The Factor Content of Bilateral Trade:

Evidence from Spanish regions

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Abstract

Deviating from the factor content studies on the Heckscher-Ohlin-Vanek (HOV) theorem, this paper applies the methodology proposed by Choi and Krishna (2004) to test the restrictions (derived by Helpman, 1984) on the factor content of bilateral trade flows. They require neither factor price equalisation nor any restrictions on preferences. We test the restrictions using a unique dataset that covers the 17 Spanish regions in 1995. We are unable to reject the restrictions implied by the theory for the majority of region pairs. We also perform an experiment: are the restrictions implied by the factor-endowment driven theory satisfied when bilateral trade flows are predicted by a gravitational model? In this case these restrictions are rejected in the majority of cases. We take this result as further evidence that the Heckscher-Ohlin model performs well at regional level.

JEL classification: F1.

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1. Introduction

The Heckscher-Ohlin model (HO) is the cornerstone of international and interregional trade theory. The popularity of HO reflects the useful insight into trade patterns as well as the income distribution consequences of trade that it provides. Firstly, trade flows are dictated by the comparative advantage arising from initial factor endowments. Secondly, trade volume is expected, *ceteris paribus*, to be positively correlated with the dispersion of relative factor endowments. A capital-abundant region is expected to trade more with a labour-abundant region than with another capital-abundant region. Finally, trade liberalisation raises the reward accruing to the relatively abundant factor and lowers the reward accruing to that which is relatively scarce.

Empirical research on the HO model has largely focused on the HOV theorem, which compares the factor content of net trade with factor abundance and predicts that a capital-abundant country should export capital services. Empirically, the HOV theorem that maintains strict assumptions of identical technology, factor price equalisation and identical homothetic preferences has been rejected repeatedly (Bowen *et al.*, 1987; Maskus, 1991). In recent contributions, Trefler (1993, 1995), Davis and Weinstein (2001) and Hakura (2001) amend the traditional model by relaxing those restrictive assumptions and provide strong evidence supporting the modified HOV theorem using country-level data.

There are only a few papers that put the HO model to test using regional data and, to the best of our knowledge, only two papers, Davis *et al.* (1997) for Japan and Requena et al (2006), have tested the HOV model using regional data. Both papers find poor support for the HOV model in its strict setting, that is, under world factor price equalisation and world identical, homothetic preferences. Both papers find that the HOV model performs remarkably well when factor price equalisation and identical homothetic preferences hold only at regional level. The main difference between both papers is that the fit of the model for the Spanish regions is not as good as it is for the Japanese prefectures.[1]

The objective of this paper is to test the Heckscher-Ohlin model. We use a new approach, that relates the factor content of bilateral trade to bilateral differences in factor

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[1] While Davis et al (1997) results exhibit a percentage of correct matches between observed and predicted factor content of trade across regions and factors above 90% of the times, Requena et al (2006) results show a 70% of correct matches.

endowments between trading partners.For Spain, past empirical evidence on the HO model has only employed data on a national scale and used Leamer's approach, which is an "incomplete test" as it does not use information regarding factor endowments. The reason for focusing on regions rather than countries is that the regions in one same country should share similar relative factor endowment, state of technology and preferences, necessary conditions for the HOV theory to hold. This central standing of the factor proportions model in international economics has appropriately prompted, particularly recently, intense empirical scrutiny. Researchers testing this framework have largely focuses on an elegant prediction of the model relating to net factor content of trade that obtains in even its multicountry, multifactor and multicommodity version: the well-known Heckscher-Ohlin-Vanek (HOV) prediction. This holds under the assumptions that technologies everywhere are identical, that trade equalises factor prices worldwide, and that consumer preferences everywhere are identical and homothetic, the net exports of factors by a country will equal the abundance of its endowment of these factors relative to the country´s world income share. Early tests of the HOV prediction in its strict form, such as that first carried out by Leontief (1953), and subsequent studies conducted by Bowen *et al.* (1987) and Maskus (1991), probed very disappointing with the theory.

The theoretical implications of the endowment-driven theory of production and trade have stimulated a line of research aimed at discovering why the HOV model performs so badly. Trefler (1995) reports that the traditional HOV model is rejected in favour of a modification that allows for international technology differences and Armington home bias in consumption. Davis and Weinstein (2001) show that the HOV model, when modified to allow Hicks-neutral technology differences, factor price differences, the existence of nontraded goods and trade costs, is consistent with data from ten OECD countries.

Recently, Choi and Krishna (2004) propose to abandon the HOV framework and to use an alternative approach to test the factor proportions theory. They implement a test of restrictions implied by the theory (derived originally by Helman, 1984) on the factor content of trade that relies neither on factor price equalisation nor on any restrictions on preferences. In addition, rather than examining the net factor content of a country´s multilateral trade, their test concern bilateral trade flows.

Helpman (1984) result, itself an intuitive (and general) formalisation of important earlier work by Brecher and Choudhri (1982) is both straightforward and powerful: even in the absence of factor price equalisation, with identical technologies across countries, it is a simple matter to observe that the more capital-rich country is, the more capital and less labour it uses in all lines of production, while correspondingly achieving a higher wage-rental ratio. Hence, whatever trade exists between two countries, exports of the capital-rich country will embody a higher capital–labour ratio than the exports of the relatively labour-rich country. This, in turn, describes a clear bilateral factor content of trade. Specifically, the theory implies, on average, a country imports those factors that are more expensive there.[2] Choi and Krishna (2004) investigate (7) for a sample of 8 OECD countries in 1980 which results into 28 bilateral comparisons.[3] Employing a variety of factor price measures, their data generate signs compatible with the theoretical predictions in about 80% of the cases. Lai and Zhu (2006) investigate (7) for a sample of 41 developed and developing countries in 1996. Again the data generate signs compatible with the theoretical predictions in about 99% of the pair regions with sufficient disparate endowments and technology and about 80% of the regions pairs with similar endowments and technology.

In contrast to previous studies that have focused on international trade flows, our empirical analysis exploits a unique dataset that covers the 17 Spanish regions and contains information on technology matrices, bilateral trade flows and factor remuneration for capital and (dissagregated) labour.

Our results are as follows: The restrictions implied by the theory for bilateral trade flows are satisfied for the majority of region pairs in our sample. We must note that in many cases, the theory is “just” satisfied. Our funding that the theory, when tested without the imposition of factor price equalisation and identical and homothetic preferences across regions, is not rejected by the data is a significant one. Our results are robust to a variety of tests. First, similar results are found when we alternative measures of factor prices. Second, the results slightly improve when we eliminate non-tradable industries from our calculations, revealing that factor price equalisation cannot explain alone our findings.

[2] It is worth noting that the theoretical restrictions that we test here are easily extended to accommodate the possibility of technological differences (Hick-neutral differences and industry-specific differences). See Choi and Krishna (2004) and Lai and Zhu (2006).

[3] The country sample consists of the US, Canada, Denmark, France, Germany, UK, Netherlands and Korea.

