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## Islands in trade: Disentangling distance from border effects

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## **Islands in Trade: Disentangling Distance from Border Effects**

*José Luis Groizard, Helena Marques, and Maria Santana*

### **Abstract**

There is a well-established literature on border effects covering trade between regions separated by a land border; however that literature has not so far considered the case of regions separated by a sea border. Whilst the former is typically studied as a political border that affects adjacent regions belonging to different countries and can be reduced by free trade agreements, the latter is a geographical border that affects regions within the same country and cannot be reduced in a similar way. Both types of borders produce similar effects upon trade, calling for a modification of the trade cost function to reflect the fixed cost caused by the need to pay fees and taxes, as well as the time-loss inefficiency, related to the existence of the border. However, in the case of the sea border that fixed cost is due to the use of two modes of transport (road and sea typically). The empirical strategy used to estimate the “island effect” proceeds in two steps. First an augmented gravity model is estimated for mainland and island regions; then a Blinder–Oaxaca decomposition is applied to the gravity estimation results in order to disentangle the distance and border effects for those regions, net of all other factors controlled for in the gravity estimations. Results show that island regions are at a substantial disadvantage compared to continental regions, which is due more to the lack of adjacency imposed by the sea border rather than to the higher average distance.

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## 1. Introduction

There is a well-established literature on border effects covering trade between regions separated by a land border;<sup>1</sup> however that literature has not so far considered the case of regions separated by a sea border. This is an important distinction because, whilst the former is typically a political border that affects adjacent regions belonging to different countries and can be reduced by free trade agreements,<sup>2</sup> the latter is a geographical border that affects regions within the same country and cannot be reduced in a similar way. Both types of borders produce similar effects upon trade, calling for a modification of the trade cost function to reflect the fixed cost caused by the need to pay fees and taxes, as well as the time-loss inefficiency, related to the existence of the border. However, in the case of the sea border that fixed cost is due to the use of two modes of transport (road and sea typically), instead of the red tape, administrative and language barriers commonly used to measure the effects of land political borders.

In this paper, we measure the trade effects of the existence of a sea border for the case of Spain, a country which includes two island regions: Balearic Islands and Canary Islands. The empirical strategy used to estimate the “island effect” proceeds in two steps. First an augmented gravity model that includes all types of trade costs incurred by island regions within their country of origin is estimated for mainland and island regions; then a Blinder-Oaxaca decomposition is applied to the gravity estimation results in order to disentangle the distance and border effects for those regions, net of all other factors controlled for in the gravity estimations. Results show that island regions are at a substantial disadvantage compared to continental regions, but their trade disadvantage is due to a greater extent to the fixed cost imposed by the lack of adjacency originated by the sea border rather than to the variable cost of higher average distance.

The gravity model has been for a long time the most widely used empirical model of International Economics research.<sup>3</sup> The most basic formulation of the gravity model consists of explaining bilateral flows as a direct function of the two partners’ economic size (measured in terms of GDP, GDP per capita and/or population) and as an inverse function of the distance between them (Anderson, 2011). Anderson and van Wincoop (2003) generalized the basic gravity model to incorporate multilateral resistance terms, which in their work were price indices for the exporter and the importer regions. Although their approach was difficult to implement empirically, the two important points they made were that the multilateral resistance measures should be weighted averages of characteristics of all trading partners in the sample and should be time-varying.

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<sup>1</sup> See, among many others, Anderson and van Wincoop (2003), Chen (2004), Evans (2003), Head and Mayer (2000), McCallum (1995).

<sup>2</sup> US and Canadian regions or European Union countries are the most studied cases (see footnote 1).

<sup>3</sup> These models have been applied to trade (Marques and Metcalf, 2005, 2006; Papazoglou et al, 2006; Armstrong 2007; Spies and Marques, 2009; Marques, 2011), migration (Gil-Pareja et al 2006; Marques, 2010), FDI (Head and Ries 2008), and tourism (Eilat and Einav, 2004; Gil-Pareja et al, 2007; Santana et al, 2010; Fourie and Santana 2012; Rosselló and Santana-Gallego 2014). Moreover, this specification has also been used both in the international and regional context (see, for the case of Spain, Sansó et al (1990), Sanz (2000), Gil-Pareja et al (2005)).

Another approach that was easier to implement empirically was that of Feenstra (2002), who used importer and exporter (or bilateral) fixed effects. However, for these to be true multilateral resistance terms they need to meet the second criterion of Anderson and van Wincoop (2003), for which they need to be time-varying importer and exporter (or bilateral) fixed effects, which is achieved interacting them with time dummies.<sup>4</sup> Whilst this approach allows capturing all the unobserved characteristics in a very intuitive way, the amount of dummies needed makes the estimation computationally cumbersome for very large samples. Furthermore, the country-time interactions absorb the effects of all variables that vary along those dimensions, such as GDP, population or GDP per capita, and as a consequence their trade impact appears not significant. A similar difficulty occurs with Bun and Klaassen's (2007) approach to include country-pair time trends, as the dummies absorb the explanatory power of other bilateral time-varying variables. However, the model specified with economic variables can be seen as a particular case of the fixed effects model, given that the fixed effects capture all observed and unobserved variation along their dimensions, whilst the economic variables do not capture unobserved variation. Nevertheless, since it is of interest to know their coefficients, a model specified with economic variables is an interesting particular case of the more general fixed effects model.

Spies and Marques (2009) built on this literature by proposing an approach where multilateral resistance is measured through all the variables that also influence the bilateral resistance to trade. Their partially time-varying character overcomes the bias present in earlier estimations that solely rely on country (pair) fixed effects to proxy for the multilateral resistance terms. At the same time, standard panel data estimation techniques can be applied to the full sample. In the current paper we propose an extension of the approach taken in Spies and Marques (2009) to incorporate a simplified version of the trade cost function of Novy (2013) and Feenstra and Romalis (2014), who consider both fixed and variable trade costs.

