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DOMESTIC TRANSPORT COST REDUCTIONS AND FIRMS' EXPORT BEHAVIOUR*

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Abstract:
Transport infrastructure investment reduces the cost of distance and enables firms to establish and maintain contacts over larger distances. Spain has developed an ambitious road building programme over the last decades, which has considerably reduced transport costs to access European markets. In this paper we depart from the traditional aggregate approach in analysing the impacts of transport infrastructure investment. In particular, we examine the export decision of Spanish manufacturing firms and test how domestic transport cost reductions affect firms' probability of becoming exporters. We estimate models that control for unobserved heterogeneity among firms, endogeneity and initial conditions problems. Our results provide some support for a positive effect of domestic transport improvements on firms' exporting probability. However, the magnitude of this effects is small, being the strongest effect the one due to previous export experience which suggests high entry costs into export markets.

Keywords: export decision, transport infrastructure, accessibility

JEL: F14, R1, R4

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1. INTRODUCTION

With increasing globalisation and international competition, a strong domestic export base is of high priority among policy makers and economists. At the same time, major transport investment projects have often been argued to be necessary for economic integration and balanced economic growth. Yet, there exists still very limited research on the contribution of major transport investments projects on international trade.

Transport infrastructure has re-emerged as a key policy issue in Europe. The evaluation of such investment has until recently relied on evidence from aggregate studies. Such studies, however, mask important firm-level differences in impacts that lead to sectoral and spatial variations in benefits created by such investment. Heterogeneity in impacts requires a better understanding of the mechanisms whereby transport investment creates benefits at the firm level. One such important mechanism is through reducing the cost to access international markets.

Recent work analysing the export decision of individual firms has emphasised the importance of various plant characteristics. Spatial effects are an under-explored element in this research stream. The few studies that have looked at spatial effects have focused on spillovers among different types of exporters.[1] The effect of domestic transport infrastructure improvements that reduce the cost to access international markets has not been considered in this literature. We will use accessibility measures based on the real transport network and its improvements. To construct these measures we use Geographic Information Systems (GIS). Studies based on the popular gravity model have frequently used great circle distances. These are crude proxies of transport costs, but most importantly, great circle distances cannot pick up on transport cost variations over time.[2]

A practical problem faced by empirical studies analysing the role of spatial characteristics for export behaviour is that location may be determined simultaneously with the export decision. This can be the case, for instance, when firms are attracted to regions that offer more favourable conditions for exporting. Head and Mayer (2004), for

[1] See, for example, Aitken et al. (1997) who find that the probability that Mexican plants export is positively related to the presence of multinational firms in the same region. Greenaway et al. (2004) and Kneller and Pisu (2007) show for the UK that the presence of multinational firms is positively related to the decision to export by domestic firms.

[2] For more details on the measurement of transport costs, see Combes and Lafourcade (2005).

example, show that multinationals locate according to "market potentials", with regions bordering central markets attracting disproportionally affiliates from multinationals. At the same time, domestic firms that plan to engage in exporting could take geographical advantages for exporting into account in their location decision. This could generate a higher export propensity among firms closer to international borders (Crozet and Koenig, 2008 show evidence for this for French firms) and hence shorter travel times to international markets. Biased estimates will result if unobserved firm-specific characteristics affect both the choice of location as well as the probability of exporting. To deal with this self-selection problem we use panel data estimation techniques that allow us to estimate the effect of transport infrastructure improvements free of potential biases.

In this paper, we extend the evidence of the micro-econometric literature on international trade by studying the impact of domestic transport-cost reductions stemming from major transport investment on firms' export behaviour. In the next section, we provide a literature review on the determinants of firms' export behaviour. In Section 3 we first describe the data set for our analysis and then present some descriptive statistics about the exporting firms in our sample. In Section 4 we present our empirical model. In Section 5 we first describe our estimation strategy and then present our results. Section 6 provides some conclusions.

2. EXPORT DETERMINANTS

Traditionally the empirical testing of trade theory has relied on aggregate data for countries and sectors. Recently, however, there has emerged a growing body of empirical research looking at the underlying micro-economic determinants of trade. These studies depart from the assumption of a representative firm for countries and sectors.

2.1. Exports and firm-level characteristics

Starting with the work of Bernard and Jensen (1995, 1999) and Aw and Hwang (1995), a number of recent studies have shown the importance of firm-specific influences on exporting. These micro-level studies emphasise how firm heterogeneity affects

participation in international markets. A set of stylised facts about exporting firms has been established in this literature. Greenaway and Kneller (2007) and Wagner (2007) provide recent surveys of this literature.

Export activity has been related to firm size in a number of studies (see, for example Wagner 1995; and Merino and Salas 2000 for evidence on Spanish manufacturing firms). In general export activity is found to be more common among large firms. Larger firms have more resources to access international markets. Given the higher entry cost in international than in the domestic market, this is argued to make them more likely to be exporters. Most studies find that the size-export intensity relationship is only significant up to a certain threshold of company size after which the relationship becomes non-significant. Foreign ownership has also been positively related to firms' export probability (Roberts and Tybout, 1997; Aitken et al., 1997; Bernard et al. 2004). Furthermore, most studies find that age is also positively related to the probability to export.

In technology-based approaches a firm's export performance depends on its capacity to implement new technologies or develop new products or processes. Previous empirical research has established such a positive relationship between the technology factor and firms' export performance. Braunerhjelm (1996), for example, in a study of Swedish firms finds that R&D expenditure and investment in skilled labour have a positive effect of export intensity. Similarly, Sterlacchini (1999) and Basile (2001) find a positive relationship between firms' innovative activities and export performance of Italian manufacturing firms. Recent evidence for Spain is provided in Cassiman and Martínez-Ross (2007) using the ESEE data for 1990 to 1999. Using an instrumental variables approach to control for potential endogeneity, they find that product innovation positively affects the decision to export (rather than process innovation). Becker and Egger (2007) use matching techniques and survey data of German firms and also find a strong positive role of product innovation for firms' export propensity.

One dimension that has received particular attention in firm-level studies of international trade is the relationship between productivity and exporting. A positive relationship between firm-level productivity and export behaviour has been documented in most of these studies (see, for example, Bernard and Jensen 1995, Girma et al. 2004). Various factors can account for this. First, higher productivity firms are more likely to

be able to absorb the sunk costs associated with foreign market entry. Second, competition in international markets could be fiercer than in home markets, thus only allowing the most efficient firms to participate. This literature suggests that high productivity firms self-select themselves into foreign markets. The process of self-selection is formally shown in the theoretical models of Melitz (2003) and Bernard et al. (2006, 2007). Self-select into exporting of more productive firms occurs because they are more able to overcome the fixed costs of entering export markets. Alternatively, it has been argued that learning effects associated to exporting imply that exporting itself makes firms more productive. The micro-level empirical studies that have directly tested both hypotheses tend to present more evidence in favour of the self-selection explanation. Clerides et al. (1998), for example, find strong evidence for self-selection in their data from Colombia, Mexico and Morocco. Using a sample of Spanish manufacturing firms Delgado et al. (2002) find higher levels of productivity for firms entering export markets compared to non-exporters, but they also find some evidence for the learning explanation. Similarly, Arnold and Hussinger (2005) report evidence in favour of self-selection for German manufacturing firms.

Among the central findings of the micro-level literature on international trade are that relatively few firms export, exporters tend to be larger, more productive, and more innovative.

2.2. Exports and transport costs

Building on Melitz (2003), Bernard et al. (2006) show in a theoretical model of international trade how falls in trade costs make high-productivity non-exporters more likely to start exporting and existing exporters to increase their exports. With heterogeneous firms operating in monopolistically competitive industries, trade costs imply that only the most productive firms export. When trade costs fall, the most productive non-exporters begin to export and current exporters expand their foreign sales. In contrast falling trade costs drive out the least efficient firms through pushing up the productivity threshold for survival.

