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Abstract

New Economic Geography (NEG) models stress the importance of access to demand as a key driver of the spatial and temporal distribution of economic activity (Krugman, 1991). Therefore, in order to test the theoretical predictions emanating from NEG a sound measure of accessibility is required. In line with Crafts (2005b), this paper constructs market potential estimates for Spain at the province level (NUTS3) between 1867 and 1930 using Harris's (1954) equation. This period is particularly appealing as it was during these years that the Spanish market became integrated thanks to the fall in transport and trade costs. A number of key processes, including the substitution of traditional transport modes and the improvement in transport technologies (the railways and steam navigation), were set in motion. At the same time, the Spanish economy was experiencing the early stages of industrialization in a context characterised by changing trade policies. Interestingly, these long-term processes brought about asymmetric changes in regional accessibility, thus potentially affecting the evolution of Spain's regional economies. The results show that the main changes to regional market accessibility in Spain can be traced to the second half of the 19th century, a period characterised by centrifugal tendencies. The availability of this dataset is essential for undertaking empirical exercises, through the lens of NEG, examining the Spanish experience up to the Spanish Civil War (1936-1939), when an increasing spatial concentration in the country's manufacturing sector and an upswing in regional per capita income inequality took place.

JEL classification: F15, N73, N74, R12

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1. Introduction

With the emergence in recent decades of New Economic Geography (henceforth, NEG), the role of market accessibility has regained significance as an explanatory factor of the spatial distribution of economic activity (Fujita et al., 1999; Combes et al., 2008). And while the study of this factor has been of long-standing tradition among geographers and economists, NEG models place access to demand at the core of the explanation of agglomeration processes. Broadly speaking, these models suggest that the interaction between transport costs, increasing returns and market size in a framework of monopolistic competition favours the spatial concentration of production, setting in motion a snowball effect that ensures the continuous strengthening of the process.

In Krugman's (1991) seminal work, the author describes the centripetal forces leading to the cumulative process of agglomeration. The core-periphery model, he proposes, considers two regions in which the immobile factor (farmers) is used as an input in the agricultural sector and the mobile factor (workers) is used as an input in the manufacturing sector, which tends to be characterised by increasing returns and monopolistic competition. In this context, firms prefer to locate near large centres of demand for manufacturing goods so that they can save on transport costs (*backward linkages*). The resulting increase in the market size of such a location generates, by means of the home market effect, a more than proportional increase in the share of firms (Helpman and Krugman, 1985). Hence, firms are attracted by proximity to demand and are willing to pay higher nominal wages. Moreover, the larger share of firms in a location means that a greater variety of local goods can be produced, which combined with lower transport costs means the local price index is lower. The subsequent increase in real wages then acts to attract new workers to this location *(forward linkages*). So, market access plays a key role in generating the centripetal forces identified in NEG models, since such access has a positive influence on the location decisions made by firms and workers, inducing factor mobility (capital and labour, respectively) and boosting the agglomeration process[1].

[1] This market access mechanism may be further expanded by demand for intermediate goods or *input-output linkages* (Krugman and Venables, 1995; Venables, 1996). As such, it accounts for the emergence of large industrial regions in economies characterised by low labour mobility, given that in Krugman (1991) the key to agglomeration lies in the mobility of workers.

Yet, while the initial fall in transport costs favours agglomeration, further advances may reverse the process. Puga (1999) identifies the non-monotonic relationship between market integration and the spatial concentration of manufacturing over time[2]. When transport costs are high, industry tends to be spatially dispersed, but as these costs fall to an intermediate level, centripetal forces intensify the forces of agglomeration given that workers are mobile. However, when transport costs are low, there will be a tendency towards dispersion once more. In this case, congestion costs, wage differentials, fragmentation of firms or non-economic motives affecting the decision to migrate (*amenities*) act as centrifugal forces dispersing economic activity. Thus, NEG models highlight the relevance of transport costs and their evolution over time for the understanding of the long-term processes that have shaped the spatial distribution of economic activity.