This is an important issue for island economies because distance and border effects play a different role for those economies. Whilst distance determines variable trade costs (the typical gravity model iceberg cost), border effects, seen as the existence of a sea border, originate a fixed trade cost. As shown in Figure 1, Spain has 17 regions, out of which 15 are mainland regions, located in the Iberian Peninsula, and two are island regions: the Balearic Islands (located in the Mediterranean Sea) and the Canary Islands (located in the Atlantic Ocean). As an example, one could argue that the variable trade cost due to distance between the Balearic Islands and Barcelona (both in the Mediterranean area) is lower than that between Barcelona (in Catalonia) and Vigo (in Galicia); however, the fixed cost of trade between the Balearic Islands and Barcelona due to the sea border does not exist between Barcelona and Vigo, because the latter are both located in the Iberian Peninsula. As a consequence, whichever effect predominates will determine the total trade cost between each pair of regions and, following the gravity model, the volume of trade between them.

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<sup>4</sup> See, for example, Baltagi et al (2003) and Broto et al (2006) for trade and Bertoli and Fernández-Huertas (2013) and Ortega and Peri (2014) for migration.

Figure 1: Regions of Spain



NOTE: Kindly and freely available from <http://www.map-of-spain.co.uk/>

It can be concluded that, at the regional level in Spain, variable trade costs essentially depend on distance, whilst fixed trade costs are more complex and are related to the factors that either facilitate or hinder the regions' connectivity. The facilitating factors considered in this paper are the adjacency of two regions and having a coast. The most important hindering factor is that one of the trading regions is not located in the Iberian Peninsula, meaning that it must incur all sorts of fees and delays related to using either a combination of two modes of transport (road and sea) or alternatively using air transport, which entails its own fixed costs too. Finally, one must consider the multilateral resistance terms for each exporting and importing region, which, following previous work by Baltagi et al (2003), Broto et al (2006), Bertoli and Fernández-Huertas (2013), Ortega and Peri (2014), among others, are represented by origin, destination and time fixed effects.

In what follows, section 2 explains the two-step empirical strategy used to estimate the "island effect". Section 3 describes the data sources and the main features of those regions' international and interregional trade structure. Section 4 presents the empirical results and section 5 concludes.

## 2. Empirical strategy

The empirical strategy used to estimate the "island effect" proceeds in two steps. First an augmented gravity model, derived in section 2.1., is estimated for Spain's mainland and island regions. Then a Blinder-Oaxaca decomposition, explained in section 2.2., is applied to the gravity estimation results in order to disentangle the distance and border effects for those regions, net of all other factors controlled for in the gravity estimations.

## 2.1. Augmented gravity model

The derivation of the augmented gravity equation to be estimated modifies the approach taken in Spies and Marques (2009) to incorporate a simplified version of the trade cost function of Novy (2013) and Feenstra and Romalis (2014), who consider both fixed and variable trade costs, as well as the multilateral resistance terms represented by origin, destination and time fixed effects as in Baltagi et al (2003), Broto et al (2006), Bertoli and Fernández-Huertas (2013), Ortega and Peri (2014), among others.

Assuming identical, homothetic Constant Elasticity of Substitution (CES) preferences, region  $i$ 's aggregate total value of imports from region  $j$  in year  $t$  ( $M_{ijt}$ ) can be expressed as:

$$M_{ijt} = N_{jt} Y_{it} \left( \frac{p_{ijt}}{P_{it}} \right)^{1-\sigma} \quad (1)$$

with  $N_{jt}$  representing the number of products sold by region  $j$ ,  $Y_{it}$  being region  $i$ 's nominal expenditure (measured by its GDP);  $\frac{p_{ijt}}{P_{it}}$  is the relative price determining the share of region  $i$ 's GDP allocated to purchasing imports from region  $j$ , with  $P_{it}$  being region  $i$ 's price index for all import-competing goods (whether produced in the region or in third regions) and  $p_{ijt}$  standing for the price at destination (in region  $i$ ); finally,  $\sigma > 1$  is the elasticity of substitution between goods originating from the two trading regions  $i$  and  $j$ .

Assuming the existence of both fixed ( $T_{ij}$ ) and "iceberg" variable ( $\tau_{ij}$ ) bilateral trade costs, the price at destination ( $p_{ijt}$ ) is defined as:

$$p_{ijt} = \tau_{ij} P_{jt} + T_{ij} \quad (2)$$

where  $P_{jt}$  is region  $j$ 's producer price index.

Substituting (2) into (1) yields:

$$M_{ijt} = N_{jt} Y_{it} \left( \frac{\tau_{ij} P_{jt} + T_{ij}}{P_{it}} \right)^{1-\sigma} \quad (3)$$

Under general equilibrium, region  $j$ 's producer price must adjust such that the market clearing condition is satisfied. Assuming instantaneous adjustment, which seems fairly plausible at the regional level, we have that:

$$Y_{jt} = \sum_{i=1}^I M_{ijt} \quad (4)$$

Substituting the import demand equation (3) into the market clearing condition (4), we can solve for  $N_{jt}$  as follows:

$$N_{jt} = \frac{Y_{jt}}{\sum_{i=1}^I Y_{it} \left( \frac{\tau_{ij} P_{jt} + T_{ij}}{P_{it}} \right)^{1-\sigma}} \quad (5)$$

Plugging (5) into (3), we obtain the following gravity equation:

$$M_{ijt} = Y_{it}Y_{jt} \frac{\left(\frac{\tau_{ij}P_{jt} + T_{ij}}{P_{it}}\right)^{1-\sigma}}{\sum_{i=1}^I Y_{it} \left(\frac{\tau_{ij}P_{jt} + T_{ij}}{P_{it}}\right)^{1-\sigma}} \quad (6)$$

If we further define the total income of Spain in year  $t$  as  $Y_{St} = \sum_{i=1}^I Y_{it}$  and the share of region  $i$ 's income in Spain's total income in year  $t$  as  $S_{it} = \frac{Y_{it}}{Y_{St}}$ , equation (6) can be rewritten as:

$$M_{ijt} = \frac{Y_{it}Y_{jt}}{Y_{St}} \frac{\left(\frac{\tau_{ij}P_{jt} + T_{ij}}{P_{it}}\right)^{1-\sigma}}{\sum_{i=1}^I S_{it} \left(\frac{\tau_{ij}P_{jt} + T_{ij}}{P_{it}}\right)^{1-\sigma}} \quad (7)$$

where region  $i$ 's total imports from region  $j$  not only depend on the relative incomes of the two regions and on their bilateral trade costs, but also depend on the importing regions' share in Spanish total income and on their average trade costs with respect to all exporting regions.