So far, however, transport costs have been largely ignored by the empirical literature on the export decision of firms. Yet, from the trade literature we know that geography matters for international trade. Studies based on the familiar gravity model indicate how

volumes of trade between countries rapidly decline with distance (for a recent review, see, Disdier and Head 2004). Distance matters because of transportation costs. Hummels (1999) finds that average expenditure on freight of U.S imports weighted by volumes of trade is about 3.8% of import values. This, at first, might not seem large. However, there are considerable variations among goods. Unweighted freight rates are considerably higher than the trade-weighted rates. Vegetables and fruits, for example show a freight rate of 17.4% of import values. Unweighted rates reflect the fact that products with lower freight rates have larger shares of trade. Limao and Venables (2001) estimate the elasticity of trade to transport costs and find that a 10-percentage point increase in transport costs reduces trade volumes by approximately 20%.

Direct transport costs are only part of distance related costs in trade. Distance has also an important effect on the time cost of trade. Anderson and van Wincoop (2004) argue that trade costs are still large even among highly integrated economies and in the absence of informal barriers to trade. They calculate a transportation cost mark-up over production costs of 21% for the U.S. This includes both freight costs and the time value of goods in transit. Time in transit is increasingly important with emerging business trends of time-based competitive strategies such as just-in-time production and quick response delivery. Hummels (2001) finds that each day of increased ocean transit time between two countries reduces the probability of trade by 1 to 1.5 percent.

Transport costs are not only determined by distance. What also matters is the quality of infrastructure. Bougheas et al. (1999) develop a bilateral trade model with transport costs depending on the level of infrastructure. Infrastructure is shown to raise the volume of trade. Limao and Venables (2001) find that a deterioration of infrastructure from the median to the 75th percentile raises transport costs by 12% points and reduces traded volumes by 28%. Redding and Venables (2003) study the determinants of countries' export performance. Using data for Sub-Saharan Africa, they find that poor external geography, poor internal geography, and poor institutional quality contribute in approximately equal terms to export performance. Francois and Manchin (2007) use a panel of bilateral trade flows from 1988 to 2002 to study the influence of infrastructure, institutional quality, and geographic context on bilateral trade patterns. Results from Heckman selection model regressions show that infrastructure and institutional quality

are significant determinants not only of export levels, but also of the likelihood that exports take place, and that they are more important than variations in tariffs.

Geographical variation in transport costs and transit times mean that some locations will be better locations for exporters, because of better international market access while firms in locations more distant from export markets will suffer a market access penalty on their sales (Hummels 1999, 2001; Limao and Venables 2001).

The international trade literature has studied the effect of distances and transport costs variations among countries, but has largely ignored national transport costs. Anderson and Wincoop (2004) criticise that international trade studies have tended to treat countries as dimensionless points. Yet understanding the role of trade costs in determining international trade volumes requires also knowledge of internal trade costs of countries. After all, all goods to be exported have to go first through the domestic transport system to reach export markets. Poor access to export markets increase the transaction costs implied and thus product prices on export markets. Beyond a certain threshold this may increase to a level beyond competitiveness. As argued in Limao and Venables (2001), poor domestic transport infrastructure can inhibit a country's participation in global production networks.

Some indirect supporting evidence on the role of domestic differences in access to export markets is provided in Nicolini (2003) who studies the effect of transport costs on regional export flows using a gravity model approach. She finds for a sample of European regions that distance reduces trade while the density of local transport infrastructure positively affects export flows. Building on Nicoloni (2003), Matthee and Naudé (2007) study regional manufacturing exports from South Africa and find that the distance to the nearest port is a significant determinant of regional manufacturing exports. Costa-Campi and Viladecans-Marsal (1999) study the propensity to export among 332 Spanish municipalities with a population of over 15,000 inhabitants and find some evidence that distance to the European border has a negative effect. At the same time, they find a positive effect for the presence of an international seaport in some sectors. These studies provide evidence for aggregate trade. At the firm level, Sterlacchini (2001) and Basile (2001) find for Italian manufacturing firms that being located in southern Italy reduces export probability and intensity.

In summary, few empirical studies have specifically addressed the importance of export market access in affecting firms' probability of entry into exporting. These studies have, however, not explicitly considered the effect of transport cost reductions derived from domestic infrastructure improvements, nor have these studies taken into account unobserved heterogeneity and potential problems of self-selection of location.

3. DATA AND SOME DESCRIPTIVE STATISTICS

3.1 The Data

The primary source of data for the analysis is the survey of Spanish manufacturing firms. The Encuesta sobre Estrategias Empresariales (ESEE) published by the Fundación Empresa Pública provides a wide range of information on a sample of 4.357 Spanish manufacturing firms including information on exporting. The survey is undertaken annually since 1990 and constitutes an unbalanced panel of manufacturing firms. It is approximately representative of Spanish manufacturing firms with more than 10 employees (for more details on the survey, see, for example, Fariñas and Jaumandreu, 1999). We use data for the period from 1990 to 2006. The final sample for this analysis consists of an unbalanced panel of 4.312 firms. In Table 1, we show our definition of the main relevant variables for our study. In Table 2, we provide information on the distribution of firms by year in our sample. The ESEE provides location information at the Autonomous Community level as well as the size (5 size categories) of the municipality where the firms' main establishment is located.[3]

Insert Table 1 about here

Insert Table 2 about here

[3] Companies could also export from their other establishments. The percentage of multi-plant companies is, however, relatively small in our sample. Less than 15% report more than one establishment. Moreover, more than half of these multi-establishments have their presence only in one Autonomous Community, e.g. all their establishments are located in the same region.

To include the impact of transport improvements we use spatially geo-referenced data of the Spanish road network and information on the timing of openings of new motorways. We obtained detailed information from the Minstry of Public Works (Ministerio de Fomento) regarding the opening to traffic of new road segments, providing the year a particular link was finished and opened to traffic. This information has been combined with the annual official roadmaps published by the Ministry of Public Works to construct time series information based on the real evolution of the actual transport networks. We combine the transport network data with spatially geo-referenced municipality data in order to calculated accessibility indicators at the fine-grained geographical level. We have calculated accessibility indicators based on the shortest path road travel time to international borders and to main sea ports. The indicators define locations with respect to the road network and their ease to access export markets.[4] They are based on travel time and are a proxy for generalized transport costs.[5] What transport infrastructure improvements do foremost is lowering travel times. As argued in Combes and Lafourcade (2005) transport cost reductions over the last decades have also been driven by transport technology and market structure. These factors, while important for the overall magnitude of historic transport cost reductions, are largely invariant across regions. Thus, the main factor that accounts for spatial variations in transport cost reductions are infrastructure improvements.

Ideally we would like to have information on the exact location of each company in the ESEE, but for reasons of confidentiality, such detailed information is not provided. Therefore, we have calculated for each Autonomous Community the weighted average of accessibility levels for each of the five municipality-size categories in order to relate each ESEE company to the accessibility data.[6]

[4] Transport statistics show that road and sea transport account for up to 94% of international goods transport in Spain in terms of quantity. In terms of value the percentage of these two modes is somewhat smaller but together they still account for slightly over 80% in the case of extra-EU trade from Spain, while for intra-European trade flows roads are by far the predominant mode of transport. Alternatively, we have also tested measures of accessibility to main airports of freight transport. This could presumably be more important for high-value or highly perishable goods.

[5] See, for example, Combes and Lafourcade (2005) for a more complete representation of transport costs.

