)	
B_leather & shoes	-0.705		-2.023	***	-0.472	
	(1.63)		(5.64)		(1.15)	
B_wood products	3.131	***	0.683		-1.210	***
	(5.14)		(1.21)		(3.53)	
B_paper & print	7.004	***	6.560	***	2.662	***
	(11.05)		(8.91)		(5.02)	
B_chemical products	5.983	***	5.762	***	2.808	***
	(9.25)		(7.96)		(5.22)	
B_plastic&rubber	1.110	**	-0.314		-1.005	***
	(2.23)		(0.72)		(3.44)	
B_nonmetal mineral	10.339	***	12.003	***	4.844	***
	(13.72)		(13.01)		(6.92)	
B_metal products	4.940	***	4.007	***	1.096	***
	(9.18)		(6.72)		(2.80)	
B_mechanical machinery	1.133	**	-2.156	***	-1.417	***
	(2.20)		(6.53)		(4.96)	
B_electric & electronic goods	-1.328	***	-2.093	***	-1.467	***
	(2.95)		(5.98)		(5.25)	
B_transport equipment	-0.138		-1.797	***	-1.513	***
	(0.28)		(5.01)		(5.72)	
B_Other manufactures	-1.130	**	-1.964	***	-1.856	***
	(2.54)		(5.75)		(7.25)	
Pseudo R2	0.303		0.198		0.194	

Note: Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. Heterokedasticity-robust t-statistics in parenthesis with *** denoting significance at the 1-percent level and ** significance at the 5-percent level.

Table 3. Robustness analysis. Aggregated export flows. Geographic unit of origin is province. Year 2005.

	Sample: REST OF SPAIN		Sample: REGION		Sample: PROVINCE	
	(1)	(2)	(3)	(4)	(5)	(6)
Origin						
Provinces	50	50	50	50	50	50
Destination						
Provinces	-	-	-	-	50	50
Regions	-	-	17	17	-	-
Rest of Spain	1	1	-	-	-	-
Countries	24	24	24	24	24	24
Sectors	1	1	1	1	1	1
Observations	1250	1250	2000	2000	3650	3650
Gross output i	1.496***	1.508***	1.564***	1.562***	1.758***	1.755***
	(7.23)	(7.29)	(19.10)	(19.07)	(17.85)	(17.82)
GDP j	11.611**	11.861**	0.863***	1.091***	1.032***	1.593***
	(2.25)	(2.30)	(15.12)	(14.34)	(11.62)	(12.86)
Distance ij	-0.232	-0.232	-1.301***	-1.317***	-2.395***	-2.411***
	(0.98)	(0.98)	(11.04)	(10.89)	(24.34)	(24.34)
Contiguity ij		0.797*		-0.310		-1.129
		(1.84)		(0.58)		(1.35)
EUEFTA ij		14.897***		-0.121		0.771
		(2.37)		(0.31)		(1.30)
Border	13.608***	14.093***	3.151***	2.705***	-0.127	1.584**
	(2.94)	(3.04)	(8.41)	(7.92)	(0.24)	(2.00)
Pseudo-R2	0.370	0.370	0.241	0.242	0.142	0.143

Note: Tobit estimations, sample mean elasticities. Origin and destination industry-specific fixed effects. ***, **, * denote significance at 1%, 5% and 10% levels. Robust t-statistics in parentheses.

Table 4. Robustness analysis. Geographic unit of origin is region. Disaggregated export flows for 13 manufacturing industries. Year 2005.

	Sample: REST OF SPAIN			Sample: REGIONS		
	(1)	(2)	(3)	(4)	(5)	(6)
Origin	-	-	-	-	-	-
Regions	17	17	17	17	17	17
Destination	-	-	-	-	-	-
Rest of Spain	1	1	1	-	-	-
Regions	-	-	-	17	17	17
Countries	24	24	24	24	24	24
Sectors	13	13	13	13	13	13
Observations	5525	5525	5525	8840	8840	8840
Gross output i	1.619***	1.668***	1.694***	1.719***	1.673***	1.744***
	(20.78)	(20.25)	(19.25)	(17.72)	(16.37)	(15.99)
GDP j	0.952***	1.070***	1.070***	1.097***	1.139***	1.064***
	(18.20)	(16.68)	(16.69)	(15.93)	(14.73)	(12.84)
Distance ij	-1.390***	-1.092***	-1.098***	-1.650***	-1.651***	-1.683***
	(16.44)	(7.92)	(7.98)	(21.64)	(19.50)	(19.70)
Contiguity ij		0.120	0.112		-0.440	-0.470*
		(0.59)	(0.55)		(1.60)	(1.71)
EUEFTA ij		1.058***	1.048***		0.321	0.120
		(3.13)	(3.10)		(0.89)	(0.33)
Weight-to-value		-0.235	-0.931***		0.358*	-0.641**
		(1.65)	(4.36)		(1.69)	(2.13)
Border	4.193***	4.315***		2.122***	2.158***	
	(19.49)	(18.56)		(8.58)	(8.48)	
B_food & drinks			3.747***			1.817***
			(8.91)			(5.97)
B_textile & apparel			3.463***			0.467
			(6.02)			(0.55)
B_leather & shoes			2.442***			-0.408
			(3.88)			(0.44)
B_wood products			4.535***			3.720***
			(8.32)			(4.54)
B_paper & print			5.763***			4.725***
			(10.84)			(5.86)
B_chemical products			4.815***			3.298***
			(9.10)			(4.10)
B_plastic&rubber			4.526***			2.564***
			(8.63)			(3.25)
B_nonmetal mineral			4.803***			2.802***
			(8.34)			(3.20)
B_metal products			4.980***			3.606***
			(9.67)			(4.61)
B_mechanical machinery			3.416***			-0.035
			(6.34)			(0.04)
B_electric & electronic goods			4.371***			3.051***
			(7.68)			(3.59)
B_transport equipment			3.275***			1.460*
			(6.23)			(1.87)
B_Other manufactures			3.777***			1.792**
			(6.95)			(2.22)
Pseudo R2	0.340	0.340	0.341	0.209	0.213	0.210