Finally, we apply the restrictions implied by the theory for bilateral trade flows to bilateral export flows predicted by a gravitational model. In this case, the restrictions are rejected for the majority of regions pairs and in most cases the values are lower than those obtained using actual bilateral trade flows. We interpret this last finding as evidence in favour of the Heckscher-Ohlin model.

The rest of the paper is structured as follows: Section 2 presents the Helpman´s (1984) basic result regarding restrictions on bilateral trade flows, incorporating additionally into the analysis the use of intermediates in production. We discuss the advantages and disadvantages of testing these restrictions over the standard HOV tests. Section 3 describes the data and Section 4 presents the empirical results. Section 5 concludes.

2. Theory and empirical hypothesis

Our analysis considers a freely trading world with many goods and countries in which production technology is convex, the technology for producing any good is assumed (for now) identical across countries, and perfect competition characterises both goods and factor markets. In this framework, as we have noted before, Helpman (1984), building on the work of Brecher and Choudhri (1982), derived intuitive restrictions on the factor content of bilateral trade between countries – relating factor content of trade to relative factor scarcities in the trading countries. The basic insight behind the Helpman´s result can be easily explained using the Lerner diagram. Figure 1 considers the case of 3 countries, 6 goods and 2 factors (capital, K, and labour, L). Countries are ranked according to their relative factor endowments: $(K/L)^1 > (K/L)^2 > (K/L)^3$. Moreover, there is a one-to-one correspondence between this factor endowment ranking and the ranking of free trade equilibrium price ratios: $(w/r)^1 > (w/r)^2 > (w/r)^3$. Therefore, in any pairwise comparison, the more capital abundant country will also have the higher equilibrium wage-rental ratio. Since countries´ factor endowments are assumed to be in different cones of diversification, the three countries will specialise in the production of different goods. The most capital abundant country 1 will produce the most capital-intensive goods 1 and 2; country 2 will produce the goods 2 and 3 and the least capital-abundant country 3 will produce the least capital intensive goods 5 and 6.[4] It is a simple manner then to observe that the more capital-rich country is, the more capital and less labour it uses per euro of output in all lines of production. Hence, whatever trade takes place between any two countries, the exports of the relatively capital-rich country will embody a higher capital-labour ratio than the exports of the relatively labour-rich country. This, in turn, describes a clear bilateral factor content pattern of trade even in the absence of factor price equalisation and any assumption regarding preferences.

<INSERT Figure 1 HERE>

Formally, consider a competitive equilibrium with m countries, n goods and f factors. Under the maintain assumption of identical technologies across countries, nonequalisation of factor prices will still result in the use of different techniques of production across countries. For any country *i*, let Q^i be the gross output vector, Y^i be the net output vector, and V^i the vector of factor endowment. Then $Y^i = (I - B^i)Q^i$ and $D^i(I - B^i)^{-1}Y^i = V^i$, where $D^i(I - B^i)^{-1}$ is the technology matrix or matrix of gross factor input requirements, which indicates the total (both direct and indirect) amount of each of the factors needed to produce one unit value of gross output within each of the industries, D is a matrix whose element (m,n) gives the average amount of factor *m* used directly to produce one unit of final output *n*, and B is the amount of intermediate input *m* used to produce one unit of good *n*. The matrix $D^i(I - B^i)^{-1}$ can be used to determine the factor content of trade by country *i*. If X^{ij} denotes the vector of gross exports from *i* to region *j*, define F^{ij} as the factor content of X^{ij} evaluated at the exporter´s input techniques,

(1) $F^{ij} = D^i(I - B^i)^{-1}X^{ij}$

In a free trade equilibrium a region´s GDP can be written as $G(p,V^j) = p'Y^j = w^{j\prime}V^j$ where w^j is the free trade factor price vector of the importing

[4] Brecher and Choudri (1982) used a 2-country Lerner-Pearce diagram to prove that the factor content version of the Heckscher-Ohlin theorem holds also in the absence of factor price equalisation: the relative capital abundant country will be a net exporter of capital and a net importer of labour.

county j and p is the free trade equilibrium price vector. Helpman (1984) derives the following relationship:

(2) $G(p,V^j) + p'X^{ij} = w^{j\prime}V^j + p'X^{ij} \leq G(p,V^j + F^{ij})$

(3) $G(p,V^j + F^{ij}) \leq w^{j\prime}V^j + w^{j\prime}F^{ij}$

Helpman´s justification for inequality (2) is based on the following experiment. If region j were given a factor endowment gift of F^{ij}, then the assumption of identical technologies implies that it would be feasible for region j to produce X^{ij} itself. However, since factor prices in region j are different than in region i, region j could do "potentially better" than that. Specifically, region´s j GDP from its "gift-augmented" endowment $G(p,V^j + F^{ij})$ will be at least as large as the sum of its pre-gift $G(p,V^j)$ and the market value of the corresponding imports $p'X^{ij}$. The second inequality (3) is a direct implication of the concavity of the GDP function with respect to factor endowments. Combining inequalities (2) and (3), one obtains $p'X^{ij} \leq w^{j\prime}F^{ij}$. Using the zero profit condition in the exporting country i, $p'X^{ij} = w^{i\prime}F^{ij}$, one obtains the relationship between the factor content of bilateral exports and the bilateral difference in factor prices:

(4) $\left(w^j - w^i\right)'F^{ij} \geq 0$

Applying the same logic to the factor content of exports from region j to i, F^{ji}, one obtains

(5) $\left(w^i - w^j\right)'F^{ji} \geq 0$

Combining (4) and (5), we can derive the following predictions on net bilateral factor content of trade for the bilateral trade flows between regions i and j:

(6) $\left(w^j - w^i\right)'(F^{ij} - F^{ji}) \geq 0$

Inequality (6) may be interpreted as saying that factors embodied in trade should flow towards the region with the higher factor price. If factor f has a higher absolute price in region j, $w_f^j - w_f^i > 0$, then region j will, "on average", be a net importer of that factor relative to region i, i.e. $F_f^{ij} - F_f^{ji} > 0$.

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Equation (6) can be rewritten in the following manner:

$$(7)\quad \frac{w^{j\prime}F^{ij} + w^{i\prime}F^{ji}}{w^{i\prime}F^{ij} + w^{j\prime}F^{ji}} \equiv \theta \geq 1$$

Equation (7) [henceforth CK inequality test] has a convenient interpretation. For any region pair, *i* and *j*, with gross bilateral exports flows, X^{ij} and X^{ji}, the ratio in (7) is the ratio of the sum of the importers´ *hypothetical* cost of production (using the factor prices of the importer and the factor usage of the exporter) to the *actual* cost of production of the exporting region (using the factor prices and factor usage of each of the exporting regions).

It should be readily evident that all variables in (7) relate to the equilibrium with trade. Inequality (7) may therefore be tested using data from the trade equilibrium that we “observe”. In implementing (7), one needs to take into account the important observation of Staiger (1986) that when intermediated are freely traded, Helpman´s measure of the bilateral factor content of trade needs to be modified to exclude the factor content of traded intermediate goods. Therefore, we perform the tests described above using the input-output matrices that include only the domestically produced intermediates.