Due to the presence of the fixed trade cost, equation (7) contains a non-linearity that calls for a linear approximation so that standard panel data estimation techniques can be applied to the full sample (Baier and Bergstrand, 2009). We approximate that non-linearity by considering the squared distance. This formulation is also justified by the data, as shown in the next section, where it can be observed that Spanish island regions trade more at shorter and longer distances, but less at intermediate distances. Furthermore, in line with the basic idea behind gravity models that the intensity with which two partners trade is subject to pull and push factors, we follow Melitz (2007) and assume the total trade cost function  $TC_{ijt}$  to be a log-linear function of a set of all observable and unobservable factors that influence trade costs. Accordingly, we also incorporate the multilateral resistance terms represented by origin, destination and time fixed effects as in Baltagi et al (2003), Broto et al (2006), Bertoli and Fernández-Huertas (2013), Ortega and Peri (2014), among others. Thus we obtain the fully specified trade cost function as follows:

$$TC_{ij} = \delta_1 \ln d_{ij} + \delta_2 \ln d_{ij}^2 + \delta_3 \text{adj}_{ij} + \delta_4 \text{coast}_{ij} + \delta_5 \text{islands}_{ij} + F_i + F_j + F_t \quad (8)$$

where distance  $d_{ij}$  is measured in kilometres covered by road between regional capitals (for the case of island regions, sea distance is also measured in kilometres although they are not covered by road); the dummy  $\text{adj}_{ij}$  takes value 1 if both regions are adjacent; the dummies  $\text{coast}_{ij}$  and  $\text{islands}_{ij}$  take value 1 if one of the trading partners has coast or is an island, 2 if both have coast or are islands, and 0 if both trading partners are landlocked or are mainland regions;  $F_i, F_j, F_t$  are origin, destination and time fixed effects, respectively.

Log-linearizing equation (7), approximating regional demand by GDP and population, and incorporating the trade cost function (8) to approximate the non-linear term, we obtain the log-linearized reduced-form gravity equation to be estimated:

$$\ln M_{ijt} = \alpha + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \delta_1 \ln d_{ij} + \delta_2 \ln d_{ij}^2 + \delta_3 \text{adj}_{ij} + \delta_4 \text{coast}_{ij} + \delta_5 \text{islands}_{ij} + F_i + F_j + F_t + \varepsilon_{ijt} \quad (9)$$

where  $\frac{1}{Y_{st}}$  is absorbed into the constant term  $\alpha$ , common to all years and all country pairs, and into the fixed effect term  $F_t$ , and  $\varepsilon_{ijt}$  is the i.i.d. error term.

## 2.2. The Blinder-Oaxaca decomposition

Our method to disentangle distance and the “island effect” is based on the Blinder-Oaxaca methodology originally used in labour economics to study the effect of discrimination on wages. The procedure is due to Blinder (1973) and Oaxaca (1973) and it allows decomposing mean differences in any variable based on regression models adopting a counterfactual approach. With this technique, we decompose the bilateral trade differential between two groups of regions into a part that is explained by the regions’ characteristics, such as size and distance, and into a residual part that is due to other factors, such as differences in the estimated coefficients associated to the previous characteristics or to unobserved variables. This last term is often used as a measure of discrimination.

More explicitly, we estimate the gravity equation (9) for two groups of regions, group A (mainland regions) and group B (island regions), without imposing the constraint that coefficients are the same for both groups. This is justified by the empirical gravity equation that establishes that trade costs have two components, one that is fixed and another one that is variable. The average trade cost for a firm that wants to export from an island region using a combination of road and sea transport is going to be higher than the average cost that a firm faces when it exports from a mainland region and covers the same distance by road only.

Let’s define the expected (average) trade of a region  $r$  ( $r = \{A, B\}$ ) as  $E[Y_r]$  and the difference of expected trade between the two regions as:

$$\Delta Y = E[Y_A] - E[Y_B] \quad (10)$$

Given that the trade from region  $r$  is predicted by a linear gravity model defined as a set of size and friction variables of origin and destination, as represented by equation (9), the method gives a precise answer to the question of how much of the difference in expected trade  $\Delta Y$  is explained by differences in size or trade frictions.

The linear gravity model in equation (9) defines a relationship between a trade variable ( $Y_r$ ) and the regressors ( $X_r$ ) that can be represented in the following manner:

$$Y_r = X_r' \beta_r + e_r \quad (11)$$

Under the usual assumptions and rearranging, we can decompose the difference of expected trade between the two groups of regions as follows:

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]' \beta_B + E(X_B)' (\beta_A - \beta_B) + [E(X_A - X_B)]' (\beta_A - \beta_B) = D + C + I \quad (12)$$



Equation (12) shows three main terms. The first term,  $D = [E(X_A - X_B)]' \beta_B$ , is called endowments and it represents the part of the trade differential that is explained by group differences in the observed characteristics in vectors  $X_r$ , from the point of view of group B (island regions). In other words, it measures the expected change in Group B's average trade if Group B would have Group A's characteristics. For example, this term will capture the differences in trade due to size and trade frictions that island regions face. The second term,  $C = E(X_B)' (\beta_A - \beta_B)$ , is called coefficients and it represents the part of the trade differential explained by differences in coefficients. It measures the expected changes in Group B's average trade if Group B had the same coefficients as Group A. For example, this term will capture our hypothesized effect that distance impacts differently on island regions. The third term,  $I = [E(X_A - X_B)]' (\beta_A - \beta_B)$ , is called interaction and it represents the interaction between characteristics and coefficients. It measures the expected change in the average trade of island regions if these had both the same characteristics and coefficients of mainland regions.