NEG empirical studies have sought to test these theoretical predictions directly linked to market access[3]. Some studies have provided evidence that market access attracts production factors, both capital (Head and Mayer, 2004a; Crozet et al., 2004) and labour (Crozet, 2004), and thus they demonstrate the significance of *backward* and *forward linkages*. Likewise, empirical analyses have sought to confirm that market access raises the prices of the factors of production, both internationally and nationally: on the one hand, the relationship between market potential and cross-country income inequality has been examined (Redding and Venables, 2004; Head and Mayer, 2011[4]); on the other, the existence of a spatial structure in regional wages based on Krugman's wage equation has been analysed (Hanson, 1998, 2005). This second line of research has proved to be very fruitful and a good number of studies have tested and verified the existence of the wage equation.

NEG studies have also explored the impact of international integration on the internal economic geography of countries. Hanson (1997), based on the experience of Mexico, stressed that trade liberalization may have an asymmetric effect on regional accessibility. The abandonment of protectionist policies and the transition to an open

[2] Puga (1999) combines the assumptions of interregional mobility of labour, as in Krugman (1991), and of *input-output linkages*, as in Krugman and Venables (1995) and Venables (1996). In addition, the model considers mobility between sectors and thus it is a more suitable framework for regional studies.

[3] Recent reviews of the NEG empirical literature can be found in Head and Mayer (2004b) and Redding (2010).

[4] See, from the perspective of economic history, Crafts and Venables (2003).

economy in the 1980s fostered the relocation of manufacturing activities from Mexico DF to the north of the country near the US border. Multi-regional theoretical models provide a foundation for this result: the increase in the relative importance of foreign markets accounting for this relocation (Krugman and Livas, 1996). However, other authors suggest that trade liberalization creates two counteracting effects: access to foreign markets benefits export production, but domestic firms may have to face stiffer import competition from foreign producers. As such, the concentration or dispersion of manufacturing production is dependent on which of these two effects dominates (Crozet and Koenig, 2004; Brülhart et al., 2004)[5].

The assumptions made by NEG models, and the description of the processes illustrated in them, make it a particularly appropriate theoretical framework for undertaking empirical historical studies. Industrialization processes, the marked fall in transport costs as a result of the application of new technologies in the sector and the integration of domestic (and international) markets may generate the agglomeration forces that change the distribution of economic activity across space and reinforce spatial disparities over time. Economic historians have drawn on NEG models to analyse national historical experiences and, for obvious reasons, the manufacturing sector has received most of the attention. The evolution of the spatial distribution of manufacturing and its determinants has often been analysed contrasting two competing explanations: that provided by NEG and the comparative advantage in factor endowments as suggested by traditional trade theory (the Heckscher-Ohlin model). Kim (1995) examined the US long-term experience concluding that comparative advantage was responsible for the bell-shaped evolution of the manufacturing sector. A new avenue of research was opened up by the work of Midelfart-Knarvik et al. (2002). The empirical strategy developed by these authors for the EU in recent times has been used to study a good number of historical experiences, including, those of interwar Poland (Wolf, 2004, 2007), Victorian Britain (Crafts and Mulatu, 2005, 2006) and the US at the turn of the 20th century (Klein and Crafts, 2012)[6].

[5] An excellent survey on this topic can be found in Brülhart (2011). From an economic history perspective see A'Hearn and Venables (2011), where the case of Italy is studied.

[6] A clear advantage of this empirical strategy is that in the equation estimated by Midelfart-Knarvik et al. (2002) the role of market potential in industrial location decisions can be tested directly. Interestingly, Klein and Crafts (2012) questioned the conclusions reached by Kim (1995) for the US. According to their results, NEG-type mechanisms were at the root of the strengthening of the manufacturing belt in 1880-1920.

The Spanish case has also been analysed through the lens of NEG by economic historians. In line with Kim (1995), Tirado et al. (2002) identified scale economies and market size as determinants of the industrial geography of mid-19th century Spain. At the end of the century, these NEG elements increased their explanatory power in parallel with the advance in the process of market integration. Recently, Martínez-Galarraga (2012), adopting the approach developed by Midelfart-Knarvik et al. (2002), has confirmed and extended the previous findings up to the Civil War (1936-39). Betrán (2011) has also analysed industrial location and regional specialization for the period 1856-2000, and, from a different perspective, Rosés (2003), following Davis and Weinstein (1999, 2003), found evidence of a home market effect in the manufacturing sector in mid-19th century Spain.