[6] Firm relocation could also affect the accurateness of our accessibility measure. Relocation is however not a common phenomenon. 97% of our sample firms stayed in the same region over the entire period of analysis, while 93% also stayed in the same municipality.

3.2 Descriptive Analysis

Some descriptives on firm's export behaviour

Table 3 summarizes the export behaviour of our sample of Spanish manufacturing firms covering the period from 1990 to 2006. Over this period, there were almost 1.900 firms that exported during all years, while about slightly above one third (1.597) of firms never exported. There has also been a marked turnover of firms participating in exporting. About 20% of firms (827) showed variation in their export behaviour. About 35% of these firms started exporting over the period, about 15% stopped exporting and about 48% showed various spells of exporting and non-exporting. Figure 1 shows how the percentage of firms participating in exporting has increased markedly over the period of the nineties from 49% to more than 65%. Since then export participation has remained rather stable with even a small drop in 2005 and 2006.

Insert Table 3 about here

Insert Figure 1 about here

Table 4 shows the percentage of firms that exported according to firm size and sector for our sample covering the period of 1990 to 2006. As documented in the literature, export activity is much more common among large firms (more than 200 employees) across all sectors. The rational is that larger firms may have more resources to access international markets. Given the higher entry cost in international than in the domestic market, this is argued to make them more likely to be exporters. While exporting occurs in all manufacturing industries, there are also important differences across sector in the percentage of exporting firms. Sectors with larger percentages of exporters are leather and footwear, office machinery, data processing, and optical equipment, motor vehicles, mechanical equipment, chemical products and metal processing industries (Table 4).

Insert Table 4 about here

Table 5 provides further descriptive statistics of some key characteristics of exporting firms. As mentioned above, exporters are on average larger. They are also on average older and have to a greater degree foreign capital participation. Exporters also spend more on R&D and introduced to a greater degree both product as well as process

innovations. Finally, exporters in our sample are also more productive than non-exporters in terms of value added per worker. These descriptive statistics are in line with the previous literature on key differences between exporting and non-exporting firms.

Insert Table 5 about here

Table 6 reflects the geographical pattern of export propensity among Spanish manufacturing firms. Average exporting propensity in the peripheral regions is lower than in the areas that concentrate most economic activity. However, all regions experienced an increase in the percentage of exporting firms over the period analysed, and the increases in the periphery have been larger bringing them closer to the percentage of exporting firms observed in the core-areas.

Insert Table 6 about here

Accessibility

Figure 2a shows maps for our accessibility indicators based on the shortest travel time to main seaports for 1990 and 2005. Figure 2b shows the change in accessibility over this period for the seaport accessibility indicator. Figure 3a shows maps for general accessibility to export markets based on the shortest travel time to main border crossings and main seaports for 1990 and 2005. Figure 2b shows the change in general export market accessibility between 1990 and 2005.

Insert Figure 2a about here

Insert Figure 2b about here

Table 7 shows the percentage of exporters according to our accessibility indicators for 1990 and 2005. On average, exporters are closer to the French border and closer to main seaports. However, areas closer to the Portuguese border show fewer exporters than those further away. Mean difference tests also confirm that exporters are on average closer to the French border and to main seaports, however at a greater mean distance from the Portuguese border than non-exporters.

Insert Table 7 about here

Table 8 reports the average changes in accessibility that exporters and non-exporters experienced. In general, export market access improved significantly more for locations with traditionally more non-exporters than exporters. This is consistent with Table 6 and 7. Non-exporters have been to a greater degree in the peripheral areas and these are the areas that gained more in terms of export market access.

Insert Table 8 about here

4. EMPIRICAL MODEL

Our theoretical framework is based on a simple model of optimization for a firm facing the export decision. The model should take into account the effects of transport costs.

The profit maximising firm makes its decision based on expected profits from exporting, now and in the future, taking into account the fixed costs of entering the new market, and other variable costs which include transportation costs.

Firm profits are given by:

$$\Pi_{it} = p_t q_{it} - c_{it}(x_t, z_{it} \mid q_{it}) ,$$

where q_{it} is the level of exports, p_t is the price of the exported goods, and $c_{it}(.)$ is the variable cost of producing the goods for the export market (including transportation costs). Exogenous factors affecting profitability are given by x_t (for instance, macroeconomic conditions), and firm specific factor by z_{it}. Variables that may be included in this firm specific term could include size, skill composition of the labour force, firm productivity, product characteristics, and ownership structure.

The export status of the firm i in period t is denoted by E_{it}, so

$$E_{it} = 1 \text{ if } \Pi_{it} >= c$$

$$E_{it} = 0 \text{ if } \Pi_{it} < c,$$

where the threshold *c* determines the export status taking into account the fixed costs of exporting, which depends on previous export behaviour.

The profit maximizing conditions are obtained by differentiating the profit function with respect to q_{it}, and setting the partial derivatives equal to zero. It can be shown that those derivatives depend on the transportation costs: an increase in the transportation costs will decrease exports.

This theoretical setting can be empirically modelled as a dynamic model with unobserved heterogeneity. It is important to account for state dependence in export decisions since, as explained before, they depend on past export behaviour due to the existence of sunk cost when entering new markets. Additionally, we want to characterise the probability of exporting as a function of other variables which appear to be relevant according to the previous theoretical discussion. This can be achieved using a linear probability model or using a probit framework to take into account the binary nature of the dependent variable.

On the hand, some unobserved permanent factor increase the likelihood of exporting; for instance, quality of the products or managerial ability which affects productivity. It is crucial to control for these two components in order to obtain unbiased causal effects of any other explanatory variable (in particular, the effect of reduction in transportation costs).

Other variables that according to the previously discussed theoretical model can have an effect on the probability of exporting are firm size, age, R&D, productivity, labour force qualification, foreign ownership, sector of activity, and transportation costs, measured using accessibility indicators. Finally, we included two spillover variables to control for the effects of spillovers due to the presence of domestic and multinational exporters, as well as time dummies to account for business cycle effects.

It is worth noting that accessibility measures are to some extent determined by the initial location decision. Thus, potential simultaneity in both decisions (location and exporting) leads to an endogeneity problem. In order to correct for this problem we make use of exogenous instrumental variables, which allows identifying the true causal effect of the transportation costs on the probability of exporting.

5. ESTIMATION ESTRATEGY AND RESULTS

In this section we first present the estimation strategy followed to obtain a causal effect of transport cost reductions in exports decisions. Then, we show and comment our main results.

Econometric Issues

We face basically two problems to identify the effect of reductions in transportation cost on export decisions by firms: endogeneity of the main variable of interest and unobserved time invariant heterogeneity among firms. First, transportation costs depend on firm's location and this original location decision could be related to the exportation decision. For example, firms that plan to engage in exporting could take geographical advantages for exporting into account in their location decision. Thus, our measure of accessibility can be regarded as endogenous;[7] this issue can also be viewed as a typical initial conditions problem. Secondly, we want to control for time invariant unobserved determinants of the exportations decision such as managerial ability, etc, potentially correlated with the determinants of exporting.

It is relatively easy to deal with these econometric issues in a linear probability model (LPM). The advantage of the LPM is that it allows dealing with endogeneity and panel data issues in a simple way. However, it is well known that this model presents some drawbacks when the dependent variable is discrete since it does not restrict the predicted values to lie within the (0, 1) interval. Thus, our estimation strategy is progressive in the sense that we will first estimate different linear models in which all these issues are accounted for in different steps. Moreover, given the non-linear nature of our problem, we then estimate discrete choice models in order to exploit properly the characteristics of our data. Similarly to the linear case, we try to deal with the initial conditions and unobserved heterogeneity problems in order to obtain a true effect of the variable of interest, free of potential biases.

