The border effects in Spain: an industry-level analysis

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Abstract

A gravity-model approach is used to estimate the magnitude of the internal border (home bias) and external border (frontier) effects in Spain using industry-level trade flows. We find that the average border effects are about 30 and 10, respectively. Next we explore the variation in the industry-specific border effects. First, the border effects are larger in highly product differentiated industries. Second, the internal border effect is twice bigger for trade in intermediate goods than for trade in final goods. Third, conditioning on the geographic concentration of firms reduces significantly the internal border effect. These results suggest that as the border effects arise endogenously their welfare consequences are minimal.

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1. Introduction

As global trade barriers are being steadily dismantled and economies are becoming increasingly integrated, one would expect national boundaries to have a diminishing effect on trade flows. Nevertheless, recent empirical research using data on interregional and international merchandise trade flows finds that a pair of regions within a country tends to trade 10 to 20 times as much as an otherwise identical pair of regions across countries.[1] Other authors find that countries tend to trade with themselves 4 to 20 times more than with another country.[2] A last strand of literature has focused on the magnitude of the domestic market fragmentation when intraregional trade flows are available. Again trade flows appears substantially impeded by internal borders, within a range between 2 and 20.[3]

After several studies have estimated the magnitude of the border effects, the next issue on the agenda research is to search for possible reasons explaining why the administrative and national borders matter so much in trade. As pointed out by Evans (2003), the previous estimated border results are economically meaningless if we do not know the underlying forces that cause the volume of local transactions to exceed the volume of trade with other partners. There are a number of factors that may explain the downward impact of boundaries on the volume of trade: tariffs, non-tariff barriers, information and transaction cost differences, the "origin" of the product, the elasticity of substitution between local and foreign goods, the geographic location of firms and the importance of intermediate goods. The different reasons that explain the border effects have different welfare consequences and policy implications. If the border effect variation across industries is consistent with the presence of high elasticities of substitution between goods, it implies neither unrecognised barriers to trade nor high welfare costs. Moreover, if the border effects are endogenously determined, the welfare consequences and policy implications are minimal. Therefore, it is necessary to identify the cause of the border effects in order to assess their welfare implications.

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[1] The external border effect or frontier effect has been studied by McCallum (1995), Helliwell (1996, 1998), Anderson and Smith (1999), Anderson and van Wincoop (2003), Okubo (2004), Gil et al. (2005).

[2] Wei (1997), Head and Mayer (2002), Nitsch (2002), Evans (2003) and Chen (2004). These papers all calculated domestic trade as gross output minus exports, a "rough" estimate of intra-national trade flows.

[3] Helliwell (1997), Wolf (2000), Hillberry and Hummels (2003), Millimet and Osang (2006) and Combes et al. (2005) find an internal border effect between 2 and 6 in Canada, USA and France. Djankow and Freund (2000), Poncet (2003) and Daumal and Zignago (2005) find an internal border effect between 11 and 20 in ex-former USSR, China and Brazil.

In this paper we estimate both the internal and external border effects in Spain. We measure the internal border effect asking how many times a region trades more with itself than with another (non-adjacent) region of the same country. We measure the external border effect asking how many times a region trades more with another region of the same country than with any other (non-adjacent) country. For that purpose we use industry-level trade flows within each of the 17 Spanish regions, between Spanish regions and between each Spanish region and each one of the OECD countries for the year 2000. Next, we try to explain why border effects vary substantially across industries. First, we examine the extent of product differentiation across industries in order to estimate the tariff equivalent border effect. Second, we check whether the magnitude of the internal border effect is sensitive to the type of product use (intermediate goods versus final goods) since intermediate goods move mainly within short distance while final goods are able to cover longer distances. Third, we examine whether the degree of industry specialisation of the regions matters to understand the internal border effect.

Our empirical investigation of the border effects yields several findings that are particularly interesting and novel. To begin, we estimate two different border effects, the internal or interregional border and the external or frontier border. Our analysis reveals that the internal border effect is larger than the external border effect. The average internal border effect is about 17 for all industries (30 for manufactures) in non-adjacent trade. The average external border effect is 13 for all industries (10 for manufactures) in non-adjacent trade. Our estimated external border effect is smaller than the one found by Gil et al (2005), who estimated an average external border effect of 20 in non-adjacent trade. The difference is explained partly by the upward bias caused by their use of aggregated trade flows rather than sectoral data.

Second, we observe large variation in the border effects at industry level. The internal border effect ranges between 6 and 45 and the international border effect ranges between 4 and 156 in non-adjacent trade. Moreover, we observe a negative correlation between the internal and external border effects across industries. This is explained by two non-manufacturing industries (mining and energy and water), which exhibit low internal border effects and high external ones compared to the manufacturing industries.

Third, after accounting for the importance of the degree of product differentiation across industries, the tariff-equivalent of the border barriers are smaller than in the case of no taking into account product differentiation. Moreover, conditioning on product differentiation reduces more the external border effect than the internal border effect. Nevertheless, the tariff-equivalent border barriers remain still high.