Note: Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. Heterokedasticity-robust t-statistics in parenthesis with *** denoting significance at the 1-percent level and ** significance at the 5-percent level.

Table 5. Robustness analysis. B-spline transformation of distance (Geographic unit of origin is province; Disaggregated export flows for 13 manufacturing industries. Year 2005).

	Sample REST OF SPAIN		Sample REGIONS		Sample PROVINCES	
	(1)	(2)	(3)	(4)	(5)	(6)
Origin						
Provinces	50	50	50	50	50	50
Destination						
Provinces	-	-	-	-	50	50
Regions	-	-	16	16	-	-
Rest of Spain	1	1	-	-	-	-
Countries	24	24	24	24	24	24
Sectors	13	13	13	13	13	13
Observations	16250	16250	26000	26000	47450	47450
Gross output ik	0.968 ***	1.116 ***	0.937 ***	0.944 ***	0.747 ***	0.768***
	(25.56)	(25.32)	(25.53)	(23.08)	(29.03)	(28.67)
GDP j	1.012 ***	1.013 ***	0.868 ***	0.904 ***	0.713 ***	0.750***
	(27.76)	(22.78)	(25.32)	(22.95)	(29.91)	(28.54)
Distance ij (000kms)	-14.532 ***	-17.823 ***	-16.639 ***	-16.583 ***	-19.219 ***	-14.040***
	(4.79)	(4.52)	(24.45)	(24.31)	(48.91)	(48.82)
Distance ij ^2 (000kms)	0.011 ***	0.014 ***	0.014 ***	0.014 ***	0.013 ***	0.012***
	(3.82)	(3.85)	(20.32)	(20.12)	(39.74)	(39.03)
Knot p33	-0.010 ***	-0.126 ***	-0.014 ***	-0.014 ***	-0.013 ***	-0.013***
	(3.26)	(3.43)	(17.94)	(17.58)	(34.57)	(33.35)
Knot p66	-0.001 ***	-0.002 ***	0.000	0.000	0.000 ***	0.000***
	(4.53)	(4.59)	(0.09)	(0.49)	(4.30)	(2.61)
Contiguity ij		-0.329		0.208		0.165
		(1.29)		(1.16)		(1.20)
EUEFTA ij		-0.008		0.622 *		0.761***
		(0.02)		(1.89)		(3.41)
Weight-to-value k		-0.954 ***		-0.013		-0.296***
		(6.47)		(0.09)		(2.58)
Border	1.974 ***	1.949 ***	1.602 ***	1.778 ***	0.817 ***	1.012***
	(8.27)	(8.07)	(12.02)	(11.34)	(8.10)	(8.76)
Pseudo R2	0.300	0.301	0.199	0.199	0.197	0.198

Note: Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. Heterokedasticity-robust t-statistics in parenthesis with *** denoting significance at the 1-percent level and ** significance at the 5-percent level.

Table 6. Robustness analysis. Continental Europe (Geographic unit of origin is province; Disaggregated export flows for 13 manufacturing industries. Year 2005).

	Sample REST OF SPAIN				Sample REGIONS				Sample PROVINCES			
	(1)		(2)		(3)		(4)		(5)		(6)	
Origin												
Provinces	50		50		50		50		50		50	
Destination												
Provinces	-		-		-		-		50		50	
Regions	-		-		16		16		-		-	
Rest of Spain	1		1		-		-		-		-	
Countries	17		17		17		17		17		17	
Sectors	13		13		13		13		13		13	
Observations	11700		11700		21450		21450		42900		42900	
Gross output ik	0.945	***	1.080	***	0.894	***	0.885	***	0.708	***	0.727	***
	(21.71)		(21.32)		(22.16)		(19.65)		(26.27)		(25.95)	
GDP j	1.151	***	1.163	***	0.903	***	0.903	***	0.764	***	0.765	***
	(22.23)		(22.32)		(20.63)		(20.63)		(27.30)		(27.33)	
Distance ij	-1.420	***	-1.342	***	-1.277	***	-1.278	***	-1.114	***	-1.120	***
	(18.44)		(14.80)		(31.18)		(30.16)		(62.16)		(61.84)	
Contiguity ij			0.287				-0.018				-0.266	**
			(1.55)				(0.10)				(2.12)	
Weight-to-value k			-0.852	***			0.069				-0.279	**
			(5.09)				(0.43)				(2.37)	
Border	1.106	***	1.221	***	0.811	***	0.810	***	0.177		0.168	
	(4.22)		(4.57)		(5.91)		(5.85)		(1.63)		(1.55)	
Pseudo R2	0.321		0.321		0.193		0.193		0.194		0.194	

Note: Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. Heterokedasticity-robust t-statistics in parenthesis with *** denoting significance at the 1-percent level and ** significance at the 5-percent level.