[7] Moreover, there are additional sources of endogeneity in this problem: for instance, productivity is also endogenous.

Linear Probability Models

Our analysis begins with the estimation of linear probability models, both neglecting unobserved heterogeneity and endogeneity issues. For that, we estimate by Ordinary Least Squares (OLS) a model in which we pool each wave of data (i.e., each cross-section) and control for the business cycle by including time dummies in the estimates. This estimate treats all explanatory variables as strictly exogenous and does not account for the existence of time invariant unobserved heterogeneity among firms, thus, it is very likely that the estimates are biased. Therefore, it is difficult to infer a causal effect from them and these results should only be taken as a benchmark.

Second, in order to gain consistence for our empirical results, we consider the existence of unobserved individual heterogeneity at the firm level. In this case, we obtain within groups (WG) estimates. However, if we think that even after controlling for time invariant unobserved heterogeneity any of the explanatory variables is endogenous, WG estimates do not provide consistent estimates of the parameters.

Therefore, in a next step we account for the endogeneity problem by estimating a model by the Generalized Methods of Moments. In this case, we present two sets of estimates. In the first one (GMM-FD) we apply first differences to the equation of interest to drop out the unobserved heterogeneity; then we estimate this equation in first differences using lagged values of the variables in levels as instruments (see Arellano and Bond, 1991). Nonetheless, given small variations of some variables in our data, once first differences of the variables are taken, we also exploit the information in levels. In this case, we estimate by GMM the model using the orthogonality conditions given by the lack of correlation between the errors in levels and the variables in differences (see Arellano and Bover, 1995). This estimator combines information from the equation in levels and in first differences; thus it is called System GMM (GMM-SYS).

We are particularly interested in finding a proper instrument for our main variable of interest, "accessibility". We use changes in accessibility (time to main sea ports) as a valid instrument for the equation in levels. As commented before, accessibility is potentially endogenous because it can be correlated with the unobserved heterogeneity in the equation in levels (through the location decision). We exploit the fact that the Spanish road system was considerably improved throughout our sampling period and this improvement was rather general, affecting in practice almost any location. Since the

mayor road building programs started in the first half of the 1980's over 10.000 kilometers of new motorway and dual-carriageway roads have been built improving accessibility throughout the country. In the case of the Spanish road building program, motorway placement was guided primarily by the design of the principal trunk road connections that already existed; as a consequence, changes in accessibility can be regarded as uncorrelated with the unobserved heterogeneity and firm's location.

Non-linear models

We now present the estimation strategy of the model which accounts for the discrete nature of the dependent variable. The estimation of discrete choice models is very useful for predictive purposes, since it ensures that the predicted values of the dependent variables will lie in the (0,1) interval. But, on the other hand, the non-linearity of the model makes more difficult both the control for the time invariant unobserved heterogeneity and to deal with the endogeneity of the explanatory variables. Moreover, within this context, one need to control also for the so called "initial conditions problem". The idea is that the initial period of observation does not correspond with the first period the firm is in the market. The beginning of the process is unobserved for the econometrician and possibly correlated with the unobserved effects. This problem does not appear in the linear case, since the unobserved effects can be ruled out by using a proper transformation of the model. In non-linear models generally, there are no known transformations that eliminate the unobserved effects.

First of all, we estimate a pooled probit model that treats all explanatory variables as strictly exogenous and does not account for unobserved time invariant heterogeneity.

It is well known that, differently from the linear case in which the unobserved effects can be dropped out, in non-linear models it is more difficult to deal with the unobserved heterogeneity. In this paper we follow a random effects approach (RE Probit), which assumes that the firm effects are uncorrelated with the explanatory variables.

Nonetheless this assumption is quite likely violated in our export decision model, as plant characteristics are apt to be correlated with unobserved product attributes, managerial ability, technology, and other unobserved plant effects that may affect firms'

export participation decision. For that reason, we estimate also a correlated random effects probit model, which allows us to control also for the initial conditions problem.

Two approaches can be used in order to solve this problem (see Hsiao, 1986). The first approach is to use the joint distribution of all outcomes -including that in the initial time period- conditional on unobserved heterogeneity. As Wooldridge (2005) points out, the main complication with this approach is specifying the distribution of the initial condition given unobserved heterogeneity. For the dynamic probit model with covariates, Heckman (1981) proposed approximating the conditional distribution of the initial condition. This avoids the practical problem of not being able to find the conditional distribution of the initial value. But this approach is computationally cumbersome. The other method is proposed by Wooldridge (2005) and consists in modeling the unobserved heterogeneity conditionally on the initial condition (and the exogenous variables in all time periods) and to specify the unconditional distribution of unobserved factors. In this paper we consider this method (CRE Probit), because it is flexible and simple to implement. The likelihood of interest has the same structure as in the standard random effects model, except that among the explanatory variables for each time period we include the initial observation of the dependent variable (exports) and a number of time invariant variables (time mean of other explanatory variables) as a reduced form for the unobserved factors.

Results

In this section we report the estimates from the different models described in the previous section. Two sets of estimates are presented. The first set (see Table 9) compares the results from linear models that account for the endogeneity issues and unobserved heterogeneity with those that do not account for those considerations. The second set of results (see Table 10) presents the estimates from non-linear models. Although we are mainly interested in the estimated effect of accessibility, we will briefly comment on other parameters discussed in the literature.

Similarly to previous studies, we find that state dependence is very important in the exportation decision: the parameter for lagged export status is strongly positive and significant in all our estimates. Our results show that age and size of the firm are also important determinants of firms' exporting decision, displaying an inverted U-shaped

for this relationship. Foreign ownership of the company also seems to have a positive effect on exporting. In the estimates that treat R&D and productivity as strictly exogenous variables, we obtain a positive effect. Nonetheless these variables are likely to be endogenous. In our results that account for endogeneity (GMM-FD and GMM-SYS) these two variables become insignificant. Moreover, firms with more skilled workers do not seem to export more than those firms with less skilled workers. Finally and contrary to some previous studies, we cannot find spillover effects in the export decision stemming from the presence of other domestic or multinational exporters. The latter is, however, consistent with the findings in Barrios et al. (2003) for Spanish manufacturing firms.

Insert Table 9 about here

Results for accessibility are based on access to main seaports. This measure performed better than those based on access to national borders. The main seaport accessibility measure is calculated as the minimum travel time to the six largest seaports in mainland Spain (Algeciras, Valencia, Barcelona, Bilbao, Tarragona, and Gijon), and partly captures at the same time access to the North and thus the French border. We find a significant effect of this accessibility measure on firms' export decision. We always obtain a negative sign for this variable: when the time to reach the main sea ports is lower, it is more likely that the firm exports. The estimated parameter gives us the increased probability of exporting when accessibility time is reduced by thirty minutes. In the linear probability model, the effect becomes insignificant when we control for unobserved heterogeneity (WG and GMM-DIF). While there have been immense improvements in almost the entire main road network and consequently accessibility levels, variability over time for a given firm may not be large enough to provide sufficient accuracy to estimates. Thus, the GMM-SYS is our preferred estimation procedure, since it allows us to control for endogeneity and to exploit level information to obtain more precise estimates. In this case, we find a significant effect. When we consider nonlinear models, we reach similar conclusions. "Accessibility" has a negative significant effect in the Pooled Probit and in the Random Effect Probit. However, in the more general Correlated Random Effect Probit that also controls for the initial conditions problem the effect becomes insignificant: although the point estimate is similar in magnitude to the previous ones, standard errors increase because variability

over time of "accessibility" for a given firm may again not be sufficiently large for this type of estimation.