The CK inequality test offer some significant advantages over the HOV-based tests that currently dominate the literature but also suffer from some disadvantages. The primary advantages are that the restrictions do not require that factor prices be equalised across countries and do not require any assumptions on consumer preferences. Both of these are significant relaxations of the theoretical assumptions that most HOV-based testing of the factor proportions model has been conducted. The focus on bilateral trade flows also enables the examination of trade flows between only a subset of countries for which quality data are available. The disadvantages of the restrictions are twofold. While the HOV-based tests provide exact predictions regarding the factor content of trade in each factor, the CK inequality test provide only a statement regarding the direction and magnitude of the flow of factors, on average. While the HOV-based tests permit to focus on only those factors in which we are interested or on which we have data, the CK test require information on all factors of production.

3. Data

The CK inequality test is performed using Spanish regional data in the year 1995. In order to do it we collect data on a technology matrix ($D^i (I - B^i)^{-1}$) and a factor price vector (w) for each region as well as the gross bilateral export vectors (X^{ij}) between them..

Our research is possible thanks to the access to two new databases, the *Spanish intertio* (Perez and Llano, 2000; Llano, 2004a) and the *interregional trade matrices 1995* analysed outside the input-output framework (Llano, 2004b). The first one contains comparable input-output tables for each one of the 17 Spanish regions in 26 sectors in 1995 so we can obtain homogeneous data on domestic demand, gross output and intermediate good consumption. It is worth noting that we use intermediate matrices that include only the usage of domestically produced intermediates, since Helpman´s measure of the bilateral factor content of trade needs to be modified to exclude the factor content of traded intermediate goods. The second database provides disaggregated (bilateral) trade flows between regions and between regions and the rest of the world.

The factor price data that we use in this paper were put together from a variety of sources. We consider two primary inputs, capital and (disaggregated) labour. Endowments data is taken from the *Encuesta de Población Activa* (EPA-INE) for the labour force and *El Stock de Capital en España* (Fundación BBVA-IVIE) for the capital stock data.

Regional value added, the number of employees and total compensation of employees in 1995 are obtained from *Contabilidad Regional de España* (CRE-INE). For the same year, labour return was obtained from *Encuesta de Estructura Salarial* (EES-INE). To achieve consistency of the factor price data with regional accounts, we started first with returns to aggregates (of labour and capital) and then moved on disaggregated returns. Thus to begin with, we require that the total return to labour in any region be equal to its compensation of employees; that is, we set compensation equal to $\sum_i w_i L_i$ where the summation is across disaggregated labour categories (described in greater detail below).

To determine the total return to capital, we let the operation surplus obtained from *intertio* database equal to ex post return to capital in the region (i.e. to set the operating surplus equal to rK). To obtain the return to capital per unit of capital we simply divided by the regional capital stock.[5]

Given the overall compensation for calculations of the total return to capital, we need next to returns to disaggregated labour. This is accomplished in the following manner. Endowments of labour in various education categories or occupations categories are obtained from EPA-INE (L_i) and the wage rates for each education category or occupational category are obtained from EES-INE. (w_i). To achieve consistency between regional income accounts (CRE) and the estimated number of employees (EPA) and wage rates (EES) we modified the series of employment and wage rate data as follows. We first scaled the number of employees obtained from EPA to equal the total number of employee from CRE. Next we calculated the modified wage rate ($\hat{w}_i$) for each labour category by solving

$\sum_i \hat{w}_i L_i = \text{wage bill}$ where $w_i / w_j = \hat{w}_i / \hat{w}_j \ , \forall i, j \in n$.

That is, we took the information about wage ratios between labour categories from the reported wage series and made the sum of constructed wage rates multiplied by the employment level of each labour category consistent with the measure of compensation of employees in the regional income accounts.

We use three types of labour categorisation. The first is to divide the labour force into high-educated (completed secondary education or more) and low-educated (incomplete secondary education or less). The second one is to divide the labour force into seven categories according to occupation: managerial, professional/technical, clerical and others non-manual workers, qualified non-manual and nonqualified manual workers.

<INSERT Table 1 HERE>

Table 1 presents the factor remuneration rates (panel A) and factor endowment stocks (panel B) for the 17 Spanish regions in 1995. A key point of the Lerner-Pearce diagram is that there is a positive correlation between relative factor rates and relative factor

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[5] We also constructed an alternative measure of total return on capital as the difference between GDP and wage compensation from CRE. The differences between both measures of capital remuneration were so small that the results were unaffected by the use of one or another variable.

endowments. The last panel of Table 1 reports the correlation across regions between relative factor rewards (w_i^{f1}/w_i^{f2}) and relative factor endowments (V_i^{f2}/V_i^{f1}) where i stands for region and *f1* and *f2* refer to two different endowments. For example, the value of 0.22 refers to the pair of factors capital and high education workers and indicates a positive correlation between $(w^{highedu}/w^{capital})$ and $(V^{capital}/w^{highedu})$. For case of the three factors, all the correlation coefficients are positive and relatively high. For the case of seven factors, three out of 21 coefficients are positive. The three exceptions include only labour categories: “other non-manual workers” and “qualified manual workers” (-0.33), “other non-manual workers” and ”qualified manual workers” (-0.11) and “managers” and “non-qualified manual workers” (-0.22).

4. Main results

The values of θ obtained using three factors and seven factors are reported in table 2 and 3, respectively. Keeping in mind the theoretical prediction that $\theta \geq 1$, we can see that the theory is satisfied directly for 89 of the 136 region pairs in table 2 (three factors) and for 85 pairs in table 3 (seven factors). In percentage terms, the inequality $\theta \geq 1$ is satisfied about 65% cases. The raw value of θ and the number of cases for which these values exceed one are indicative of the “degree” of success of the theory. A more formal analysis requires us to take into account the fact that our calculations of θ are subject to stochastic errors and that some assumptions about these errors are needed to interpret the results above. One possibility is to assume that a stochastic model in which the estimated value of the statistic θ equals the true value plus an error term that is symmetrically and independently distributed with zero mean. The probability that the value of the statistic exceeds one is 0.5 under the null hypothesis and greater than 0.5 under the alternative (that is θ >1). When the normal approximation to the binomial distribution (with 136 observations and with a probability of “success” in any given trial of 0.5) is used, the probability of finding 89 or more cases with the value of the stochastic above one is 0.0002 and that of finding 85 or more cases to be greater than one is 0.002. Thus the results reported in tables 2 and 3 reject the null hypothesis that the true value of the statistic is equal to one (against the alternative that it is greater than one) at even the 1 percent level.[6]

<INSERT table 2 HERE>

<INSERT table 3 HERE>

A point regarding the magnitude of the calculated θ´s is worth noting. While they are greater than one in most cases and while the theory is therefore not met with rejection in the data, it can be easily be seen that exporters´ costs do not seem much lower than importers´ costs of production (as reflected in value of θ not much greater than one in most cases). Should one infer that the value of θ close to one reflect near equalisation of factor prices among the Spanish regions?