Notice that both the second and third terms from equation (12) include the influence of coefficients on average trade and, as a consequence, both of them are going to be the centre of our interest. Our hypothesis states that differences in trade frictions between Mainland and Island regions (groups A and B, respectively) are going to display a stronger effect in explaining average trade gaps.

The literature has proposed various methods for allocating the interaction term to one of the other two components, so that differences in the variable of interest can be attributed either to differences in characteristics ( $X$ 's) - called explained difference - or to differences in the coefficients ( $\beta$ 's) - called unexplained difference - which is often used as the measure of discrimination. This follows from the two ways of representing the differences in the mean of the variable of interest. On the one hand, the difference between the average trade of Group A and Group B can be expressed by weighting the differences in the  $X$ 's by the coefficients of Group B, as follows:

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]' \beta_B + E(X_A)' (\beta_A - \beta_B) \quad (13)$$

On the other hand, the trade variation can also be equivalently expressed with respect to the coefficients of Group A, in which case, the equation becomes:

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]' \beta_A + E(X_B)' (\beta_A - \beta_B) \quad (14)$$

In both expressions there are two ways to partition the interaction term, since equations (13) and (14) are actually special cases of the general decomposition defined in equation (12). That is, equation (13) places the interaction into the unexplained part while equation (14) places it into the explained part:

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]' \beta_B + E(X_A)' (\beta_A - \beta_B) = D + (C + I) \quad (13')$$

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]' \beta_A + E(X_B)' (\beta_A - \beta_B) = (D + C) + I \quad (14')$$

Here it is important to note that the implicit assumption made in equation (13) is that discrimination is directed towards Group A (Mainland regions) and there is no positive

discrimination for Group B (Island regions). In equation (14) the assumption is the opposite, that is, there is negative discrimination for Group B (Island regions) but there is no positive discrimination for Group A (Mainland regions). Under our theoretical framework, we are testing whether discrimination runs against Island regions since distance and, likely, other trade frictions are going to have different effects on trade with respect to Mainland regions. In section 4 we present both types of decompositions.

Moreover, Oaxaca and Ransom (1994) suggest the use of a matrix of relative weights,  $W$ , as in the following expression:

$$E[Y_A] - E[Y_B] = [E(X_A - X_B)]'[W\beta_A + (I - W)\beta_B] + [(I - W)'E(X_A) + W'E(X_B)]'(\beta_A - \beta_B) \quad (15)$$

where  $W$  and  $I$  are the weights of the coefficients of Group A and the identity matrix respectively. When  $W = I$ , equation (15) becomes equivalent to decomposition (14), and when  $W = 0.5$  it is equivalent to the Reimers (1983) decomposition that uses the average coefficients over both groups. However, Neumark (1988) argues that when there is no economic reason to assume that the coefficients of one of the groups should be used as the nondiscriminatory reference model it is preferable to use the coefficients from a pooled regression over both groups. In section 4 we present the results under different assumptions.

### 3. Features of Spanish regions' trade

In this section Spanish regions' trade is described using two main sources of data for the total international and interregional trade of goods, in millions of euros, of each of the 17 Spanish regions (*Comunidades Autónomas*), in the period 1995-2011. International trade data was obtained from the Datacomex database, which is compiled by Spain's Ministry of Economy and Competitiveness. This database presents trade values and volumes of exports and imports, disaggregated by industry and mode of transport. Interregional trade data was extracted from the C-interreg database, compiled by the Center for Economic Forecasting (*CEPREDE – Centro de Predicción Económica*) at the Autonomous University of Madrid. Interregional trade flows are computed by multiplying the quantities in thousands of tons exported by each region to every other, using each mode of transport, by regional export prices obtained for each year, province (sub-region), mode of transport and product type. The data is cleaned to eliminate the international transit of goods that does not have Spanish regions as origin and/or destination, but it includes goods produced and sold within each region (internal trade). Here bilateral imports are simply the mirror image of bilateral exports. In section 4 our empirical analysis will focus only on interregional trade, that is, trade between Spanish regions.

Data for GDP (at 2008 market prices), population, and GDP's deflator (chained volume index with base 2008) are obtained from Spain's National Institute of Statistics (*INE – Instituto Nacional de Estadística*). The distance between regional capitals was calculated using the road distance in kilometers, which was extracted from the regional distance matrix provided by Spain's National Geographic Institute (*IGN – Instituto Geográfico Nacional*). In the case of the

Canary Islands and the Balearic Islands, a combination of road and sea distance is calculated using Google Map's API.

Before turning to estimation results, a preliminary look at the trade data already reveals important differences in the trade structure of mainland and island regions (Table 1). On the one hand, island regions sell more domestically (57.9% for island regions against 30.5% for mainland regions). On the other hand, they sell relatively more internationally than to other Spanish regions (the interregional trade of island regions is 71% of their international trade, against 63% for mainland regions). This fact reveals that Spain's island regions do not lack international competitiveness, however their substantial interregional trade deficit, driven by their lower share of interregional sales and a higher dependence on interregional imports (52.2% against 37.7% for mainland regions), reveals their trade disadvantage within Spain. Moreover, the issue assumes greater political economy relevance for these regions, because the small economic size of island regions elevates their trade deficit up to 27.3% of their GDP, whilst they account for only 2.3% and 4.5% of Spain's export and import flows, respectively.

	Total		International			Interregional			Internal		
	million €	% Spain	million €	% Spain	%Geo	million €	% Spain	%Geo	million €	% Spain	%Geo
<b>EXPORTS</b>											
MAINLAND REGIONS	507,013	97.6%	136,308	98.4%	26.9%	216,170	98.6%	42.6%	154,536	95.5%	30.5%
ISLAND REGIONS	12,059	2.3%	2,110	1.5%	17.5%	2,973	1.4%	24.7%	6,976	4.3%	57.9%
SPAIN	519,359	100.0%	138,456	100.0%	26.7%	219,160	100.0%	42.2%	161,743	100.0%	31.1%
<b>IMPORTS</b>											
MAINLAND REGIONS	542,494	95.2%	183,370	97.0%	33.8%	204,588	93.4%	37.7%	154,536	95.5%	28.5%
ISLAND REGIONS	25,860	4.5%	5,387	2.8%	20.8%	13,496	6.2%	52.2%	6,976	4.3%	27.0%
SPAIN	569,945	100.0%	189,043	100.0%	33.2%	219,160	100.0%	38.5%	161,743	100.0%	28.4%
<b>TRADE BALANCE</b>											
	Total		International			Interregional					
	million €	%GDP	%Spain	million €	%GDP	million €	%GDP				
MAINLAND REGIONS	-35481	-4.8%	70.1%	-47063	-6.4%	11582	1.6%				
ISLAND REGIONS	-13801	-26.2%	27.3%	-3278	-6.2%	-10523	-20.0%				
SPAIN	-50586	-6.4%	100.0%	-50586	-6.4%	0	0.0%				

Sources: DataComex and C-interreg

Note: The data for Spain is the aggregate of mainland regions, island regions, and the two autonomous cities of Ceuta and Melilla.