A key issue in NEG empirical exercises is endogeneity. Theoretical models describe a process characterised by reverse causality in which market potential, by attracting firms and workers, increases production in a particular location, and this, in turn, raises its market potential. To address this estimation problem the analyses make use of instrumental variable techniques. This requires finding a good instrument, that is, a variable that is correlated with the endogenous explanatory variable but not with the residuals of the regression. Among the instruments used in the empirical literature, the most common include geographical distances from the main economic centres (Redding and Venables, 2004; Klein and Crafts, 2012) or the use of lagged variables for the market potential (Wolf, 2007; Martínez-Galarraga, 2012). Yet, when the analysis is focused on comparative economic development other (persistent) factors like institutions or natural endowments may also be playing a role, making it difficult to isolate the effect of market access (Redding, 2010). In this context, an alternative approach involves identifying exogenous shocks that may have caused a variation in market access. The impact on population density of the bombing of Japanese and German cities during Second World War (Davis and Weinstein, 2002; Brakman et al., 2004), the effect of the new border on West German cities after the division of Germany and the subsequent reunification in 1990 (Redding and Sturm, 2008) or even variations in trade policy (Hanson, 1996, 1997; Tirado et al., 2013) have been used as natural experiments to study the outcome of asymmetric changes in market access.

Most of the empirical work undertaken to test NEG predictions relies, nonetheless, on the availability of a sound indicator of accessibility. So, how can market access be best measured? An initial alternative involves the direct structural derivation of market potential

from an NEG theoretical model. In this sense, Redding and Venables (2004) obtained a measure of market potential using the coefficients estimated in a gravity trade equation. Thus, they were able to construct the market access (MA) and supplier access (SA) variables. Yet, the alternative of obtaining a structural estimate of market potential based on NEG models requires a volume of data regarding bilateral trade flows that all too frequently is not available. This difficulty is even more apparent when regional studies are undertaken from a historical perspective[7]. In the calculation of market potential estimates in Victorian Britain, Crafts (2005b), given the absence of data for interregional trade, turned to the market potential equation defined by Harris (1954). In short, this equation captures the idea that the accessibility of a location depends on the size of other markets, usually measured in terms of GDP, once distances (or bilateral transport costs) have been deducted. Since Harris's pioneering work, and prior to the emergence of NEG, this equation was adopted in a large number of studies by geographers and economists (Clark et al., 1969; Keeble et al., 1982), as well as within the same analytical framework (Head and Mayer, 2004a).

In the case of Spain, information regarding regional trade flows is not available for most historical periods. Having ruled out, therefore, the possibility of deriving a measure of market access structurally using a gravity equation, market potential is calculated on the basis of Harris's equation. The period of study extends from the mid-19th century to the outbreak of the Spanish Civil War, when the domestic market was integrated, industrialization was entering its early stages and transport costs underwent a notable fall as a result of the construction of the railway network and the improvements in maritime navigation (in the context of the first globalisation). Indeed, this period was characterised in Spain by a notable increase in the spatial concentration of manufacturing (Tirado and Martínez-Galarraga, 2008) and an equally remarkable upswing in regional income inequality (Rosés et al., 2010). In this context, market potential estimates for the years 1867, 1900, 1910, 1920 and 1930 are obtained. The spatial unit chosen is the Spanish provinces, that is, a NUTS3 level of disaggregation according to the EU nomenclature for statistical territorial units. The contribution of the paper is twofold: firstly, the aim is to detail the methodology employed in the construction of market potential estimates, and, secondly, to present an essential tool for empirical exercises and an in-depth analysis of the historical evolution of the Spanish economy through the lens of NEG.

[7] The exception here would be Wolf (2004, 2007).