It is worth recalling that the present theoretical framework offers no further insight into what the value of θ ought to be other than to require it to be greater than one. Nevertheless, given that θ simply measures ratio of production costs, one may imagine that the literature offers priors on what values of θ one should expect to see. This is, however, not immediately the case. First, it should be recognised that the ratio of θ is not a measure of autarky production costs differences between regions. Rather, it reflects differences in production costs in a trading equilibrium, which, given the tendency towards factor price equalisation of factors through trade, can be reasonably expected to be smaller than any measure of differences in production costs in autarky. The academic literature, to date, does not provide any priors on the extent of cost differences across regions in trade equilibrium.

Nevertheless, with values of θ so close to one, one may still suspect that the measured values of θ simply reflect nearly full equalisation of factor prices rather than trading patterns (i.e., export of cheaper factors, on average, as implied by the theory). Could the dot product on the left-hand side of (7) be close to zero, that is θ be close to one, simply because each term is the product is zero owing to identical factor prices across regions? We examine this possibility in two ways. A causal examination of the factor remunerations indicates significant factor price differences among the Spanish regions. For

[6] Probabilities are calculated using
http://people.hofstra.edu/faculty/stefan_waner/RealWorld/stats/bernoulli.html

instance, there is about 5 percent difference in the capital remuneration between Extremadura (14.0%) and La Rioja (19.1%); about 8000 euros difference in the remuneration of high educated workers between Murcia (15953 euros) and Madrid (24119 euros); and, about 6000 euros difference in the low education workers between Castilla-León (12521 euros) and Basc Country (18596 euros). For the pair CL-PV (Castilla-León-Basc Country), factor price differences are 2 percent higher in capital for CL, 23 percent higher in high educated wages for PV and 48 percent higher in low educated wages for PV. Such large wage differences should be reflected in a large values of θ. Table 2 reports a value of 0.93. This provides strong evidence that, among other things, production methods (i.e. technology matrices) are correspondingly different as well (themselves reflecting the factor price differences).

<INSERT table 4 HERE>

Second, we conducted an industry by industry analysis in which values of θ were determined for each industry for each region pair. If our reported findings on θ were driven simply by nearby equalised factor prices across regions, it must be the case that θ take values very close to unity for every industry as well. This is, however, most definitely not the case. Indeed, combining measures of θ across industries region pairs and analysing them gives us the following breakdown: Of 1470 industry-region pairs combinations, over 510 take value greater than 1.1 and 347 take value greater than 1.2.[7] Even at the industry level, θ takes values greater than 1 in the overwhelming majority of cases (993 cases). In contrast, fewer than 330 observations take values below 0.9, and only 58 observations take value below 0.8.

While it should be clear from the preceding discussion that factor price equalisation does not drive our findings of values of θ close to unity, one final observation regarding factor price differences and the “success” of the theory (fraction of region pairs for which the value of θ is greater than one) is nevertheless worth making. Consider the following

[7] The total number of industry-region pair combinations is 1768. This number is reduced to 1470 due to lack of bilateral trade between some regions pairs for some industries.

measure of “differences” in factor price vectors between *i* and *j*: $\sum_f \left(w_f^j - w_f^i\right)^2 \left(\overline{V_f^j / Y^j}\right)^2$.

We perform a Probit analysis to investigate the degree of correlation between the success rate of the theory (the dependent variable takes a value of one if $\theta \geq 1$, zero otherwise) and this measure of factor price differences (aggregating across factors). A positive coefficient indicates that for higher values of the expression, the success rate increases. The regression analysis is displayed in Table 5. The estimated coefficient is always positive (except when we calculate the restrictions industry by industry). However, they are only weakly significant, so our previous findings corroborating the good performance of the Heckscher-Ohlin model should be interpreted with caution.

<INSERT table 5 HERE >

An experiment

The gravity model has been widely and successfully used to explain bilateral trade flows. The gravity equation states that trade between two countries (regions) is directly proportional to their economic sizes and inversely proportional to the geographic distance between them. In this section we propose the following experiment: are the restrictions implied by the factor-endowment driven theory satisfied when bilateral trade flows are predicted by a gravitational model? If so, the CK restriction test will be valid not only for the Heckscher-Ohlin model (or other “comparative advantage” model) but also for any alternative model that serve to explain the direction of bilateral trade flows.

At the industry level, the gravity equation considered here takes the following form:[8]

(8) $\ln\left(1 + X_{ij,k}\right) = \beta_0 + \beta_1 \ln Y_{i,k} + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 ADJACENT_{ij} + \beta_5 HOME_{ii} + \varepsilon_{ij,k}$

where *i* indicates an exporting Spanish region and *j* indicates an importing Spanish region. $X_{ij,k}$ is the exports from region *i* to region or 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*; D_{ij}

[8] See Evans (2003) and Chen (2004) for a similar specification using international bilateral exports and industry-level data.

is the geodesic distance between i and j.[9] We add a dummy that takes the value of one for trade flows within regions and zero otherwise, to measure the border effect within Spain.
We estimate equation (8) using Ordinary Least Square.[10] The industry-specific regressions are reported in Table 6. The adjusted R^2 statistic is quite high in all the industries, ranging between 0.48 and 0.77. The results for each industry show that the elasticity of trade with respect to origin industry gross production to be greater than to unity in all but three industries; the elasticity of trade with respect to destination total market size to be close to unity and smaller than the previous elasticity; the elasticity with respect to distance to be smaller than one in absolute value. Regions that share a common border tend to trade much more among themselves than with non-adjacent regions. Finally, the border effect ranges between 13 [=exp(2.6)] and 900 [=exp(6.8)], taking most of the times a value between 20 and 60.

<INSERT table 6 HERE>

Next we calculate the factor content of bilateral trade of the bilateral exports predicted by the gravity model and implement the CK restrictions test (8). The results are displayed in Table 7. The data are consistent with the theory, that is $\theta \geq 1$, in 59 of the 136 region pairs (43% of the cases).[11] Table 8 calculates the difference ($\theta^{actual} - \theta^{gravity}$). It can be easily observed that the difference is positive in the vast majority of region pairs. Therefore the CK restrictions test seems not to perform well for the bilateral trade predicted

[9] To obtain the distances between Spanish regions we consider those cities with more than 20000 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. See Llano and Requena (2006) for more details.
[10] We also estimated equation (9) using a Poisson pseudo-maximum likelihood (PPML) estimator. Santos-Silva and Tenreyro (2006) have shown that show that the parameters of log-linearized gravity models estimated by ordinary least squares can be highly misleading in the presence of heteroskedasticity. In contrast, the PPML estimator not only is heteroskedastic-robust but also provides a good alternative to deal with zero values of the dependent variable since this method consists in estimating in levels the dependent variable. In addition, the data do not have to be Poisson at all and the dependent variable does not have to be an integer. Using this alternative estimation method, the results did not change the conclusions derived from Table 6.
[11] When the normal approximation to the binomial distribution (with 136 observations and with a probability of "success" in any given trial of 0.5) is used, the probability of finding 59 or more cases with the value of the stochastic above one is 0.94.

by the gravity model compared to the actual bilateral trade flows. We interpret this result as further support of the "comparative advantage" based on the Heckscher-Ohlin theory.