Insert Table 10 about here

6. CONCLUSIONS

In this paper, we have aimed to contribute to a better understanding of firms' export decision by focusing on the role of domestic transport-cost reductions stemming from major transport investment. While trade costs are central to trade theory, the specific role of transport costs in firms's exporting decision has not been analysed in the empirical microeconomic-trade literature.

In line with the previous literature we find that a number of firm characteristics are important in determining the propensity to export. However, we also find that domestic transport costs reductions increase the probability of entry into exporting. The results confirm the importance of transport costs as barriers to export.

As the international environment is becoming more competitive and fast paced, issues of access are likely to become more important. With increasing fragmentation and globalisation of production, poor domestic transportation can imply an important obstacle to participate in global production networks which rely heavily on speed across global space. Findings of this paper also have important policy implications for developing countries seeking to expand trade as they typically face poor domestic transportation infrastructure and are also far from international key markets.

There are several directions for further research. First, the impact of lower transport costs on export decisions may be heterogeneous across firms. Export products vary in their value-weight characteristics and this will influence firms' reliance on road transport and thus the way firms in different sectors respond to road infrastructure improvements. Transport improvements could also influence small and large firms to a different degree.

Second, impacts could be destination-specific. While we do not have information on destinations of individual exports, the ESEE provides the relative share of European Union, OCDE, and rest of World exports. Domestic transport improvements could have a greater impact on the probability of EU-exports compared to exports to non-EU

countries. EU-exports rely almost exclusively on road transport. We have included access to main seaports to account for the impact that domestic road infrastructure may have on sea-exports, but the share of road transport cost to get the merchandise to the exporting sea-port may be small compared to the total transport cost to the final export destination.

Third, so far we have concentrated on the extensive margin; the impact on the number of firms exporting. Transport infrastructure improvements could however also increase the export value of firms already engaged in exporting (intensive margin) by helping them to compete more effectively on the international market. Recent theoretical (Chaney 2008) and empirical work (Crozet and Koenig, 2008) shows a distinctive effect of distance on the two margins.

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Table 1. Definition of Variables

Variable	***Definition***	***Mean***	***Standard Deviation***	***Min.***	***Max.***
EXPORT	Indicator for firm's export activity (=1 if firm exports)	.594	.491	0	1
ACCESIBILTY	Access to main seaports (time in minutes)	92.99	69.80	0	260.5
ID	Indicator for firm's R&D activity (=1 if firm hires or carries out R&D activities)	.362	.480	0	1
PRODUCTIVITY	Value Added over number of employees	38628.8	48445.21	11	5915654
HIGH SKILL	Percentage of workers with a University degree	3.518	6.282	0	78.9
MED. SKILL	Percentage of workers with a High School degree	4.660	7.680	0	100
AGE	Years since firm's foundation	27.029	24.096	0	224
SIZE	Total number of employees (in hundreds)	2.569	8.118	0.01	253.63
FOREIGN	Percentage of foreign shareholding	0.208	0.406	0	1
SPILLOVER (DOM.)	(Exports by domestic firms in sector j / total exports in j) / (total exports by domestic firms/total exports)	1.846	0.995	0.062	5.074
SPILLOVER (MUL.)	Same as above for multinational firms	0.701	0.334	0	1.456

Table 2. Sample: number of firms by year

Year	Number of firms
1990	2113
1991	2020
1992	1924
1993	1754
1994	1716
1995	1631
1996	1652
1997	1853
1998	1667
1999	1695
2000	1781
2001	1619
2002	1645
2003	1311
2004	1308
2005	1835
2006	1924
Total	29448

Table 3. Export behaviour of firms: 1990-2006

	No. of firms	% of firms
Firms that export in all years	1.888	43.8
Firms that never export	1.597	37.0
Firms that change export behaviour	827	19.2
Start exporting between 1990-2006	295	35.8
Stop exporting between 1990-2006	130	15.8
Stop and start exporting between 1990-2006	399	48.4

Source: ESEE

Table 4. Export behaviour by sector: 1990-2006

Sector	% of firms exporting	
	200 and less employees	More than 200 employees
Meat products	33.7	84.1
Other food products and tobacco	33.1	92.4
Beverages	53.7	63.9
Textiles	40.9	90.3
Leather and leather products/footware	57.3	100.0
Wood	34.6	88.1
Paper	52.5	89.0
Printing products	29.2	69.3
Chemical products	63.7	94.4
Rubber and plastic products	53.7	97.1
Non-metallic mineral products	34.1	86.1
Basic metals	65.1	94.7
Fabricated metal products	40.0	94.1
Machinery and mechanical equipment	59.3	97.8
Office equipment, precision, optical equipment	60.6	96.8
Electrical equipment	46.7	91.9
Motor vehicles	60.8	97.7
Other transport equipment	50.3	89.8
Furniture	43.0	97.2
Other manufacturing	66.3	98.9

Source: ESEE

Table 5. Key characteristics of exporting firms

	Exporters	Non-exporters	t-test of means difference	sig.
Mean number of employees	392.8	58.3	-35.6	***
Mean company age (years)	32.3	19.1	-47.2	***
Mean % of foreign capital	27.1	3.4	-58.2	***
Average R&D expenditure (thousands)	1176.1	42.4	-12.7	***
% with product innovation	34.2	12.1	-42.5	***
% with process innovation	40.8	21.5	-34.0	***
Average value added per employee	45382.2	27682.6	-29.8	***

Source: ESEE; Note: *** significant at the 1% level

Table 6. Export behaviour by NUTS 1 Region

	Percentage of exporting firms				
NUTS 1 - region	**1990**	**1994**	**1998**	**2002**	**2006**
Industrial core-areas					
ES5 – East	51.8	61.7	67.9	70.1	69.8
ES2 – North East	62.7	65.2	71.4	71.7	70.7
ES3 - Madrid	45.8	54.6	61.2	60.0	56.6
Periphery					
ES1 - North West	42.4	46.7	61.6	66.9	64.1
ES4 - Centre	37.0	42.6	55.8	54.0	57.5
ES6 - South	35.7	40.7	53.6	56.7	44.7
National	48.7	55.6	63.9	64.9	62.6

Table 7. Percentage of exporting firms by accessibility level

	High accessibility areas		Low accessibility areas	
NUTS 1 - region	1990	2006	1990	2006
Access to French border	56.7	70.8	42.5	57.3
Access to Portuguese border	44.1	59.0	53.4	68.9
Access to main seaports	54.0	67.5	42.5	58.9

Source: ESEE, GIS own calculation

Table 8. Change in accessibility for exporters versus non-exporters

	Exporters	Non-exporters	t-test of means difference	sig.
Last 15 years: 1990-2005				
travel time to French border	-15.8	-21.4	-25.7	***
travel time to Portuguese border	-23.6	-23.5	0.32	
travel time to seaports	-9.4	-11.7	-16.4	***
Last 25 years: 1980-2005				
travel time to French border	-23.2	-32.4	-26.3	***
travel time to Portuguese border	-38.4	-37.2	4.90	
travel time to seaports	-13.1	-16.1	-15.0	***

Source: ESEE; Note: *** significant at the 1% level

Table 9. Estimation results: linear probability model.