Four, the large magnitude of the internal border effects is largely explained by the high volume short-distance intermediate goods trade. This is a novel finding since it is the first time that interregional trade flows are split into final use goods and intermediate use goods. Finally, the border effects are substantially diminished once we control for the geographic concentration of the industry. Our findings suggest that as the border effects arise endogenously their welfare consequences are minimal.

The paper proceeds as follows. Section 2 presents the methodological framework and the empirical model used. Section 3 describes the data set. Section 4 discusses the main estimation results. Section 5 analyses the factors that help to explain the border effects variation across industries. Finally, Section 6 concludes the paper.

2. The empirical gravity equation.

The gravity equation has been widely and successfully used to analyse the border effects. The gravity equation states that bilateral trade between two geographic areas is directly proportional to their economic sizes and inversely proportional to the distance between them. At the industry level, the gravity equation considered here takes the following form:

$$\begin{aligned} \ln X_{ij,k} = \; & \beta_0 + \beta_1 \ln Y_{i,k} + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 ADJREG_{ij} + \beta_5 ADJCOU_{ij} \\ & + \beta_4 OWNREG_{ij} + \beta_5 SPAIN_{ij} + \alpha_{i,k} + \alpha_{j,k} + \varepsilon_{ij,k} \end{aligned} \qquad (1)$$

where subscript *i* indicates an exporting Spanish region, *j* indicates an importing Spanish region or an importing foreign country and *k* indicates a specific industry. $X_{ij,k}$ is the exports from region *i* to region (country) *j* in industry *k*, expressed in euros; $Y_{i,k}$ is the production of exporter *i* in industry *k*; Y_j is the market size of the importer j ;[4] D_{ij} is the geodesic distance between *i* and *j*. These variables are expressed in logs. We include two additional variables to capture contiguity. *ADJREG* is a dummy variable equal to one when two Spanish regions share a common border, and zero otherwise. *ADJCOU* is a dummy variable equal to one when a Spanish region and a foreign country share a common border, and zero otherwise. In order to estimate the effects of crossing a border in this framework, we include two additional explanatory variables. *OWNREG* is a dummy equal to 1 for intra-regional trade and 0, otherwise ($HOME = 1$ if $i = j$). SPAIN is a dummy equal to 1 for trade between two Spanish regions and 0 for international trade or intraregional trade ($SPAIN = 1$ if $i, j \in SPAIN$ and $i \neq j$). The internal border effect is equal to $\exp(\hat{\beta}_4 - \hat{\beta}_5)$ and measures how many times intraregional trade exceeds interregional trade. The external border effect is equal to $\exp(\hat{\beta}_5)$ and measures how many times interregional trade exceeds international trade.

Finally, to ensure the correct specification of the gravity model, we also need to take into account the magnitude of alternative trading opportunities faced by the members of each bilateral trading pair; the so-called “multilateral resistance” terms, whose omission leads to over-estimate the border effect (Anderson and van Wincoop, 2003). Since the multilateral resistance terms are generally not observable, it is common practice to use importer and exporter fixed effects to replace the resistance terms, an approach that gives consistent estimates and is easy to implement (Feenstra, 2003; Helpman et al., 2004). Since we work with sectoral trade flows, we include industry-specific exporter and importer fixed-effects.

3. Data

The construction of the database includes intraregional trade flows, the bilateral trade flows between Spanish regions and the bilateral trade flows between each Spanish region and each OECD country. The data set includes 17 Spanish regions and 28 OECD

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[4] Evans (2001), Hillberry (2001) and Chen (2004) also use industry value added as a measure of exporter´s economic size rather than origin-region GDP to control for industry location patterns.

countries for the year 2000.[5] Trade flows are available for 15 different industries (at the 2-digit SIC rev. 3 level: agriculture, mining, energy and water and 12 manufacturing sectors). For each industry there are 765 observations: 17 intra-region trade flows, 272 interregional flows (17*16) and 476 international export flows from Spanish regions to each of the OECD countries (17*28). The sample covers a total of 11,220 observations (15*765).

The interregional trade data was estimated indirectly for each sector using available data about domestic transport flows of goods and translated into "monetary flows" by means of international export prices. The transport statistics used in the estimation of Spanish interregional trade include origin-destination flows by the following modes of transport: road (*Permanent Survey on Road Transport of Goods, Ministerio de Fomento)***,** railway (*Complete Wagon and Containers flows, RENFE)***,** sea (*Spanish Ports Statistics, Puertos del Estado)*, air (*O/D Matrices of Domestic flows of goods by airport of Origin and Destination, AENA)* and pipe (O/D matrix of oil flows using pipe, CLH). We combine data on transport flows with additional information related to the output per regions and sectors (*Industrial Enterprises Survey, INE*) in order to constrain the interregional transport flows such that they are consistent with *National and Regional Accounts* (INE).[6] The data on bilateral trade between Spanish regions and OECD countries in the sample are taken from the *Dirección General de Aduanas*. The figures are expressed in Euros.