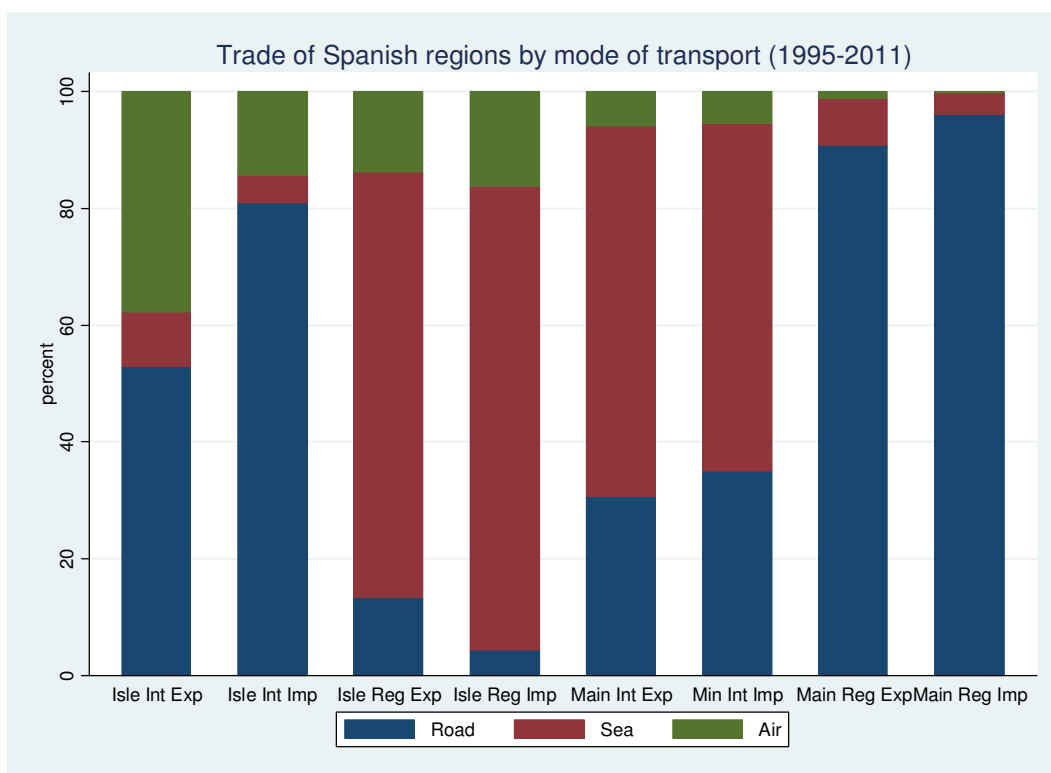
Gravity models suggest that, in the absence of all sorts of barriers typical of international trade such as tariff and non-tariff barriers, language barriers or red tape costs, the island regions' disadvantage in interregional trade is likely due to the trade fixed costs incurred by these regions. Since distances are greater in international trade, the higher variable costs due to greater distances help to offset the islands' fixed costs, which are not present for mainland regions. However, in the shorter distances of interregional trade, variable costs are not high enough to lower average costs sufficiently and island regions incur a disadvantage that leads to an interregional deficit that is 3.6 times larger than their international trade deficit.

As presented in Figure 2, some indirect evidence regarding the different decomposition of trade costs for mainland and island regions is provided by their relative use of road, sea and air modes of transport in their interregional and international trade.<sup>5</sup> For both region groups, the use of air transport is higher in international trade, but island regions use it relatively more in

<sup>5</sup> See the Appendix for the group codes used in Figure 2.

both cases. In the case of Spain, the higher use of air transport in interregional trade made by island regions is determined mainly by tourism-related activities.<sup>6</sup> The use of sea transport made by island regions in interregional trade is roughly comparable to that of mainland regions in international trade. This is because mainland regions are able to use only road transport in their trade with other mainland regions, whilst island regions have to use a combination of road and sea transport, which bears high fixed costs in terms of fees and taxes, besides the time lost in transport. This is thus indirect evidence that higher fixed trade costs are incurred by island regions in shorter distance (lower variable cost) trade compared to longer distance (higher variable cost) trade, with the consequence that the average trade cost is relatively higher for island regions, especially at intermediate distances such as those of interregional trade.

**Figure 2**



In conclusion, it can be said that, in the case of Spain, island regions trade relatively more internally and internationally than with other regions in the same country. They also show a strong dependency from regional imports and this, together with their higher focus on international export markets, causes a high and persistent interregional trade deficit. At the same time, the performance of island regions in international markets reveals that they do not lack competitiveness, but instead their interregional deficit is due to higher fixed and variable trade costs springing from respectively the impossibility of using solely road transport and a greater average distance from markets and suppliers. Moreover, the fixed trade cost is

<sup>6</sup> For example, the refilling of airplane tanks is classified as an export of fuel and the acquisition of airplanes is classified as an import of equipment.

relatively more important at intermediate distances, which raises their interregional average trade cost. Combining this information with the importance of internal trade, it appears justified that distance does enter the trade cost function quadratically: it matters less in short and long distances (internal and international trade), but it matters the most in intermediate distances (interregional trade). This non-linearity will be formally tested in the following section.