	OLS	*WG*	*GMM-FD*	*GMM-SYS*
EXPORT(-1)	0.838*	0.415*	0.421*	0.547*
	(0.004)	(0.007)	(0.030)	(0.026)
ACCESIBILITY(-1)	-0.002*	-0.006	-0.013	-0.010*
	(0.0007)	(0.005)	(0.019)	(0.004)
ID(-1)	0.036*	0.009	-0.007	0.004
	(0.004)	(0.006)	(0.010)	(0.010)
PRODUCTIVITY(-1)	8.20-08**	5.87-09	-2.30-10	2.41-08
	(3.41-08)	(3.42-08)	(5.42-09)	(2.11-08)
HIGH_SKILL(-1)	0.0007**	0.0004	-0.001	0.0002
	(0.0003)	(0.0005)	(0.001)	(0.0011)
MED_SKILL(-1)	0.0004***	0.00009	0.0007	0.001
	(0.0002)	(0.0003)	(0.0006)	(0.0008)
AGE	0.0009*	-0.247	-7.380	0.004*
	(0.0002)	(0.160)	(7.542)	(0.001)
AGE2	-4.46-06*	-0.00002**	-0.00004	-0.00002***
	(1.45-06)	(9.66-06)	(0.00003)	(0.00001)
SIZE	0.002*	0.004*	0.012	0.008*
	(0.0004)	(0.001)	(0.013)	(0.002)
SIZE2	-0.00001*	-0.00001***	-0.0001	-0.00006*
	(3.77-06)	(6.96-06)	(0.0001)	(0.00002)
FOREIGN(-1)	0.0003*	-0.0008*	0.0009	0.0009*
	(0.0005)	(0.001)	(0.0008	(0.0001)
SPILLOVER (DOM.)	-0.004	-0.0005	-0.012	0.002
	(0.006)	(0.006)	(0.012	(0.006)
SPILLOVER (MUL.)	-0.017	0.001	-0.089**	-0.011
	(0.020)	(0.019)	(0.045	(0.022)
TIME DUMMIES	yes	yes	yes	yes
INDUSTRY DUMMIES	yes	yes	yes	yes

Note: Standard Errors in parenthesis. Significant coefficients are indicated by *, **, ***, for significance at the 1%, 5% and 10% level, respectively.

Table 10. Estimation results: non-linear model

	POOLED. PROBIT	*RE PROBIT*	*CRE PROBIT*
EXPORT(-1)	2.814*	2.724*	2.021*
	(0.030)	(0.040)	(0.044)
ACCESIBILITY(-1)	-0.022*	-0.027*	-0.041
	(0.006)	(0.008)	(0.062)
ID(-1)	0.346*	0.384*	0.147**
	(0.037)	(0.042)	(0.064)
PRODUCTIVITY(-1)	2.57-06*	2.82-06*	4.44-07
	(6.80-07)	(7.42-07)	(1.11-06)
HIGH_SKILL(-1)	0.002	0.003	0.004
	(0.003)	(0.003)	(0.005)
MED_SKILL(-1)	0.005*	0.006*	0.003
	(0.002)	(0.002)	(0.003)
AGE	0.007*	0.009*	0.010*
	(0.002)	(0.002)	(0.003)
AGE2	-0.00004*	-0.00005*	-0.00007*
	(0.00001)	(0.00001)	(0.00002)
SIZE	0.088*	0.104*	0.107*
	(0.009)	(0.012)	(0.032)
SIZE2	-0.0004*	-0.0004*	-0.0003***
	(0.00005)	(0.00006)	(0.0002)
FOREIGN(-1)	0.003*	0.004*	0.004*
	(0.0005)	(0.0007)	(0.0009)
SPILLOVER (DOM.)	0.033	0.042	0.053
	(0.055)	(0.058)	(0.064)
SPILLOVER (MUL.)	-0.006	0.024	0.079
	(0.174)	(0.182)	(0.204)
TIME DUMMIES	yes	yes	yes
INDUSTRY DUMMIES	yes	yes	yes

Note: Standard Errors in parenthesis. Significant coefficients are indicated by *, **, ***, for significance at the 1%, 5% and 10% level, respectively.

Figure 1: Evolution of percentage of firms exporting

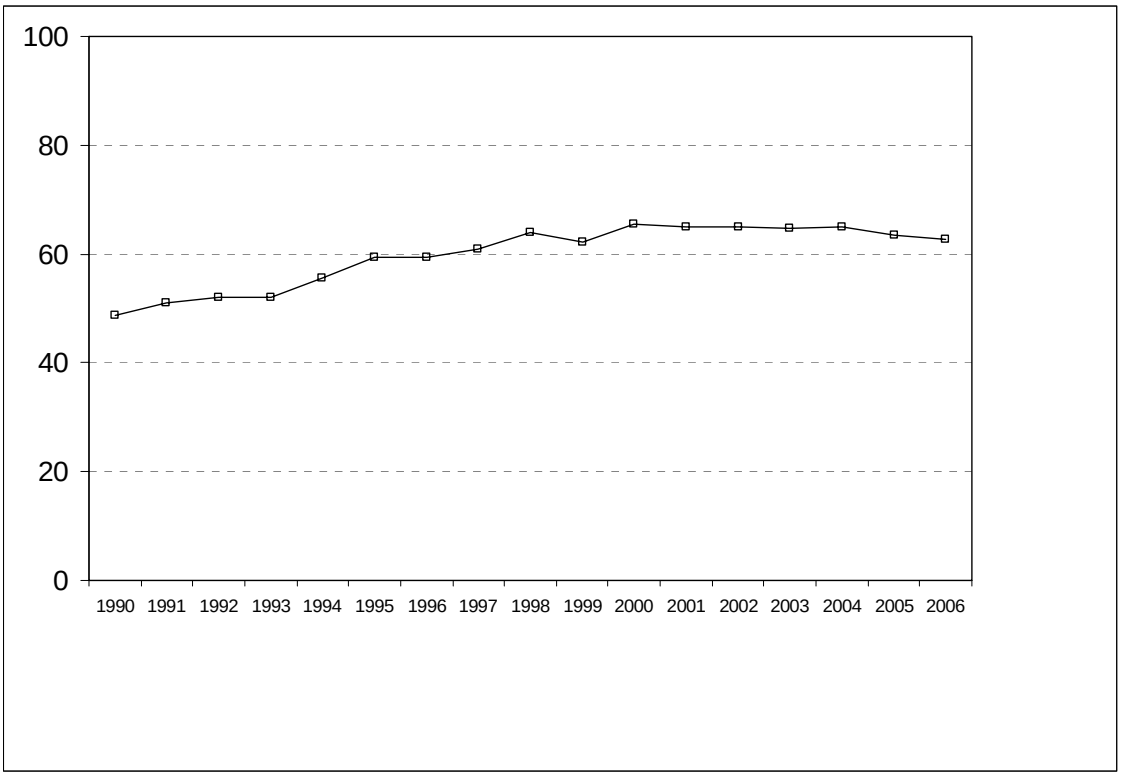
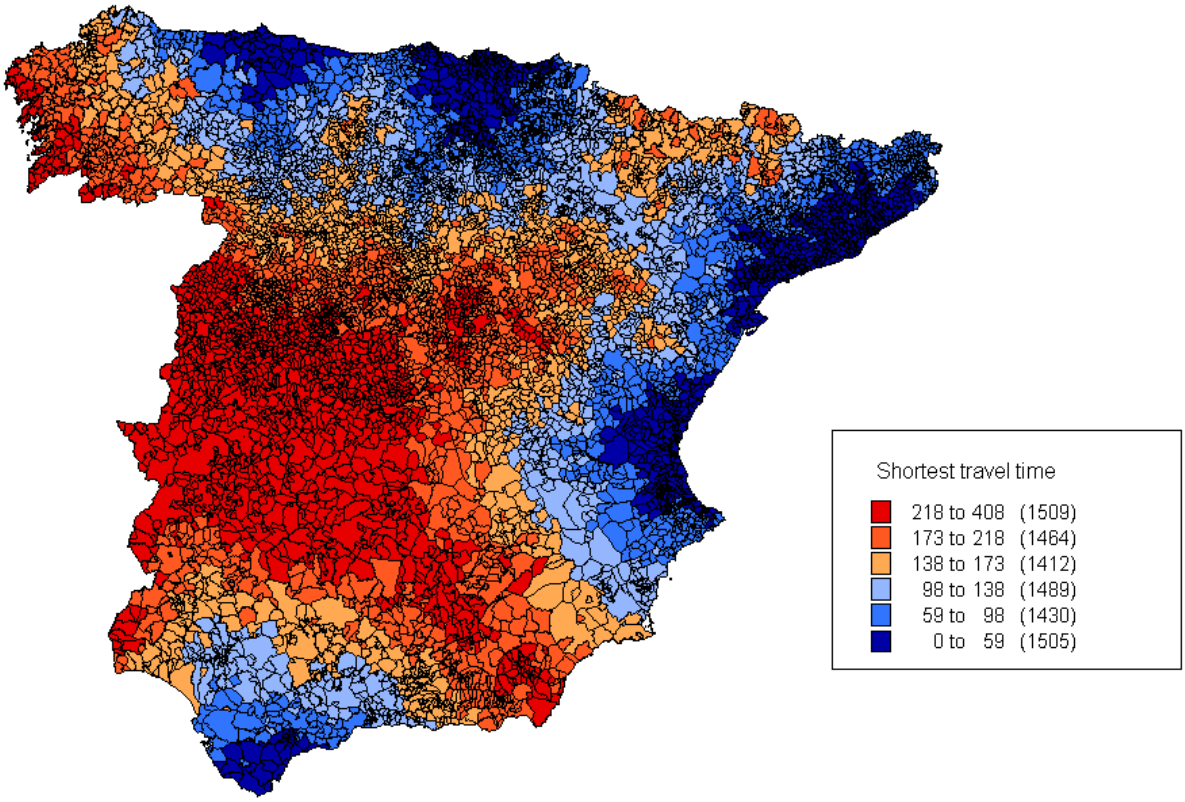