There is no data on regional gross production by industry in Spain. Therefore we use value added as a measure of economic size. Regional value added by industry at market prices is reported in *Regional Accounts* (INE). Industry-specific value added for each one of the OECD countries is taken from the *OECD STAN 2005* database and the *OECD input-output table 2002* database. International value added figures were converted to current Euros using the period-average market exchange rate as reported in *WDI 2005 on-lin*e database.

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[5] The OECD countries are: Australia (AUS), Austria (AUT), Belgium (BEL, Belgium and Luxemburg), Canada (CAN), Czech Republic (CZE), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Iceland (ISL), Ireland (IRL), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), Netherlands (NDL), New Zealand (NZL), Norway (NOR), Poland (POL), Portugal (PRT), Spain (ESP), Slovenia (SVK), Sweden (SWE), Switzerland (SWT), United Kingdom (UK), United States (USA).

[6] Llanos (2004) describes in detail the harmonization method, the estimation of non-available data, the debugging procedure for transport flows in physical units and the estimation of value/weight relations from international trade statistics.

We follow Head and Mayer (2001) and Gil et al (2005) to construct the distance variable. To obtain the distances between Spanish regions we consider those cities with more than 20,000 inhabitants within Spain. For each city in one region we calculate a weighted average of the great circle distance (in kilometres) from this city to the other cities in each partner region, in which the weights are the respective populations of the latter. Once this value is calculated for all cities in a region we again calculate a weighted average based on populations within each region. Distances between each region and each foreign country in the sample are calculated considering the distances between the province capital cities of each Spanish region and the five most important cities of each partner country. The weighting procedure is the same as defined above. [7] Descriptive statistics of all the variables employed in this paper are presented in the Appendix.

4. Econometric estimation and basic results.

We estimate Equation (1) using a Tobit procedure in order to tackle the large proportion of zero observations in our data set: about 21% of the bilateral exports are equal to zero (4% corresponding to interregional trade flows and the rest correspond to international trade flows). Since the zero observations contain information about why such low levels of trade are observed, it would be inappropriate to eliminate them. Since the dependent variable is expressed in logs, we sum 1 to the trade flow level before taking logs. The Tobit coefficients are not direct estimates of the elasticities, but those at the sample means can be recovered by the McDonald and Moffitt (1980) procedure.[8]

Table 1 contains the estimates corresponding to different specifications of equation (1). Column 1 presents the simplest gravity equation: trade flows as a function of origin and destination value added, distance and the dummies capturing the border effects. The results for all tradable goods show the elasticity of trade with respect to origin value added to be

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[7] The great circle distance between i's and j's cities is 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 by region and by country using the same formula $D_{r,r'} = \sum_{i\in r} w_i \left(\sum_{j\in r'} w_j d_{ij} \right)$, $w_i = pop_i / pop_r$.

[8] Head and Mayer (2002) and Chen (2004) use the same approach in their analysis of the home country bias in Europe using industry-levels trade flows.

greater than unity, the elasticity of trade with respect to destination value added to be close to unity and the elasticity with respect to distance to be greater than one in absolute value. The internal border effect is 14.7 [=exp(4.91-2.22)] and the international border effect is 9.2 [=exp(2.22)]. This implies that, ceteris paribus, intraregional trade is roughly 15 times greater than interregional trade and interregional trade is roughly 9 times greater than international trade.

Column 2 conditions on the neighbour (adjacency) status and the frontier (adjacency) status with France and Portugal. The results show that regions are more likely to trade with adjacent regions and with contiguous countries, than they do with otherwise similar regions and countries. Indeed, controlling for adjacency affects significantly the magnitude of the border effects. The internal border effect almost triplicates as a region trades about 22 times more with itself than with a non-adjacent Spanish region and regions trade about 16 more with other non-adjacent Spanish regions than with other non-adjacent countries. Next we include origin and destination fixed-effects across industries in order to control for omitted relative prices. Column 3 shows that the economic impact of crossing the border is greatly reduced. This finding lends support to the results obtained by Anderson and van Wincoop (2003) in that omitting relative prices leads to over-estimate the elasticity of trade with respect to trade impediments. The coefficients on distance and border effect are smaller than those in Column 2. The internal border effect falls from 22 to 17 and the external border effect falls from 16.3 to 13.

Column 4 formulates the Anderson and Wincoop (2003) transformation of the dependent variable, after imposing that the coefficients on the income variables are equal to one. The magnitude of the border effects declines until 13.2 for the internal one and until 8 for the external one. Column 5 restricts the sample to the manufacturing goods, eliminating three out of fifteen industries (agriculture, mining, energy and water). The results are similar to those obtained for the sample of all tradable goods. The main difference is that the internal border effect almost doubles (29.7) and the international border effect decreases slightly (10.4). Finally, following Chen (2004), column 6 includes an additional variable to control for the weight-to-value relationship.[9] As expected, weight-to-value has a negative

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[9] The weight-to-value measure is industry-specific and averaged across all region-country pairs, $\sum_i \sum_j Q_{ij,k} \big/ \sum_i \sum_j X_{ij,k}$ where $Q_{ij,k}$ is the weight of bilateral international exports $X_{ij,k}$.

impact on bilateral exports, reflecting the higher freight component of costs of bulky manufactures, though the coefficient is weakly significant. Nevertheless, the magnitude of the estimated border effects remains the same.