#### **4. Empirical results**

The first step of our empirical strategy consists of the estimation of equation (9) for the exports and imports of mainland and island regions. Accordingly, the dependent variable is either the total value of exports or the total value of imports from region  $j$  to region  $i$  in year  $t$ . Moreover, the gravity models for the interregional export and import flows are estimated for two different samples: Group A when the exporter/importer is a mainland region and the trade partner is either a mainland or an island region; and Group B when the exporter/importer is an island region and, again, the trade partner is either a mainland or an island region.

The estimation results are fairly standard within the gravity model literature and therefore are relegated to the Appendix (see Table B1). In general, the model explains 75-88% and 90-92% of the variation in interregional trade for island and mainland regions, respectively. As predicted by the gravity equation, the economic size of the regions, measured in terms of GDP and population, matters to explain both exports and imports. Moreover, trade costs negatively affect bilateral trade between regions. In particular for the island region sample (group B), distance presents the expected negative sign implying that regions located further away from each other trade less than closer ones, although it is only significant for imports. Moreover, the positive sign of the quadratic distance term shows that distance matters the most in intermediate distances. Island regions do not have adjacent regions, and that reduces their trade given the positive sign of the adjacency dummy in the mainland region sample, but they have a coast that facilitates trade since it allows for sea transport. Another interesting result is that island regions export more to other island regions than to mainland regions while the opposite happens for imports.

With respect to the mainland region sample (group A), distance presents an unexpectedly positive first-order effect with decreasing strength, validating the existence of non-linearity in trade costs, even for mainland regions. Moreover, the adjacency variable presents a very large positive effect, so that it captures the distance effect. Therefore, in this case, contiguous regions trade more with each other, not because they are closer, but because the transport connectivity between them is higher and because they face lower information costs in their bilateral trade due to the existence of business and personal contacts leading to better knowledge of the consumers and producers, as well as of market opportunities. Moreover, mainland regions export more to island regions, because the latter are highly dependent on imports, but they import more from other mainland regions.

Once the gravity model is estimated for the two groups, the second step consists of applying the Blinder-Oaxaca decomposition to the gravity results of Table B1. The results for the general decomposition, applied separately to exports and imports, are presented on Table 2. The results show that Island regions trade less with other Spanish regions than Mainland regions. In the case of exports, the trade difference is 2.75 while in the case of imports the difference is lower but still significant, meaning that the lower bound for the regions trade difference is 0.91. The decomposition also shows that the difference due to endowments is -5.98 for exports and 6.07 for imports, the difference due to coefficients is 5.21 and -2.74 for exports and imports respectively, and the differences due to the interaction are 3.52 for exports and -2.41 for imports.

<b>Table 2: General decomposition</b>		
	<b>Exports</b>	<b>Imports</b>
<b>Mean prediction for</b>		
<b>(A) Mainland Regions</b>	5.15*** (-0.142)	4.98*** (-0.148)
<b>(B) Island Regions</b>	2.40*** (-0.349)	4.07*** (-0.422)
<b>Differences (A)-(B)</b> <b>due to</b>		
<b>Endowments</b>	-5.98** (-2.475)	6.07** (-2.800)
<b>Coefficients</b>	5.21*** (-0.951)	-2.74*** (-0.954)
<b>Interaction</b>	3.522 (-2.606)	-2.417 (-2.916)
<b>Note: Robust standard errors clustered at region-pairs in parentheses.</b>		
<b>Significance levels are denoted by *** p&lt;0.01, ** p&lt;0.05 and * p&lt;0.1.</b>		
<b>Dependent variables are in logs.</b>		

These results reveal that differences in endowments and in coefficients are the most important explanations for the trade gap between regions. The differences in interactions are also relevant from an economic point of view, but not significant. However, due to the fact that the effects of endowments and coefficients partially cancel out each other (especially for exports) as they are of opposite signs, the interaction effect could be potentially relevant in the analysis of discrimination.

To make the interpretation clear, the analysis on Table 2 shows that if Island regions had the same characteristics as Mainland regions, the mean exports at Islands would be reduced by 6 log points while imports at Island regions would increase by 6.1 log points. That is, the differences in endowments have roughly the same effect on expected exports and imports but with opposite sign. Similarly, if Island regions had the same coefficients as Mainland regions, exports would rise at Islands by 5.2 log points and imports would be reduced by 2.7 log points. The interaction between endowments and coefficients has the same sign as the coefficient effect and opposite to that of the endowment effect, which makes unclear what the joint

effect of differences in coefficients would be on the trade outcome, since the interaction component embodies a part of the explanatory power of coefficients.

Before entering the discrimination analysis, we show in Table 3 the separate effect of detailed grouped variables such as Size, Distance and Other Frictions. Size indicates the joint prediction made by GDP and population from  $i$  and  $j$ , whilst Distance represents the polynomial of distance from  $i$  to  $j$  and its square. Other Frictions contains all  $(i, j)$  terms - the dummy for adjacency, the coast variable, and the islands variable – as well as the fixed effects  $(i, j, t)$ . The results show that the two components of the Distance effect are positive and statistically significant for exports and imports while the effect of Other Frictions is mostly negative for exports and positive for imports. Furthermore, the coefficient effect of Distance is very large for both directions of trade, suggesting that trade would rise at Islands if they had the same coefficients as Mainland regions.