<INSERT table 7 HERE>

<INSERT table 8 HERE>

5. Conclusions

This paper applies the methodology proposed by Choi and Krishna (2004) to test the restrictions (derived by Helpman, 1984) on the factor content of trade flows using Spanish regional production and trade data. These restrictions have two major advantages. First, they use the factor content of bilateral trade rather than multilateral trade. Second, they hold even under non-equalisation of factor prices and in the absence of any assumption regarding consumer preferences. We are unable to reject the restrictions implied by the theory for the majority (about 65%) of region pairs. The results are robust to alternative measurements of the factor prices. We also show that factor price equalisation is not the only mechanism explaining the results: the value of the restrictions do not converge to one when we analyse the factor content of bilateral trade for tradable goods only, which are those for which factor price equalisation applies strongly. Finally, we propose the following experiment: are the restrictions implied by the factor-endowment driven theory satisfied when bilateral trade flows are predicted by a gravitational model? The evidence shows that the restrictions are rejected in the majority of cases and that the calculated values are systematically smaller than those obtained using actual bilateral trade flows. We interpret this result as further support of the "comparative advantage" based on the Heckscher-Ohlin theory.

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Figure 1. Lerner-Pearce diagram

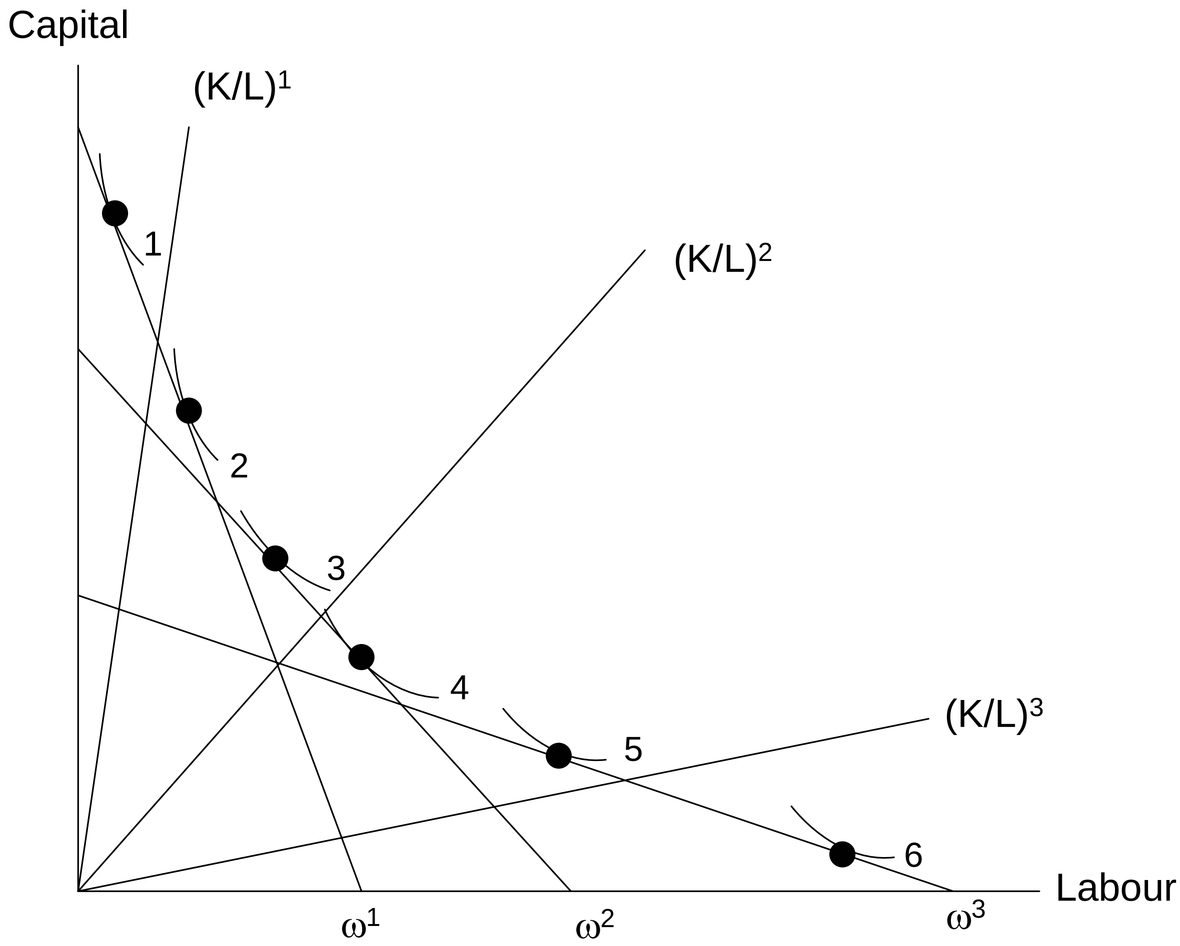

Table 1. Factor remuneration and factor endowment in Spanish regions. Year 1995.