To summarise, the internal border effect is larger than the international border effect in Spain. Inter-regional flows between two non-contiguous regions are about 17 (30 for manufactures) times lower than intra-regional ones, a higher internal border effect compared to previous studies for Canada (Helliwel and Verdier, 2001), USA (Wolf, 2000) and France (Combes et al, 2005), with values of 2, 6 and 9, respectively. Meanwhile, international flows between a Spanish region and a non-contiguous country are about 13 (10 for manufactures) times lower than inter-regional ones. Our estimated external border effect is similar to the one found by Nitsch (2002) for Germany over the period 1992-1994 but significantly smaller than the value of 20 found by Gil et al (2005) for Spain over the period 1995-1998. The difference in the results may be explained by the upward bias in the border coefficient when aggregated trade flows are used rather than disaggregated trade flows, as suggested shown by Hillberry (2002).[10]

<INSERT TABLE 1 HERE>

Border effects also differ across industries. Table 2 reports the results of estimating industry-specific border coefficients. The coefficients on the gravitational variables display the expected signs and statistically significant. All the coefficients on the industry dummies interacted with OWNREG are larger than 1 and statistically significant. There are three industry dummies interacted with SPAIN (textile, clothing and leather, electric and electronic goods, transport equipment) that are smaller than 2 and the one for transport equipment is not statistically significant. The largest *internal* border coefficients are 45.6 for wood products, 37.3 for food and drinks, 35.2 for non metallic products and 29.4 for plastic and rubber. At the opposite side of the spectrum, the smallest *internal* border effects are 3.4 for mining, 6.8 for electric and electronic goods, 6.8 for chemical products and 8.0 for energy and water. The largest *external* border coefficients are 186.8 for energy and

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[10] When we used aggregated trade flows and replicated the specification of Gil et al. (2005) using manufacturing sectors only, the magnitude of the external border effect was 15, a greater value than the one obtained using industry-specific trade flows.

water and 159.6 for mining, while the smallest *external* border effects are 4.2 for electric and electronic goods, 4.5 for mechanical machinery and 5.8 for transport equipment. The internal border effects exhibit smaller variation than external ones; the normalised standard deviation is 0.55 and 1.32, respectively. In addition, it appears that industries with a large (small) internal border effect do not have necessarily a large (small) external border effect (i.e. energy and water and mining); indeed, the correlation coefficient between the two types of border effect is -0.39. In the next section we investigate which factors may explain the magnitude of the border effects across industries in Spain.

<INSERT TABLE 2 HERE>

5. Explaining border effects

Trade frictions affect trade volumes through two channels. A direct effect occurs as frictions change relative prices, inducing substitution towards proximate products. The indirect effect occurs through co-location. Firms linked closely in the input-output structure locate nearby so as minimise trade costs. Thus border effects may arise endogenously either as a result of high degree of substitutability between local and foreign products or as a consequence of an optimal location choices of producers. Alternatively, border effects may arise exogenously due to technical and non-tariff barriers to trade together with information and transaction costs impediments.[11]

In this section we examine three factors explaining the border effects. First, we need to take into account that the estimated border effects is the product of the elasticity of substitution times the tariff-equivalent border barrier. Therefore, if more differentiated goods exhibit high border effects, the "effective" border barrier will be smaller than the "estimated" border effect. Evans (2003) showed that border effect between domestic and international trade flows in the USA was largely explained by the elasticity of substitution across varieties. The present paper checks whether product differentiation has any impact on border effects in Spain and whether, if any, the impact is different for each type of border.

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11 Chen (2004) defines the first group of factors as "behavioural responses to trade costs" and the second group as "trade costs".

Second, we examine the role of intermediate goods. Wolf (2000) pointed out that intermediate goods trade generally covers shorter distances than does final goods trade, leading him to argue that the clustering of intermediate stages of production might explain the magnitude of the internal border effect. We are able to check this hypothesis straightforwardly since the Spanish interregional trade flow data for 1995 is split into final goods and intermediate goods.

Finally we investigate whether the importance of border effects in interregional trade is conditioned by the microeconomics of distribution firm-localisation. Hillberry and Hummels (2002) used regional-level trade flows for USA finding that the spatial clustering of firms magnifies the internal border effects. Chen (2004) used country-level trade flows and found that the spatial clustering of firms magnified external border effects, respectively. Accordingly, our paper also checks for whether this alternative explanation for border effect can be validated by the data when focusing on the inter-regional trade flows for Spain.