Harris's market potential equation presents one noteworthy characteristic, namely, that market potential can be broken down into its domestic and foreign potentials. This enables to consider the impact on accessibility of a country's whole set of regions/provinces as well as that of its foreign trade partners. The market potential estimation carried out by Crafts (2005b) for Britain paved the way for the computation of this variable in historical periods[8]. The methodology developed by Crafts (2005b), which in turn is based on Keeble et al. (1982), is extended here in two ways. First, for the Spanish case, thanks to the work of various economic historians, information gathered about the average transport freight rates for different modes of transport allows the domestic market potential to be computed in terms of transport costs. Second, given that foreign market potential relies exclusively on the implicit reasoning within trade gravity equations, this procedure allows not only to consider two basic elements in Harris's equation (distances and tariffs) jointly, but also to take advantage of the more detailed information available that quantifies the impact of distance and tariffs on trade through the elasticities associated with these variables in gravity equations.

Importantly, when considering multi-regional models, the capacity of different locations to attract firms and workers varies according to their relative position in space. In this sense, most of the NEG papers that use Harris's market potential equation rely on geodesic distances between locations. However, and especially when applied historically, the consideration of bilateral transport costs in the calculation of domestic market potential presents some clear advantages[9]. For instance, different transport modes can be included, the exact routes used in the transportation of commodities by mode analysed, and the freight rates applied by companies considered, all taking into account that their evolution over time can vary for a number of reasons. The specific geographical characteristics of countries, the emergence of new transport technologies and their substitution of traditional modes, the investment in transport infrastructures, the design of the network (often politically decided), the quantity and quality of the lines of communication, or even trade policy may have an impact on transport and trade costs.

[8] Schulze (2007) obtained regional market potential estimates for the Austro-Hungarian Empire between 1870 and 1910.

[9] The measurement of transport costs has been and remains the subject of much debate. The geodesic, straight-line distance, real distance as a function of the available infrastructure, distance measured in time (Hummels, 2001), or the transport costs that include distances and the freight rates, are the various alternatives used in the empirical literature. Reviews of these studies from an NEG perspective can be found in Combes and Lafourcade (2005) and Lafourcade and Thisse (2008).

In the period analysed in this paper, remarkable changes were recorded in transport technologies, including the expansion of the railway and steam navigation. In addition, the geography of Spain, being a peninsula, offered the possibility to transport commodities between provinces both by land and by sea (coastal shipping or *cabotage*). Traditionally, inland transport had been conducted by road, but it was very expensive given the mountainous topography of the country and the poor state of conservation of roads in a context in which the absence of navigable rivers deprived Spain of an alternative cheaper transport. The construction of the railway network favoured a reduction in transport costs, but its expansion was gradual and therefore some regions benefited earlier than others from railway transportation. And in the particular case of Spain, a radial railway network with its hub in Madrid, the capital and the geographical centre of the country, was decided upon. In the transport of goods between coastal provinces by coastal shipping, key advances, such as the transition from sail to steam and the improvement in port facilities, took place. Overall, these changes often presented a regionally asymmetric pattern, thereby unevenly affecting regional transport costs and accessibility. In addition, trade policies also underwent changes across Europe, especially during the interwar period.

Finally, although Harris's equation is an *ad hoc* measure developed by geographers, contrary to the structural estimations derived from NEG models, the validity of this indicator is supported by two facts: on the one hand, the results from various empirical exercises in economic geography do not provide conclusive evidence in terms of robustness in favour of any of these alternative measures[10] and, on the other, it is possible to establish a direct relationship between Harris's equation and market access measures directly derived from NEG models, thus providing theoretical foundations to Harris's market potential equation (Combes et al., 2008). In section 2, this relationship between the measure of market access derived from NEG models and the market potential equation defined by Harris (1954) is clarified. Then, in section 3, the methodology employed is outlined in detail. The main results are presented in section 4 and the last section concludes.

[10] "Despite the fact that we bring theory to empirical implementation in a structural way, the 'correct' measure of market potential actually underperforms the atheoretical Harris (1954) measure". (Head and Mayer, 2004a,)