<b>Table 3. Detailed decomposition</b>			
	<b>Endowments</b>	<b>Coefficients</b>	<b>Interaction</b>
<b>Panel A. Exports</b>			
<b>Size</b>	1.237 (1.451)	-174.0** (71.96)	-1.495 (1.403)
<b>Distance</b>	0.934*** (0.242)	23.58* (13.25)	0.560** (0.271)
<b>Other Frictions</b>	-6.008** (2.443)	-6.741** (3.118)	4.026 (2.504)
<b>Fixed effects</b>	-2.142 (1.766)	-1.626 (3.982)	0.431 (1.832)
<b>Total</b>	-5.979** (2.475)	5.207*** (0.951)	3.522 (2.606)
<b>Panel B. Imports</b>			
<b>Size</b>	-0.0291 (0.798)	-7.771 (61.63)	0.0814 (0.757)
<b>Distance</b>	2.989* (1.547)	82.63*** (14.13)	-0.897 (1.643)
<b>Other Frictions</b>	0.00966 (0.272)	81.81*** (13.70)	1.484*** (0.408)
<b>Fixed effects</b>	0.337 (1.767)	4.616 (4.587)	0.143 (1.927)
<b>Total</b>	3.297 (3.175)	-1.803* (1.043)	-0.672 (3.306)
<b>Notes: Robust standard errors clustered at region-pairs in parentheses. Significance levels are denoted by *** p&lt;0.01, ** p&lt;0.05 and * p&lt;0.1. Dependent variables are in logs. The Coefficient column sums up to the Total effect when we introduce the differences accounted for by the intercept.</b>			

From the previous decomposition, we are unable to disentangle what part of the interaction term is attributed to the Endowment difference and what part to the Coefficient difference. Therefore, in Table 4 we perform a discrimination analysis as described in Section 2.2. In Column (1) we present the results from assuming that discrimination runs only against Group B (Island regions), as in equation (14). This is a priori our preferred assumption since the gravity

model suggests a larger trade disadvantage of Island territories when trading with the rest of regions. In Column (2) we assume that discrimination is directed towards Group A (Mainland regions). In Column (3) we employ Reimers (1983) weight, which is a simple average of coefficients of both types of regions. Last, in Column (4) we present Neumark's (1988) approach consisting of the use of the coefficients from the pooled model.

<b>Table 4: Oaxaca decomposition</b>				
	(1)	(2)	(3)	(4)
<b>Panel A. Exports</b>				
<b>Explained</b>	-2.457	-5.979	-4.218	2.001
<b>% explained</b>	-89.3	-217.3	-153.4	72.7
<b>Unexplained</b>	5.207	8.730	6.968	0.75
<b>% unexplained</b>	189.3	317.3	253.4	27.3
<b>Panel B. Imports</b>				
<b>Explained</b>	3.656	6.073	4.864	1.662
<b>% explained</b>	400.4	665.2	532.7	182.0
<b>Unexplained</b>	-2.743	-5.160	-3.951	-0.749
<b>% unexplained</b>	-300.4	-565.2	-432.7	-82.0

**Note:** Dependent variables are in logs.

The results show that the unexplained component is positive and larger than the explained component for exports in three out of four columns. In terms of our model, this implies that exports at Island regions should increase if coefficients were the same as in Mainland regions. Under our preferred assumption (i.e. first Column), exports should rise by 5.2 log points at islands. Regarding imports, the unexplained component is negative, meaning that imports would be lower at Islands if coefficients were the same as at Mainland regions. Again, under our preferred assumption, imports should decrease by 2.7 log points at islands. That result is driven by the fact that island regions are highly dependent on imports. As shown in Table 1, island regions present a large trade deficit in its interregional trade which is driven by both their low level of exports and their high level of imports.

To disentangle the contribution of different variables to the trade gaps, on Table 5 we present the separate effects of the variables grouped as in Table 3. Focusing on the role of distance, we find that in both exports and imports the unexplained component is very large, that is, around 5 times higher than the total in the case of exports, and 10 times higher than the total in the case of imports. This suggests that the difference in distance coefficients between Island and Mainland regions is explaining an important part of trade gaps. For example, if Islands would have the same distance coefficients as Mainland regions, exports at Islands would rise by 24 log points and imports by 80 log points. The explained component of distance is also positive but of lower magnitude than the unexplained one. One possible explanation could be that distance has a positive coefficient in the case of Mainland regions and adjacency captures the proximity effect.



There are other noticeable unexplained effects captured by other variables. For instance, size discrimination operates with a negative sign, meaning that Islands would trade less if size coefficients would be the same as in Mainland regions. However, this effect is only significant for exports. Although Mainland regions are larger on average, we need to take into account that it is a very heterogeneous group in terms of size. So, one possibility is that there are small regions in Spain in terms of GDP and/or population that trade less than island regions.<sup>7</sup> Other Frictions, apart from distance, seem to exert an important effect, negative for exports and positive for imports, validating the importance of the distinction between the variable costs of distance and the fixed costs of border effects.

## 5. Conclusions

The main objective of this paper is to disentangle the effect of distance and of sea borders on interregional trade involving island regions. To that end, we consider the case of Spain, a country with two island regions: Balearic Islands and Canary Islands. The impact of land borders, as political borders that negatively affect the trade of adjacent regions located in different countries, has been extensively studied in the international trade literature. On the contrary, the role of sea borders, as geographical borders that impact negatively on the trade of non-adjacent regions located in the same country, remains unstudied. Sea borders produce similar negative effects upon trade as land borders, as they originate fixed costs, and thus require a modification of the trade cost function to reflect that. However, land political borders imply red tape, administrative and language barriers, whilst sea geographical borders raise the need to pay fees and taxes, as well as the time-loss inefficiency, related to the use of two modes of transport (road and sea typically). Whereas in the former case barriers can be reduced through free trade agreements, this instrument is not available in the latter case.

The empirical strategy used in the paper consists of two different stages. Firstly, a gravity model for interregional exports and imports is estimated for two different groups: Island regions and Mainland Regions. Then, a Blinder-Oaxaca decomposition is applied to the gravity estimation results in order to disentangle the distance and border effects for those regions, net of all other factors controlled for in the gravity estimations.

We present evidence of the relevance of the Island effect as a special border effect, since island regions are at a substantial disadvantage compared to mainland regions. We disentangle the channels through which the Island effect determines trade flows among regions and evaluate their relative importance in explaining trade gaps with respect to Mainland regions. In particular we extend a gravity model to include different trade costs for Islands and estimate the separate effect of distance and other trade frictions for Island and Mainland regions.

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<sup>7</sup> La Rioja, for example, is a small Mainland region extremely specialized in producing and selling wine outside its territorial boundaries.