In order to examine the impact of product differentiation, the type of trade flow (final or intermediate) and spatial clustering on the border effects, the gravity equation is estimated over the pooled sample of industries, including the OWNREG (SPAIN) variable and an interaction term between OWNREG (SPAIN) and the explanatory variable of interest.[12]. The specification is:

$$\begin{aligned}\ln X_{ij,k} = {} & \alpha_{i,k} + \alpha_{j,k} + \beta_1 \ln Y_{i,k} + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 ADJREG_{ij} + \beta_5 ADJCOU_{ij} + \\ & + \beta_6 OWNREG_{ij} + \gamma_1 (OWNREG_{ij} \times z_k) + \beta_7 SPAIN_{ij} + \gamma_2 (SPAIN_{ij} \times z_k) + \varepsilon_{ij,k}\end{aligned} \tag{2}$$

The sign and significance of the coefficients γ_1 and γ_2 on the interaction terms indicates whether industries with a particular characteristic z_k display larger o smaller border effects. In addition, the magnitude of the OWNREG (SPAIN) and of the interaction coefficients permits to assess the relative importance of each explanatory factor z_k.

5.1. The interaction between border effects and product differentiation.

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[12] Evans (2003) and Chen (2004) use the same approach.

Theory shows that the border effect is equal to the product of the elasticity of substitution between goods and the tariff-equivalent of the border barrier. Indeed, the tariff-equivalent of the border barrier is given by the exp[(border coefficient)/(σ)] − 1.[13] As far as high border effects are associated with high elasticity of substitution between goods, the magnitude of the tariff equivalent border effect will become smaller. Thus, to provide economic significance to the border effects, we need to know whether high border effects arise from high elasticities of substitution between local, national and imported goods.

Our proxies for differences across industries in elasticities include three variables: IIT, R&D and ADV. The variable IIT is the extent of intra-industry trade as proportion of the total trade within an industry, calculated using the Grubel-Lloyd index and international trade information. The variable RandD is the ratio of research and development expenditure to value added within an industry. The variable ADV is the ratio of advertising expenditure to sales within an industry. For the three variables, a higher value indicates a higher degree of differentiation, i.e. a lower elasticity of substitution.[14]

Table 3 shows the results after the variables OWNREG and SPAIN are interacted with each measure of product differentiation. All measures indicate that a higher degree of product differentiation is actually associated with a lower border effect. This suggests that high border effects are partially attributable to the elasticity of substitution between goods produced in different locations, and that higher border effects do not indicate large price wedges between varieties produced in different locations. For example, the coefficient of -2.25 on the OWNREG*IIT interaction variable indicates that a perfect homogenous good (IIT=0) will have an internal border effect of 33.4, while a product with some degree of product differentiated (mean IIT=0.35) will have an internal border effect of 27. For the external border effect the values will be 12.3 in the case of IIT=0 and 7.1 in the case of IIT=0.35. While R&D as measure of product differentiation shows a similar result as IIT, the variable ADV only show a negative and significant coefficient for the interaction with SPAIN, but not with OWNREG. This might be due to the fact that product differentiation is more relevant to explain the international border effect rather than the home regional bias.

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[13] For a discussion, see Deardoff (1995), Anderson and Van Wincoop (2003) and Feenstra (2004)

[14] The three measures are constructed using Spain as a geographic unit. IIT was constructed using international import and export (value and quantity) flows. RandD was obtained from *Estadística de I+D* (INE) and ADV was obtained from *Encuesta Industrial de Empresas* (INE). For the variable ADV the agriculture sector is excluded due to lack of information.

Next Table 4 displays the industry border effects for nonadjacent trade and the industry-specific tariff-equivalent of the border barriers, i.e. $\exp(\hat{\beta}_k)$ and $\exp[(\hat{\beta}_k)/(\hat{\sigma}_k)]-1$, where $\hat{\beta}_k$ refers to the coefficient(s) on a industry-dummy-variable interacted with OWNREG and SPAIN variables obtained from Table 2 and $\hat{\sigma}_k$ is the industry-specific elasticity of demand calculated using the IIT index.[15]. For chemical goods, the tariff-equivalent internal border barrier is 51 percent and the tariff-equivalent external border barrier is 56 percent; for the agriculture sector they are 92 and 114, respectively. An interesting result is that the negative correlation between the internal and external border effects disappears after conditioning on the elasticities of substitution. However, the internal and external tariff-equivalent border barriers remain high after discounting for the elasticities of substitution, so further investigation is needed to explain the large border barriers implied by the estimated border effects.

5.2. The role of intermediate goods and geographic location of firms.

Border effects may arise endogenously due to the geographic location of particular industries. Firms that produce intermediates locate proximate to concentrated industrial demands in order to minimize shipping costs. Thus intermediate goods tend to be shipped short distances while final goods travel long distances.

Hillberry (2002), Hillberry and Hummels (2002) and Chen (2004) have investigated to what extent border effects are affected by firm location. They use an index of geographic concentration to measure to what extent firm's production is tied to any particular geographic location and find that that the border effect is larger in industries with high geographic concentration. They interpreted this result as evidence that firms not attached to any specific location choose their location of production so as to minimise cross-border transaction cost and as a result border effects are magnified.