Figure 2a. Access to main sea ports (shortest travel time):

1990:



2005:

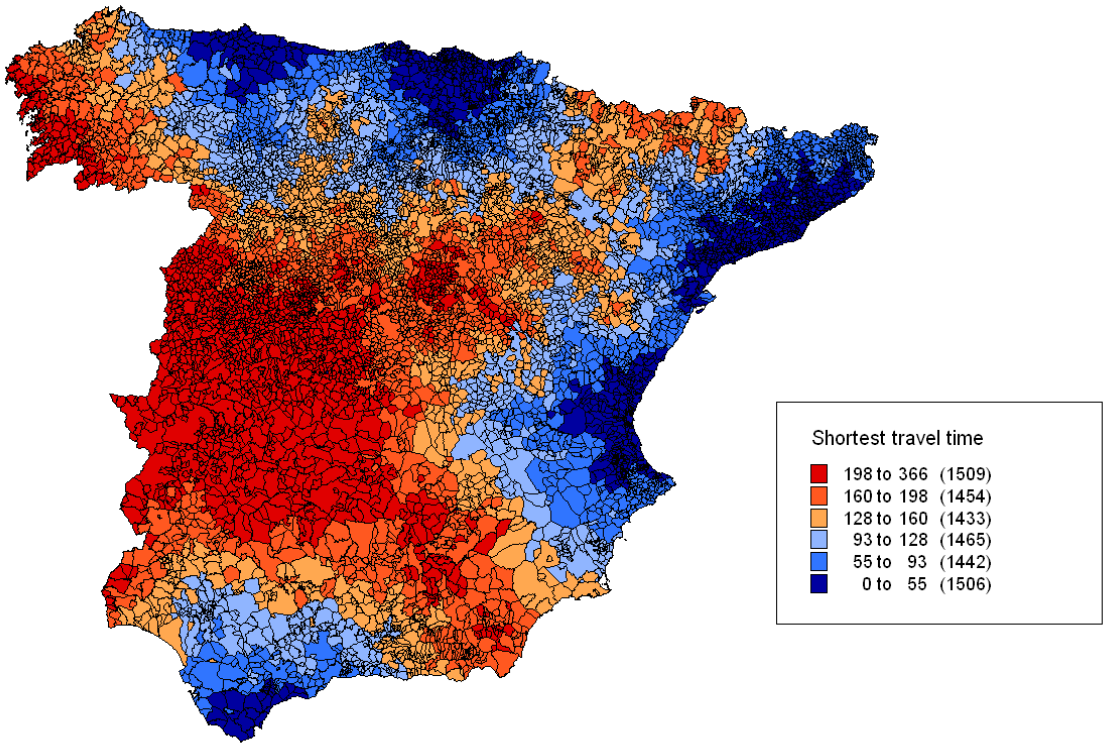


Figure 2b. Change in access to main sea ports (shortest travel time):1990-2005

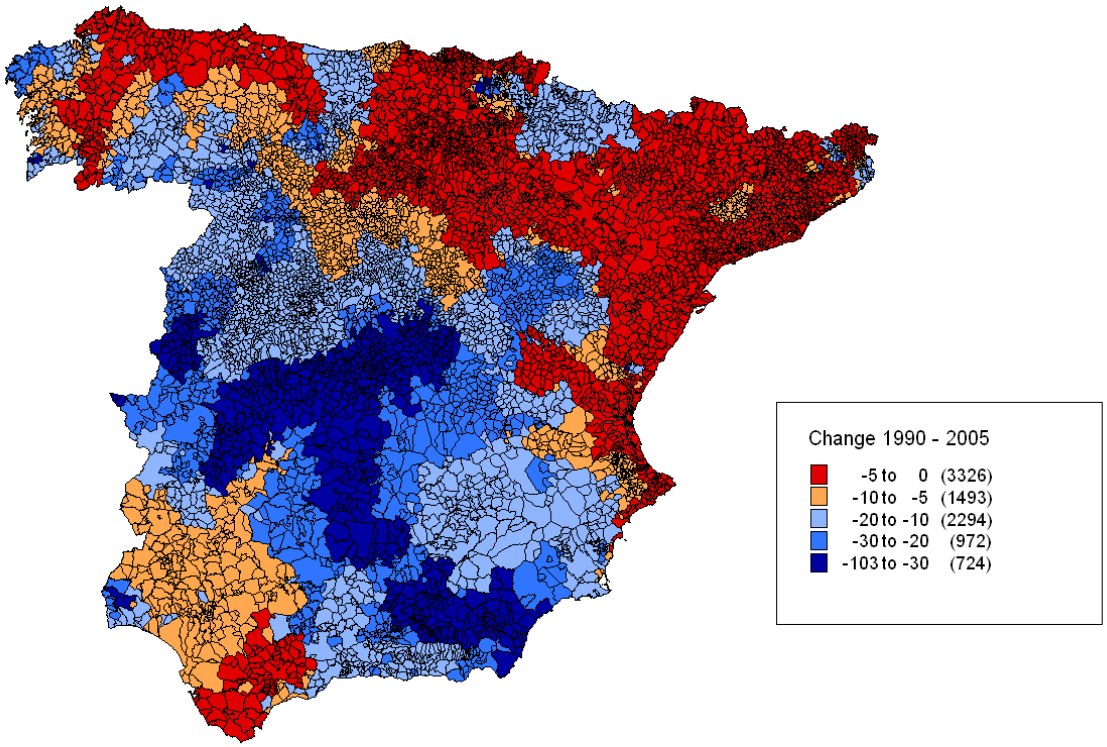
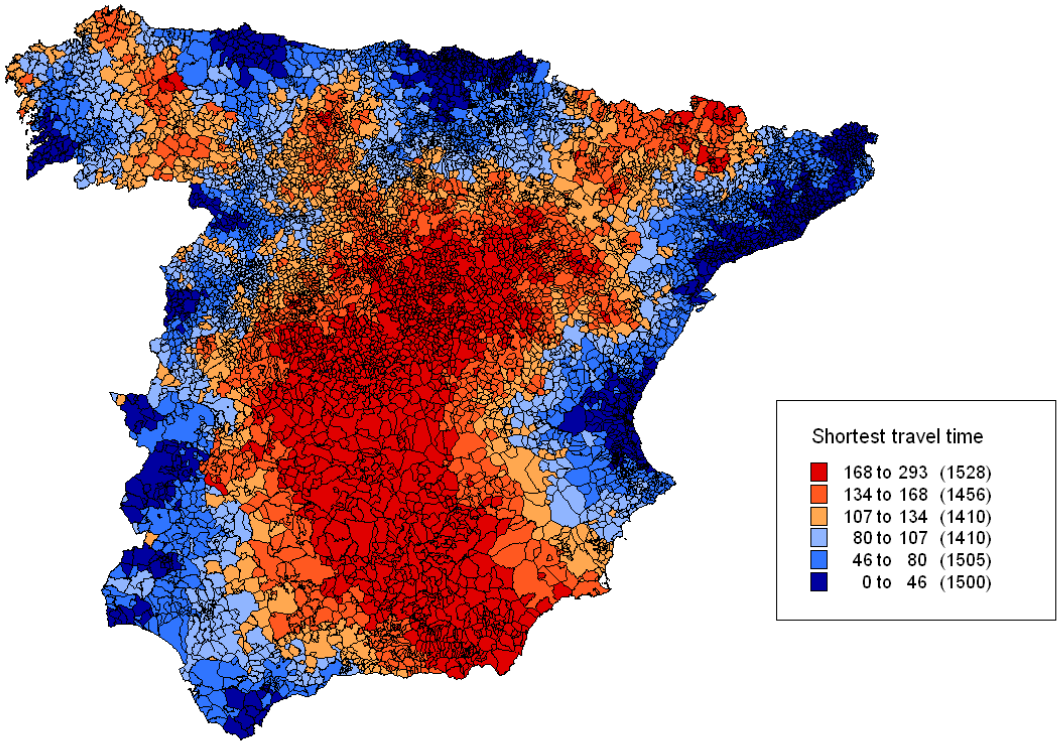