**Table 5: Detailed Oaxaca decomposition**

	(1)		(2)		(3)		(4)	
	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained
<b>Panel A. Exports</b>								
<b>Size</b>	-0.258 (0.235)	-174.0** (71.96)	1.237 (1.451)	-175.5** (72.66)	0.489 (0.766)	-174.8** (72.31)	-0.277 (0.283)	-174.0** (71.95)
<b>Distance</b>	1.494*** (0.261)	23.58* (13.25)	0.934*** (0.242)	24.14* (13.41)	1.214*** (0.212)	23.86* (13.33)	1.427*** (0.259)	23.65* (13.25)
<b>Other Frictions</b>	-1.982*** (0.658)	-6.741** (3.118)	-6.008** (2.443)	-2.715* (1.530)	-3.995*** (1.278)	-4.728** (2.113)	0.963 (0.843)	-9.686*** (2.902)
<b>Fixed effects</b>	-1.711*** (0.584)	-1.626 (3.982)	-2.142 (1.766)	-1.195 (4.550)	-1.927** (0.944)	-1.411 (4.176)	-0.112 (0.628)	-3.225 (4.028)
<b>Total</b>	-2.457*** (0.947)	5.207*** (0.951)	-5.979** (2.475)	8.730*** (2.439)	-4.218*** (1.346)	6.968*** (1.315)	2.001* (1.108)	0.750 (1.102)
<b>Panel B. Imports</b>								
<b>Size</b>	0.0911 (0.131)	-82.80 (63.27)	0.750 (0.967)	-83.46 (63.94)	0.421 (0.521)	-83.13 (63.60)	0.0826 (0.123)	-82.79 (63.29)
<b>Distance</b>	1.534*** (0.268)	79.63*** (15.27)	-0.0975 (0.284)	81.26*** (15.40)	0.718*** (0.179)	80.45*** (15.33)	1.384*** (0.249)	79.78*** (15.28)
<b>Other Frictions</b>	1.573*** (0.606)	2.026 (4.110)	3.335*** (0.736)	0.264 (4.390)	2.454*** (0.491)	1.145 (4.227)	1.712*** (0.605)	1.888 (4.279)
<b>Fixed effects</b>	0.458 (0.765)	5.254 (4.353)	2.085 (1.842)	3.627 (2.943)	1.271 (1.011)	4.440 (3.583)	-1.516* (0.891)	7.228* (4.089)
<b>Total</b>	3.656*** (0.988)	-2.743*** (0.954)	6.073** (2.800)	-5.160* (2.757)	4.864*** (1.511)	-3.951*** (1.459)	1.662 (1.123)	-0.749 (1.066)

Notes: Robust standard errors clustered at region-pairs in parentheses. Significance levels are denoted by \*\*\* p<0.01, \*\* p<0.05 and \* p<0.1. Dependent variables are in logs. Unexplained columns sum up to the Total effect when we introduce the differences accounted by the intercept.

Our findings suggest that Island regions are unevenly affected by regional characteristics but more importantly by the estimated coefficients associated to those characteristics. This is consistent with our hypothesis that there are specific trade costs that Island territories are subject to. Moreover, our results suggest that among the different variables that reduce trade, distance is by far the most important variable explaining the trade gap among different types of regions. It presents a non-linear (quadratic) behaviour which validates the presence of the fixed cost of trade and differs between groups: distance impacts on Islands trade with a U-shape, explaining their poor performance at intermediate distances, but it presents an inverted U (pre-maximum) influence on Mainland trade.

The results leave no doubt that island regions are at a substantial disadvantage in trade compared to mainland regions. However, this disadvantage seems to be even more related to the lack of adjacency imposed by the sea border rather than to the higher average distance and its non-linear effect, although both factors compound the fixed cost of trade. Islands naturally reacted to their higher fixed cost by substituting intermediate distance (interregional) trade with short distance (internal) and long distance (international) trade. Although the paper uses data for Spain, its message is transferable to other trade contexts where there are both islands and continental regions.

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## Appendix

### A. Group codes used in figure 2

REGION GROUP	GEOGRAPHICAL DIMENSION	TRADE FLOW
Islands (ISLE)	International (INT)	Exports (EXP)
Mainland (MAIN)	Interregional (REG)	Imports (IMP)

### B. Gravity model results

Table B1: Gravity model estimates				
	Island regions		Mainland regions	
	(1) Exports	(2) Imports	(3) Exports	(4) Imports
<b>GDP<sub>i</sub></b>	-5.064 (9.196)	5.174 (5.459)	1.196** (0.481)	2.261*** (0.639)
<b>GDP<sub>j</sub></b>	6.882*** (2.273)	4.322** (1.632)	1.191* (0.622)	0.791 (0.702)
<b>Pop<sub>i</sub></b>	15.17** (7.367)	2.420 (4.663)	-1.303*** (0.358)	-0.832* (0.443)
<b>Pop<sub>j</sub></b>	-3.924* (2.192)	-2.883** (1.368)	-0.156 (0.462)	-0.879 (0.556)
<b>Distance<sub>ij</sub></b>	-6.145 (4.369)	-23.71*** (4.983)	1.688** (0.814)	2.514*** (0.869)
<b>Distance squared<sub>ij</sub></b>	0.379 (0.338)	1.774*** (0.384)	-0.250*** (0.0699)	-0.318*** (0.0754)
<b>Adjacency<sub>ij</sub></b>			0.382*** (0.111)	0.455*** (0.115)
<b>Coast<sub>ij</sub></b>	3.177*** (1.130)	1.441 (3.377)	1.464*** (0.276)	1.418*** (0.326)
<b>Island<sub>ij</sub></b>	5.103* (2.707)	-3.955** (1.713)	1.619** (0.652)	-2.014*** (0.603)
<b>Constant</b>	-162.9* (81.18)	2.341 (63.34)	1.158 (7.481)	-4.509 (8.388)
<b>Observations</b>	487	527	4,512	4,472
<b>R-squared</b>	0.756	0.884	0.918	0.908

Notes: Robust standard errors clustered at region-pairs in parentheses. Significance levels are denoted by \*\*\* p<0.01, \*\* p<0.05 and \* p<0.1. Dependent variables, and GDP, Population and Distance variables are in logs. Fixed effects (i, j, t) are included in all regressions (but omitted for brevity).

Please note:

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The Editor