We adopt a different approach and compare border effects for trade in final goods and trade in intermediate goods. If intermediate goods are shipped shorter distances than final goods, border effects will be bigger for intermediates than for final goods. Our

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[15] We set the two endpoints of the elasticity range (2 to 6) to the minimum and maximum IIT index values (0.03 and 0.66), and used linear interpolation to assign elasticities to the intervening industries, based on their ITT index values (as in Evans, 2003).

analysis is carried out with the *Spanish C-Interregio database,* which separates interregional bilateral trade flows into goods for intermediate use and goods for final use (Llano, 1994). Unfortunately, there is no information on international bilateral trade flows by type of good.

Panel A in Table 5 displays the results of estimating equation (1) using only interregional bilateral trade flows for 2000. There are some interesting differences in the estimated coefficients between Column 1 in Table 5 and Column 5 in Table 1. First, the coefficient on distance is -0.26, significantly smaller than the one obtained when we include international trade data. Second, the estimated internal border effect takes a value of 35.2, which is bigger than the one found when we used both international and interregional trade flows (29.7).

Columns 2 and 3 split the sample into final goods and intermediate goods. The domestic border effect for intermediate goods is 30.8 while the one for final goods is 17.6. Our finding corroborates the idea that the composition of trade flows affects the magnitude of the border effect. In particular, the internal border effect is almost twice larger for intermediate goods than for final goods.

Next we investigate whether the clustering of firms may provide an additional explanation of border effects. In order to investigate this hypothesis, we use the index of "geographic concentration" proposed by Ellison and Glaeser (1997) and computed by Alonso Villar et al (2003) for Spanish industries at the two-digit SIC level and provincial level in 1999. When there is no spatial concentration in a particular industry, the value of the Ellison and Glaeser (EG) index takes value zero. Panel B in Table 2 displays the results of estimating equation (2) including the interaction term $OWNREGx\ln(EG_k)$. As expected, firms with a small value of the Ellison and Glaeser index display larger border effects. Interestingly, conditioning on geographic clustering seems to have a large and significant impact on the magnitude of the internal border for final goods than for intermediate goods. Moreover, the coefficient on the interaction term for intermediate goods trade is not statistically significant. Our results are in line with previous findings by Evans (2003) and Chen (2004) and supports the hypothesis that firms that are not tied to any specific location locate so as to minimise trade costs. As a result, interregional trade is reduced and border effects appear endogenously.

6.- Conclusions

This paper estimates the magnitude of the internal and international border effects in Spanish trade using a data set of intra-national and international trade flows by industry. The gravity model shows that intraregional Spanish trade exceeds the interregional trade around 30 times and that intra-national Spanish trade exceeds the international trade around 10 times, after controlling for size, distance, adjacency and industry-specific characteristics. The magnitude of the international border effect is very small when compared with the results found in previous studies for Spain. The use of disaggregated trade information matters for the size of the border effect. Industry-specific border effects were also explored. The internal border effect by industry ranges between 6 times (chemicals) and 46 times (wood products), and the external border effect ranges between 4 (transport equipment) and 156 (energy and water). These wide differences suggest that the border effect is not uniform across industries.

The paper also investigates the determinants of the border effects across industries, and in particular we ask to what extent border effect are endogenously determined. Our analysis shows that controlling for product differentiation decreases the size of the border effects, especially the international one. Therefore, the elasticity of substitution among varieties drives the cross-industry variance in border effects. Next we find that the magnitude of the internal border effect is much larger for trade in intermediate goods than trade in final goods. Finally we show that conditioning on the geographic concentration of the industry reduces the magnitude of the internal border effect. Our findings suggest that as the border effects arise endogenously their welfare consequences are minimal

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Table 1: Average border effects.

	(1) Tradables	(2) Tradables	(3) Tradables	(4) Tradables	(5) Manufactures	(6) Manufactures
ln Y i,k	1.33**	1.32**	1.00**	1	1.09**	1.09**
	(64.00)	(63.86)	(24.48)		(20.95)	(20.95)
ln Y j	0.94**	0.92**	0.96**	1	0.99**	0.99**
	(83.67)	(82.91)	(46.17)		(42.14)	(43.14)
ln D ij	-1.25**	-1.08**	-1.02**	-0.67**	-0.98**	-0.97**
	(37.08)	(30.28)	(31.60)	(12.73)	(27.71)	(27.38)
ADJREG ij		1.71**	1.50**	1.26**	1.40**	1.40**
		(12.15)	(12.46)	(32.51)	(11.16)	(10.68)
ADJCOU ij		2.34**	2.23**	0.80**	2.20**	2.19**
		(6.95)	(6.88)	(7.82)	(6.36)	(6.50)
ln WEIGHT k						-0.11*
						(1.76)
OWNREG ij	4.91**	5.88**	5.44**	4.67**	5.73**	5.71**
	(14.39)	(17.92)	(15.92)	(50.12)	(16.01)	(16.00)
SPAIN ij	2.22**	2.79**	2.57**	2.09**	2.34**	2.34**
	(16.76)	(16.27)	(12.01)	(25.74)	(11.02)	(12.28)
Fixed effects	No	No	Yes	Yes	Yes	Yes
Pseudo R2	0.10	0.11	0.14	0.24	0.14	0.14
N	22440	22440	22440	22440	17952	17952
Estimated border effects						
Internal	14.7	22.0	17.6	13.2	29.7	29.1
External	9.2	16.3	13.1	8.1	10.4	10.4

Note: Tobit estimations, sample mean elasticities. T-values are reported in parentheses. “Fixed effects” indicates whether industry-specific exporter and importer dummies are included. t-statistics in parentheses with ** denoting significance at the 5-percent level and * significance at the 10-percent level.