Factor remuneration	Capital stock (%)	High education workers (euros)	Low education workers (euros)	Manager (euros)	Professionals & technicians (euros)	Clerical (euros)	Other non-manual workers (euros)	Qualified manual workers (euros)	Nonqu. manual workers (euros)
Andalucia	0.173	19189	14956	37269	26539	16292	12252	15434	10210
Aragón	0.172	18692	15221	37294	25098	16127	11903	15799	10765
Asturias	0.155	19759	16389	34373	26178	16596	11931	16693	11407
Baleares	0.153	19610	14072	34709	27543	16009	13615	14728	10201
Canarias	0.174	18843	12697	42256	25497	14842	12400	14690	10135
Cantabria	0.156	19360	14708	39226	25898	15295	11111	15219	10362
Castilla-León	0.174	17463	12521	30810	25004	15887	10130	12703	9094
Castilla-La Mancha	0.151	18786	15395	35914	26368	16151	11005	15707	10690
Cataluña	0.175	21759	16187	41197	27860	16513	11395	15851	11237
C. Valenciana	0.148	18043	13834	34278	24196	14819	11922	13679	9975
Extremadura	0.140	18800	11821	33068	27516	15576	10421	14021	7712
Galicia	0.185	18192	12751	34799	24576	14995	11096	13017	10231
Madrid	0.176	24119	16699	53495	30470	16920	12739	16980	11525
Murcia	0.169	15973	12766	29551	22403	13856	10171	12931	11708
Navarra	0.174	19225	16128	37330	26121	16348	11560	16100	11159
Pais Vasco	0.172	21579	18596	40365	27848	17938	13194	17941	13052
Rioja (La)	0.191	16806	13346	36270	23402	14638	10188	13832	9559
España	0.167	20830	15955	41198	28191	16205	12092	15339	10719
Factor endowments	(miles euros)	(number)	(number)	(number)	(number)	(number)	(number)	(number)	(number)
Andalucia	162397401	853768	1099132	143398	222559	146995	202695	513275	723877
Aragón	39451854	221121	231731	30581	76053	28671	40137	171811	105547
Asturias	31882079	158409	188591	19430	48270	22736	33329	144103	79033
Baleares	32716495	113508	165492	24250	30431	37804	51093	71877	63446
Canarias	44244984	229120	296376	35590	53712	51836	82222	127975	174065
Cantabria	16933140	83554	85046	11688	19645	15504	13916	61633	46113
Castilla-León	78882477	405394	479406	74660	94036	60932	88583	347696	219093
Castilla-La Mancha	51466375	203425	336455	44574	44333	38556	53646	210898	147694
Cataluña	219218249	1216453	1185247	185632	357398	298581	252532	756762	550795
C. Valenciana	130251565	587540	830760	120299	167731	130801	139566	504807	355097
Extremadura	25645421	121078	186522	29282	23075	19700	28641	102223	104579
Galicia	67162492	356518	643882	79099	98191	59325	91815	461785	210185
Madrid	176917440	1200504	782696	106675	464886	305039	202257	400790	503553
Murcia	29949422	156904	197996	31545	32766	25339	32179	113163	119808
Navarra	19900815	116912	95388	13837	38102	13019	24243	88952	34148
Pais Vasco	69944705	454953	296347	66501	145268	56611	68139	246998	167784
Rioja (La)	8751291	48980	56720	8462	14392	7058	10699	45265	19223
España	1223032679	4499657	6201559	988049	1221024	1099101	1070095	4277985	1187890
Correlation between relative factor endowment abundance and relative factor reward									
Capital		0.22	0.65						
High education			0.33						
Low education									
Capital				0.59	0.39	0.11	0.01	0.34	0.21
Managers					0.67	0.65	0.04	0.14	**-0.22**
Professionals						0.70	0.03	0.16	0.17
Clerical							0.07	0.26	0.04
Other non-manual								**-0.33**	**-0.11**
Qualified manual									0.10
Non qualified manual									

Note: The correlations are calculated using the 17 observations of relative factor remuneration (w_i^{f1}/w_i^{f2}) and relative factor endowments (V_i^{f2}/V_i^{f1}). A positive correlation indicates that factor prices differences are related to factor abundance differences across regions (i.e. regions with higher wage-rental have higher capital-labour ratios).

Table 2. Values of θ_{ij} with 3 factors of production.

	AND	ARA	AST	BAL	CAN	CAT	CLE	CMA	CTL	CV	EXT	GAL	MAD	MUR	NAV	PV
Andalucia																
Aragón	**1.00**															
Asturias	**1.00**	**1.01**														
Baleares	0.97	0.97	**1.12**													
Canarias	0.95	0.90	0.87	**1.04**												
Cantabria	**1.01**	**1.01**	**1.00**	**1.02**	0.94											
Castilla-León	**1.07**	**1.05**	**1.00**	**1.11**	**1.04**	0.98										
Castilla-La Mancha	**1.00**	**1.00**	**1.01**	0.95	0.94	**1.00**	**1.03**									
Cataluña	0.97	**1.01**	**1.00**	0.89	0.87	**1.01**	0.99	**1.01**								
C. Valenciana	**1.02**	0.99	0.97	**1.04**	0.98	**1.01**	**1.01**	0.98	0.97							
Extremadura	0.96	**1.06**	**1.02**	**1.11**	**1.06**	0.98	**1.01**	**1.01**	**1.06**	**1.04**						
Galicia	**1.05**	**1.10**	**1.01**	**1.01**	**1.01**	0.97	**1.00**	**1.01**	**1.00**	**1.00**	**1.01**					
Madrid	0.97	**1.02**	**1.04**	0.90	0.79	**1.00**	0.98	**1.01**	**1.00**	0.95	**1.06**	0.99				
Murcia	**1.05**	0.93	0.97	**1.13**	**1.06**	0.98	**1.00**	0.95	0.94	**1.02**	**1.01**	**1.00**	0.89			
Navarra	0.98	0.99	**1.00**	0.93	0.89	**1.00**	**1.09**	**1.01**	**1.00**	**1.01**	**1.09**	**1.00**	**1.01**	0.99		
Pais Vasco	0.98	0.98	**1.05**	0.86	0.82	**1.04**	0.93	**1.00**	**1.01**	0.95	0.85	**1.05**	**1.01**	**1.01**	**1.05**	
Rioja (La)	**1.08**	**1.03**	**1.02**	**1.09**	**1.00**	**1.11**	**1.02**	**1.02**	**1.10**	**1.01**	**1.05**	**1.01**	**1.28**	**1.02**	**1.17**	**1.02**

Note: This table examines the hypotheses that compare the importer´s *hypothetical* production cost with the exporter´s *actual* production cost of bilateral exports. See inequality (6) in the main text. The factors of production are: capital, high-educated labour and low educated labour.

Table 3. Values of θ_{ij} with 7 factors of production.

	AND	ARA	AST	BAL	CAN	CAT	CLE	CMA	CTL	CV	EXT	GAL	MAD	MUR	NAV	PV
Andalucia																
Aragón	**1.00**															
Asturias	0.99	**1.01**														
Baleares	0.98	0.96	**1.11**													
Canarias	**1.01**	0.96	0.93	0.98												
Cantabria	**1.01**	**1.02**	0.99	0.98	0.99											
Castilla-León	**1.10**	**1.07**	0.93	**1.13**	**1.14**	**1.01**										
Castilla-La Mancha	**1.01**	**1.01**	**1.00**	0.98	**1.00**	**1.01**	**1.05**									
Cataluña	0.99	**1.01**	0.99	0.94	0.96	**1.01**	0.96	**1.02**								
C. Valenciana	**1.04**	0.99	0.92	**1.08**	**1.07**	**1.01**	**1.02**	0.97	0.98							
Extremadura	0.97	**1.04**	**1.04**	**1.06**	**1.07**	0.94	**1.00**	**1.01**	**1.03**	**1.00**						
Galicia	**1.06**	**1.11**	**1.03**	**1.02**	**1.10**	0.97	**1.00**	**1.01**	**1.01**	**1.01**	**1.01**					
Madrid	0.95	**1.02**	**1.02**	0.90	0.87	**1.00**	0.99	**1.00**	**1.01**	0.96	**1.05**	**1.01**				
Murcia	**1.05**	0.89	0.92	**1.10**	**1.14**	0.92	**1.01**	0.97	0.95	**1.01**	0.98	**1.01**	0.90			
Navarra	0.99	**1.00**	**1.01**	0.96	0.98	**1.00**	**1.10**	**1.01**	**1.00**	**1.01**	**1.05**	**1.01**	**1.00**	**1.04**		
Pais Vasco	0.97	0.98	**1.04**	0.86	0.89	**1.03**	0.94	**1.01**	**1.00**	0.95	0.88	**1.03**	**1.01**	**1.12**	0.99	
Rioja (La)	**1.07**	**1.02**	**1.01**	**1.07**	**1.07**	**1.08**	**1.04**	**1.03**	**1.07**	**1.00**	**1.02**	**1.01**	**1.22**	**1.02**	**1.01**	**1.01**

Note: This table examines the hypotheses that compare the importer´s hypothetical production cost with the exporter´s actual production cost of bilateral exports. See inequality (6) in the main text. The factors of production are: capital, managers, professional/technical, clerical, services, qualified manual and non-qualified manual.