Figure 3a. General access to export markets (shortest travel time to main border crossings or main seaports):

1990:



2005:

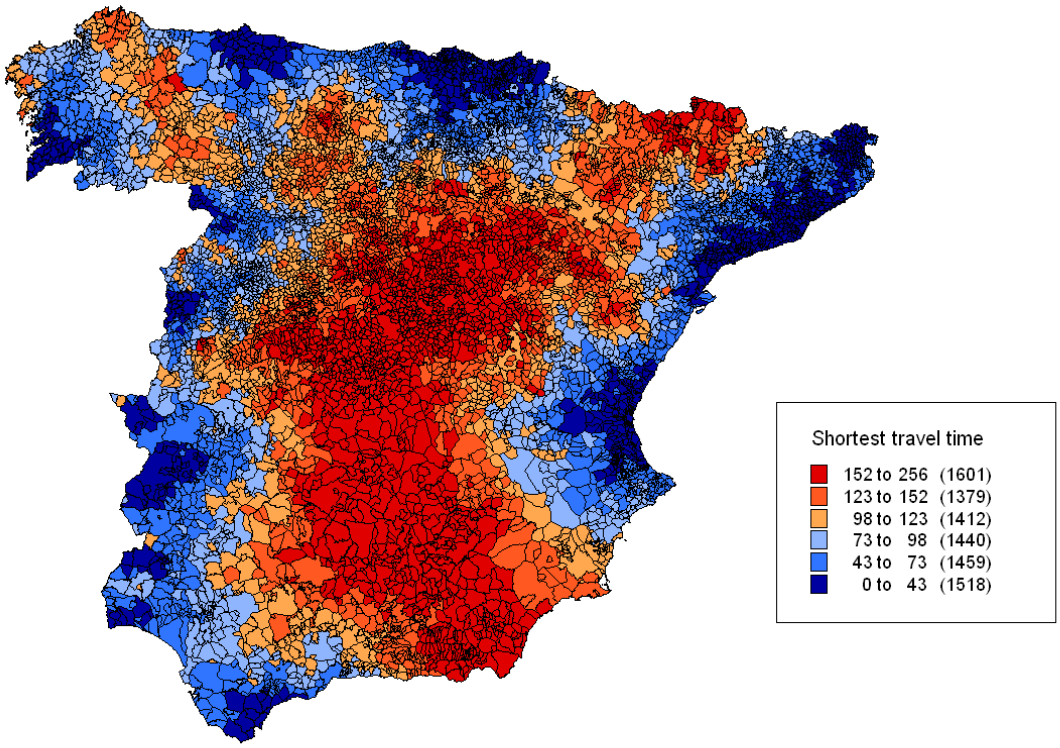
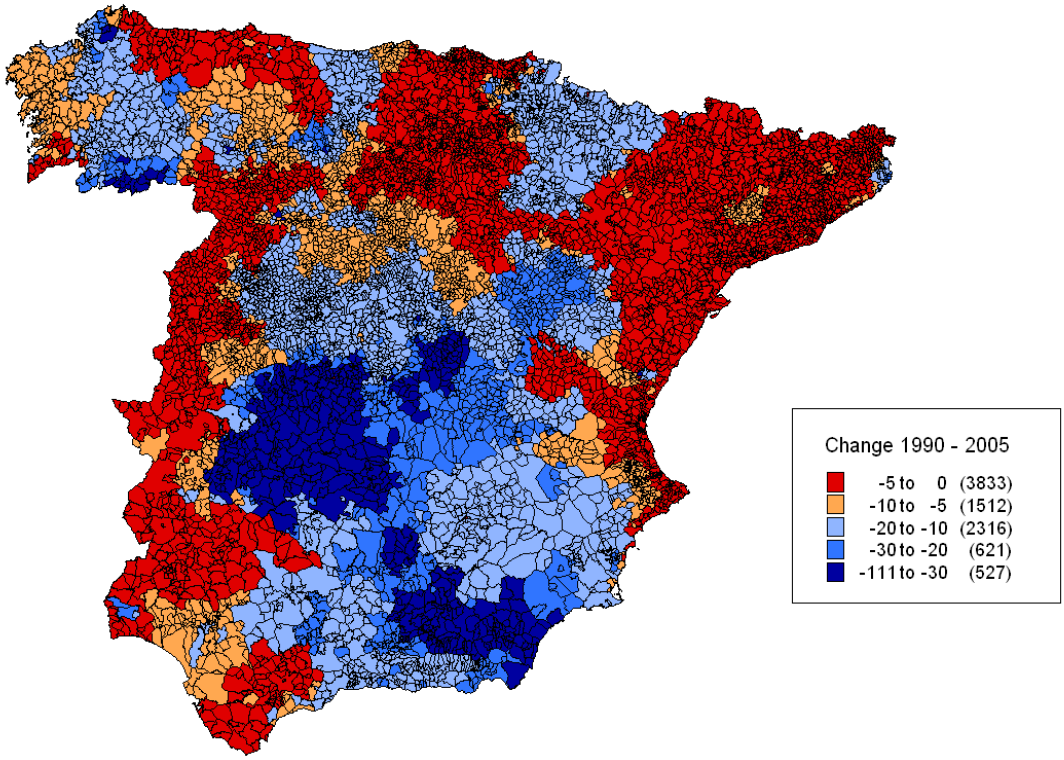


Figure 3b. Change in general access to export markets (shortest travel time):1990-2005



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