Table 2: Industry specific border effects

ln Y i,k	1.04**			
	(26.10)			
ln Y j	0.98**			
	(48.40)			
lnD ij	-0.92**			
	(41.68)			
ADJREG ij	1.49**			
	(12.84)			
ADJCOU ij	2.26**			
	(7.21)			
	Industry-specific OWNREG	**Industry-specific SPAIN**	**Non-adjacent trade border effects**	
			Internal	**External**
Agriculture	6.94**	3.84**	22.2	46.5
	(7.48)	(12.65)		
Mining	6.27**	5.05**	3.4	156.0
	(7.64)	(19.24)		
Enery & water	7.31**	5.23**	8.0	186.8
	(8.94)	(19.17)		
Food & drinks	7.23**	3.61**	37.3	37.0
	(5.84)	(12.45)		
Textile, clothing, leather	4.40**	1.91**	12.1	6.8
	(4.89)	(5.25)		
Wood products	6.53**	2.71**	45.6	15.0
	(7.97)	(9.73)		
Paper & printing	6.44**	3.18**	26.0	24.0
	(7.19)	(11.94)		
Chemicals	4.42**	2.50**	6.8	12.2
	(5.30)	(9.12)		
Rubber & plastic	5.46**	2.08**	29.4	8.0
	(5.67)	(4.15)		
Non metallic, mineral products	7.52**	3.96**	35.2	52.5
	(7.17)	(13.20)		
Steel & Metal products	6.41**	3.57**	17.1	35.5
	(6.00)	(11.60)		
Mechanical machinery	4.45**	1.51**	18.9	4.5
	(4.90)	(2.03)		
Electric & electronic goods	3.99**	1.44**	12.8	4.2
	(2.55)	(2.34)		
Transport equipment	4.57**	1.75	16.8	5.8
	(4.21)	(1.26)		
Other manufactures	6.06**	2.71**	28.5	15.0
	(6.12)	(5.91)		
Pseudo R2	0.25			
N	22440			

Note: Tobit estimations, sample mean elasticities. T-values are reported in parentheses. All specifications include industry-specific exporter and importer dummies. t-statistics in parentheses with ** denoting significance at the 5-percent level and * significance at the 10-percent level.

Table 3: Product differentiation interaction terms

	(1)	(2)	(3)
ln Y i,k	1.09**	1.06**	1.06**
	(27.03)	(26.39)	(24.12)
ln Y j	0.97**	0.98**	0.97**
	(47.64)	(47.87)	(46.04)
ln D ij	-0.73**	-0.79**	-0.95**
	(19.88)	(17.53)	(21.05)
ADJREG ij	1.50**	1.47**	1.46**
	(12.71)	(12.58)	(12.07)
ADJCOU ij	2.18**	2.23**	2.30**
	(6.87)	(7.05)	(7.02)
OWNREG ij	6.02**	5.69**	5.94**
	(11.69)	(17.10)	(12.16)
OWNREG*IIT k	-2.25**		
	(2.22)		
OWNREG*R&D k		-0.41**	
		(4.88)	
OWNREG*ADV k			-0.11
			(0.67)
SPAIN ij	2.51**	2.45**	2.54**
	(16.67)	(21.52)	(11.41)
SPAIN*IIT k	-1.52**		
	(5.57)		
SPAIN*R&D k		-0.23**	
		(11.80)	
SPAIN*ADV k			-0.12**
			(2.47)
Pseudo R2	0.24	0.25	0.25
N	22440	22440	20944
Estimated border effects			
Internal (homogenous good)	33.4	25.5	30.1
Internal (differentiated good)	25.7	18.5	30.5
External (homogenous good)	12.3	11.6	12.7
External (differentiated good)	7.1	7.9	10.4

Note: IIT=intra-industry trade index. RandD =research and development expenditure over value added. ADV=advertising expenditure over sales (agriculture is excluded due to lack of data). Tobit estimations, sample mean elasticities. All specifications industry-specific exporter and importer dummies. t-statistics in parentheses with ** denoting significance at the 5-percent level and * significance at the 10-percent level. Estimated border effects for differentiated goods evaluated at average value (IIT=0.36; RandD=1.61; ADV=1.64).