Table 4. Values of θ_{ij} with 3 factors of production and 15 tradable industries. *Actual* bilateral trade flows.

	AND	ARA	AST	BAL	CAN	CAT	CLE	CMA	CTL	CV	EXT	GAL	MAD	MUR	NAV	PV
Andalucia																
Aragón	**1.01**															
Asturias	**1.01**	**1.01**														
Baleares	0.98	0.98	**1.02**													
Canarias	0.98	0.94	0.91	**1.05**												
Cantabria	**1.00**	**1.01**	**1.00**	**1.00**	**1.05**											
Castilla-León	**1.00**	**1.01**	**1.00**	0.91	**1.01**	**1.00**										
Castilla-La Mancha	**1.00**	**1.00**	**1.00**	0.97	**1.05**	1.00	**1.01**									
Cataluña	**1.00**	0.99	**1.01**	0.93	0.93	0.99	0.94	**1.00**								
C. Valenciana	**1.02**	**1.01**	0.91	**1.04**	0.99	**1.03**	**1.01**	**1.02**	0.98							
Extremadura	0.96	**1.06**	**1.02**	**1.05**	**1.06**	0.99	**1.02**	**1.02**	**1.02**	**1.03**						
Galicia	**1.06**	**1.07**	**1.13**	**1.05**	**1.01**	**1.03**	**1.00**	**1.00**	**1.02**	**1.01**	**1.01**					
Madrid	**1.00**	**1.00**	**1.05**	**1.17**	0.85	**1.00**	0.97	**1.00**	**1.02**	0.99	**1.09**	**1.10**				
Murcia	**1.01**	0.91	0.95	**1.08**	**1.06**	**1.04**	**1.00**	**1.01**	0.96	**1.00**	**1.02**	**1.01**	**1.00**			
Navarra	**1.00**	**1.00**	**1.00**	0.96	**1.08**	**1.03**	0.98	**1.02**	**1.00**	**1.02**	**1.26**	**1.01**	**1.01**	**1.01**		
Pais Vasco	**1.00**	0.97	**1.05**	0.93	**1.00**	**1.02**	0.99	0.98	**1.02**	**1.01**	0.90	**1.15**	**1.01**	**1.00**	**1.04**	
Rioja (La)	**1.05**	**1.05**	**1.07**	**1.02**	**1.02**	**1.11**	**1.01**	**1.02**	**1.02**	**1.01**	**1.07**	**1.01**	**1.08**	**1.06**	**1.08**	**1.03**

Note: This table examines the hypotheses that compare the importer´s *hypothetical* production cost with the exporter´s *actual* production cost of bilateral exports. See inequality (6) in the main text. The factors of production are: capital, high-educated labour and low educated labour.

Table 5. Regression analysis

	3 factors All sectors (table 2)	7 factors All sectors (table 3)	3 factors Only tradables (table 4)	3 factors Only tradables Industry by industry
Sign test	0.65 (<0.01)	0.63 (<0.01)	0.68 (<0.01)	0.68 (<0.01)
Probit regression				
$\sum_f \left(w_f^j - w_f^i\right)^2 \left(\overline{V_f^j / Y^j}\right)^2$	0.002	0.001	0.003	-0.001
t-statistic	1.66	1.48	1.83	0.68
Pseudo R2	0.018	0.010	0.022	0.029
Log-likelihood	-90.15	-92.19	-87.94	-985.75
Values of θ				
Mean	1.00	1.01	1.01	0.99
Median	1.01	1.01	1.01	1.00
Standard deviation	0.06	0.06	0.05	0.11
N	136	136	136	1470

Note: In the Probit regression, the dependent variable takes a value of one if $\theta \geq 1$ and zero otherwise.

Table 6: Results from gravity estimation of bilateral trade flows.

	ln y(s) j	ln y(tot) ij	ln dist ij	adj ij	home ii	R2
Agriculture	1.14	1.06	-0.77	1.73	3.31	0.63
	(10.44)	(9.67)	(4.28)	(5.50)	(5.74)	
Mining, quarrying	0.87	0.87	-0.08	1.74	3.71	0.60
	(11.16)	(7.10)	(0.43)	(5.04)	(5.85)	
Food, beberages and tobacco	1.61	1.09	-0.59	1.54	2.60	0.60
	(12.61)	(9.79)	(3.31)	(4.95)	(4.49)	
Textiles, apparel, leather products	0.94	1.16	-0.29	1.73	4.20	0.58
	(10.71)	(8.92)	(2.79)	(4.75)	(7.59)	
Wood products	1.22	0.94	-0.16	2.02	4.42	0.63
	(12.24)	(9.66)	(1.03)	(7.47)	(8.73)	
Paper and printing	1.21	1.11	-0.30	1.33	4.02	0.68
	(17.38)	(11.04)	(0.83)	(4.70)	(7.61)	
Chemical products	1.14	1.18	-0.23	1.91	3.29	0.77
	(20.09)	(12.49)	(1.15)	(7.22)	(6.64)	
Rubber and plastic	0.96	0.76	-0.17	1.50	5.15	0.48
	(9.48)	(5.30)	(0.93)	(3.81)	(8.28)	
Non metallic mineral products	1.25	0.99	-0.33	1.86	3.86	0.66
	(14.33)	(13.06)	(2.14)	(6.97)	(7.75)	
Basic and fabricated metal products	1.44	1.09	-0.48	1.50	2.92	0.67
	(16.02)	(10.64)	(2.89)	(5.26)	(5.46)	
Mechanical engineering	0.87	0.61	-0.15	3.37	6.80	0.49
	(7.65)	(4.18)	(1.08)	(8.24)	(10.07)	
Electric, electronic and optic products	1.15	1.11	-0.02	0.94	3.40	0.67
	(18.36)	(10.93)	(0.11)	(3.31)	(6.39)	
Transport equipment	1.11	1.05	0.09	1.26	3.58	0.52
	(13.83)	(7.58)	(0.42)	(3.27)	(4.91)	
Other manufacturing	1.21	0.99	-0.12	1.28	3.53	0.63
	(14.92)	(9.71)	(1.75)	(4.52)	(6.67)	
Electricity, water, gas	1.14	0.99	-0.73	2.24	3.52	0.60
	(10.94)	(8.61)	(3.97)	(7.06)	(5.90)	

Note: Dependent variable is ln(1+bilateral exports). Estimation method: Ordinary Least Square. Robust-to-heteroskedasticty t-statistic reported in parenthesis. Number of observations by industry=289. The explanatory variables are: log of gross production of industry (s) by region of origin (ln y(s) i); log of total gross production in the region of destination (ln y(tot) j); log of geodesic distance between regions (log dist ij); dummy that takes value of one if regions share a common border, and zero otherwise (adj ij); and, dummy that takes value of one when a region trades with itself (intraregional trade) and zero otherwise (home ii).

Table 7. Values of θ_{ij} with 3 factors of production and 15 tradable industries. *Predicted* bilateral trade flows from a gravitation model.

	AND	ARA	AST	BAL	CAN	CAT	CLE	CMA	CTL	CV	EXT	GAL	MAD	MUR	NAV	PV
Andalucia																
Aragón	**1.00**															
Asturias	0.99	0.97														
Baleares	0.98	0.98	0.96													
Canarias	0.98	**1.01**	0.95	**1.01**												
Cantabria	**1.00**	**1.00**	0.98	**1.00**	**1.00**											
Castilla-León	0.97	**1.01**	0.94	**1.01**	**1.00**	**1.01**										
Castilla-La Mancha	**1.00**	**1.00**	0.98	0.99	0.99	**1.00**	0.99									
Cataluña	0.98	0.98	**1.00**	0.96	0.96	0.97	0.94	0.97								
C. Valenciana	0.99	**1.01**	0.97	**1.01**	0.99	**1.00**	0.99	**1.00**	0.97							
Extremadura	0.98	**1.02**	0.94	**1.03**	**1.00**	**1.01**	**1.00**	**1.01**	0.94	0.99						
Galicia	**1.00**	**1.04**	**1.00**	**1.03**	**1.00**	**1.03**	**1.00**	**1.00**	0.98	**1.01**	0.99					
Madrid	0.98	0.96	**1.02**	0.94	0.97	0.96	0.96	0.96	**1.00**	0.97	0.95	**1.00**				
Murcia	0.97	**1.00**	0.93	**1.02**	**1.00**	**1.01**	**1.00**	**1.00**	0.95	**1.00**	**1.01**	**1.00**	0.95			
Navarra	**1.00**	**1.00**	0.99	**1.00**	**1.02**	**1.01**	**1.02**	**1.01**	0.99	**1.02**	**1.04**	**1.06**	0.97	**1.01**		
Pais Vasco	**1.01**	0.94	**1.02**	0.96	0.98	0.99	0.98	0.98	**1.01**	**1.01**	**1.00**	**1.03**	**1.01**	0.96	0.96	
Rioja (La)	0.99	0.94	0.95	**1.02**	**1.01**	**1.01**	**1.01**	**1.00**	0.97	**1.00**	**1.03**	**1.01**	0.99	**1.00**	**1.03**	0.99

Note: This table examines the hypotheses that compare the importer´s *hypothetical* production cost with the exporter´s *actual* production cost of bilateral exports. See inequality (6) in the main text. The factors of production are: capital, high-educated labour and low educated labour.

Table 8. Differences between values of actual θ_{ij} and predicted θ_{ij} (obtained from a gravitation model). Three production factors and 15 tradable industries.

	AND	ARA	AST	BAL	CAN	CAT	CLE	CMA	CTL	CV	EXT	GAL	MAD	MUR	NAV	PV
Andalucia																
Aragón	0.00															
Asturias	0.02	0.03														
Baleares	0.00	0.00	0.05													
Canarias	0.00	**-0.07**	**-0.04**	0.04												
Cantabria	0.01	0.01	0.03	0.00	0.05											
Castilla-León	0.03	0.00	0.06	**-0.11**	0.01	0.00										
Castilla-La Mancha	0.00	0.01	0.02	-0.02	0.06	0.00	0.02									
Cataluña	0.01	0.02	0.01	**-0.04**	**-0.03**	0.02	0.00	0.04								
C. Valenciana	0.03	0.00	**-0.06**	0.03	0.00	0.03	0.02	0.02	0.01							
Extremadura	**-0.02**	0.05	0.07	0.02	0.06	**-0.02**	0.02	0.01	0.08	0.03						
Galicia	0.05	0.03	0.13	0.02	0.01	0.00	0.01	0.00	0.04	0.01	0.02					
Madrid	0.01	0.04	0.04	0.22	**-0.11**	0.03	0.01	0.04	0.02	0.02	0.14	0.10				
Murcia	0.04	**-0.09**	0.01	0.06	0.06	0.03	0.00	0.00	0.01	0.01	0.00	0.01	0.05			
Navarra	0.00	0.00	0.01	**-0.05**	0.06	0.02	**-0.04**	0.02	0.01	0.00	0.22	**-0.06**	0.04	0.00		
Pais Vasco	0.00	0.03	0.04	**-0.03**	0.02	0.03	0.01	0.00	0.01	0.00	**-0.10**	0.12	0.00	0.04	0.08	
Rioja (La)	0.06	0.11	0.13	0.00	0.01	0.10	0.00	0.02	0.05	0.01	0.05	0.00	0.09	0.06	0.05	0.04

Note: This table examines the hypotheses that compare the importer´s *hypothetical* production cost with the exporter´s *actual* production cost of bilateral exports. See inequality (6) in the main text. The factors of production are: capital, high-educated labour and low educated labour.

Appendix.

Table A1: Twenty two industries and their concordance with INTERTIO, CRE (CNAE93) and Fundación BBVA-IVE (capital stock)

Description	R26-INTERTIO	CNAE-93	BBVA-IVIE
Agriculture	1	01+02+05	1
Mining and quarrying	2	10 a 12 +23	3**+ 4 **
Food, beberages and tobacco	3	15 + 16	5
Textiles, apparel, leather	4+5	17+18+19	6
Wood products	6	20	7**
Paper and printing	7	21+22	8
Chemical products	8	24	9
Rubber and plastic	9	25	10
Non metallic mineral products	10	14 + 26	4**
Basic metal and fabricated metal products	11	13+27+28	3** + 11
Mechanical engineering	12	29 a 31	12+13
Electric, electronic and optic products	13	32+33	14
Transport equipment	14	34+35	15
Other manufacturing	15	36	7**
Electricity, water, gas	16	40+41	2
Construction	17	45	16
Wholesale and retail	18	(50 a 52) + (71 a 74)	17
Restaurants and hotels	19	55	18
Transport and communication	20	60 a 63	19
Finance and insurance	21	64	20
Real state and business services	22	65 a 67	21
Other services *	23+24+25+26	75 + (80 a 93)	23

Note: * Other services includes education and health, Public Administration and social, personal and household services. ** BBVA-IVIE figures adjusted using estimated capital stocks from Encuesta Industrial (1978-1992), obtained from Neus and Requena (2004).