Table 4: Tariff-equivalent border effects (percent)

Panel A: Internal border	Border effect	Tariff equivalent border effect	**Panel B: External border**	Border effect	Tariff equivalent border effect
Chemicals	6.8	51	Electric & electronic goods	4.2	49
Textile, clothing, leather	12.1	59	Textile, clothing, leather	6.8	53
Enery & water	8.0	60	Transport equipment	5.8	54
Electric & electronic goods	12.8	62	Rubber & plastic	8.0	54
Transport equipment	16.8	67	Mechanical machinery	4.5	55
Steel & Metal products	17.1	68	Chemicals	12.2	56
Mining	3.4	68	Other manufactures	15.0	65
Rubber & plastic	29.4	69	Paper & printing	24.0	69
Paper & printing	26.0	70	Wood products	15.0	77
Other manufactures	28.5	74	Steel & Metal products	35.5	79
Non metallic, mineral products	35.2	74	Non metallic, mineral products	52.5	81
Mechanical machinery	18.9	80	Food & drinks	37.0	82
Food & drinks	37.3	82	Agriculture	46.5	114
Agriculture	22.2	92	Enery & water	186.8	127
Wood products	45.6	104	Mining	156.0	460

Note: Industries ordered by magnitude of the tariff equivalent border effect. The tariff-equivalent border effect is equal to $[\exp(\hat{\beta}_k/\hat{\sigma}_k)-1]$ where β_k refer to the estimated coefficients of the border effects and σ_k is the estimated elasticity of substitution. We have used the variable IIT index in the calculations, which varies between 0.03 (mining) and 0.66 (mechanical machinery). Higher values indicate more differentiated products. We set the two endpoints of the elasticity range (2 to 6) to the minimum and maximum IIT index values, and used linear interpolation to assign elasticities to the intervening industries, based on their ITT index values (as in Evans, 2003).

Table 5: Separating interregional trade flows by final and intermediate goods.

	All manuf. (1)	Intermediates (2)	Final (3)	All manuf. (4)	Intermediates (5)	Final (6)
lnY i,k	1.53 **	1.49 **	1.34 **	1.52 **	1.49 **	1.35 **
	(36.51)	(38.32)	(36.82)	(41.20)	(41.97)	(41.21)
lnY j	1.11 **	1.12 **	0.86 **	1.10 **	1.13 **	0.88 **
	(6.48)	(6.31)	(4.53)	(10.88)	(10.95)	(10.80)
lnD ij	-0.26 **	-0.37 **	-0.26 **	-0.28 **	-0.38 **	-0.27 **
	(2.17)	(2.82)	(2.63)	(3.88)	(4.58)	(4.25)
ADJREG	2.61 **	2.51 **	2.14 **	2.63 **	2.52 **	2.18 **
	(15.07)	(15.20)	(13.53)	(17.07)	(17.18)	(16.64)
OWNREG	3.56	3.43	2.87	3.50	3.39	2.74
	(14.01)	(14.53)	(13.41)	(13.42)	(14.88)	(15.56)
OWNREG*ln(CR k)				-0.25	-0.16	-0.44 **
				(1.60)	(1.17)	(2.58)
Pseudo R2	0.25	0.26	0.27	0.25	0.26	0.27
N	3468	3486	3468	3468	3468	3468
Internal border	35.2	30.9	17.6	33.1	29.7	15.5

Note: Manufactures excludes agriculture, mining and energy and water sectors. Tobit estimations, sample mean elasticities. All specifications include industry-specific exporter and importer dummies. t-statistics in parentheses with ** denoting significance at the 5-percent level.

Appendix. Descriptive statistics

Sample of Spanish regions and OECD countries		**N**	**Mean**	**S.D.**	**Minimum**	**Maximum**
industry-specific bilateral exports	exp ijk	11220	37532	174779	0	5859986
industry-specific value added of exporter	vab ik	11220	542901	749605	5850	5571544
total value added of importer	vabtot j	11220	9617075	29700000	0	257000000
geodesic distance	distance ij	11220	2874	4225	17	19683
dummy regional adjacency	adjreg ij	11220	0.076	0.265	0	1
dummy country adjacency	adjcou ij	11220	0.008	0.089	0	1
dummy intraregional trade	ownreg ij	11220	0.023	0.149	0	1
dummy international trade	spain ij	11220	0.364	0.481	0	1
Sample of Spanish regions						
industry-specific bilateral exports	exp ijk	3468	74176	259842	0	6259986
bilateral exports in intermediate goods	exp interm ijlk	3468				
bilateral exports in final goods	exp final ijk	3468				
industry-specific value added of exporter	vab ik	3468	542901	749659	5850	5571544
total value added of importer	vabtot j	3468	8143513	7680491	1342984	31756987
geodesic distance	distance ij	3468	576	494	17	2170
dummy regional adjacency	adjreg ij	3468	0.197	0.398	0	1
dummy intraregional trade	ownreg ij	3468	0.059	0.235	0	1
Industry characteristics						
weight-to-value	WEIGHT k	12	4.380	7.772	0.016	62.782
Ellison and Glaeser index	CR k	12	0.033	0.027	0.003	0.086
Intra-industry trade index (GL index)	ITT k	15	0.036	0.187	0.002	0.891
R&D expenditure / value added	R&D k	15	1.617	1.794	0.100	5.080
Advertising expenditure /sales	ADV k	14	1.645	1.597	0.153	5.415