2. Harris's market potential equation and its theoretical foundations

Interest in the relationship between market access and industrial location is longstanding among geographers and economists. Harris's (1954) pioneering work sought to explain the creation of the industrial belt in the northeast of the United States and its persistence over time. Harris held that the area had experienced a process of industrial concentration characterised by a circular causation that was similar to that subsequently proposed by NEG: the north-eastern areas of the country enjoyed an advantage in terms of better market access, which would have attracted manufacturers to these locations sited as they were near the largest markets; in turn, the size of these markets would have augmented due to the concentration of manufacturers. In order to analyse the importance of markets as an industrial location factor in the United States, Harris proposed an index for measuring market accessibility based on the following formula:

$$P = \sum\left(\frac{M}{d}\right) \tag{1}$$

where market potential P is defined as the summation of markets accessible from a point divided by the distance to that point, where M is a measure of the economic activity in each area, and d is the distance between areas or regions[11]. Yet, this measure of market access suggested by geographers and widely adopted by economists is an *ad hoc* indicator and, as such, it is not built upon a solid theoretical foundation. As Krugman (1992, 7) pointed out: "*Market potential analyses have been a staple of geographical discussion, especially in Europe. The main theoretical weakness of the approach is a lack of microeconomic foundations: while it is plausible that some index of market potential should help determine production location, there is no explicit representation of how the market actually works*". However, the advances made within NEG can help overcome this absence of a theoretical link between the market access measures. Based on an NEG model and adopting a series of assumptions, it can be demonstrated that a mathematical expression that is comparable to the original market potential equation proposed by Harris can be derived. In this way, a theoretical foundation can be provided for Harris's market potential equation[12].

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[11] "*The term market potential, suggested by Colin Clark, is […] an abstract index of the intensity of possible contact with markets. The concept is derived ultimately from physics, in which similar formulas are used in calculating the strength of a field, whether electrical, magnetic, or gravitational*". Harris (1954, 321).

[12] Here, the explanation follows Combes et al. (2008). An alternative approach for deriving the market potential function using the wage equation can be found in Krugman (1992).

Combes et al. (2008) focus their analysis on the determinants of industrial location in a context in which activities with scale economies tend to establish themselves in regions that enjoy good market access, since it is these locations that offer the greatest potential benefits. Hence, the study of the benefits accruing to a firm in an NEG theoretical framework allows to derive an expression for real market potential (RMP) from which it is possible to establish a relationship with Harris's equation. NEG models show that, in equilibrium, the gross benefits of exploiting a firm π_{rs}^{*} are expressed as follows:

$$\pi_{rs}^{*} = (p_r^{*} - m_r)\tau_{rs}q_{rs}^{*} = m_r \frac{\tau_{rs}q_{rs}^{*}}{\sigma - 1} \tag{2}$$

where r and s represent the regions or countries, p_r refers to the price of a variety sold by a firm located in r, m_r denotes the marginal cost of production, q_{rs} the quantity that a firm sells in market s, τ_{rs} are the iceberg-type transport costs payable on a good on the route from r to s, and σ is the elasticity of substitution between any two varieties, an inverse index of product differentiation.

On the one hand, the equilibrium price is expressed as $p_{rs}^{*} = \tau_{rs}p_r^{*} = \tau_{rs}m_r\sigma/\sigma - 1$, while in the short-run, when the number of firms is exogenous and the benefits are positive, the quantity q_{rs}^{*} is determined using a CES-type demand function that adopts the following form:

$$q_{rs}^{*} = (p_r^{*}\tau_{rs})^{-\sigma}\mu_s Y_s P_s^{\sigma-1} \tag{3}$$

where μ_s is a parameter representing the share of the good considered in the consumption of region s, Y_s denotes income in region s, and P_s is the CES-type price index in s, according to the following expression:

$$P_s = \left[\sum_{r=1}^{R} n_r \left(p_r^{*}\tau_{rs}\right)^{-(\sigma-1)}\right]^{-1/(\sigma-1)} \tag{4}$$

Taking this into account, the total net profit of a firm located in region r can be obtained by subtracting the specific fixed costs of each plant F_r from the gross profit π^*_{rs} obtained previously, so that:

$$\prod_r^* = \sum_s \pi_{rs}^* - F_r = cm_r^{-(\sigma-1)} RMP_r - F_r \qquad (5)$$

In this instance, $c = \sigma^{-\sigma}/(\sigma-1)^{-(\sigma-1)}$ and the abbreviation RMP_r corresponds to the real market potential of region r, which would be given by the expression:

$$RMP_r \equiv \sum \phi_{rs} \mu_s Y_s P_s^{\sigma-1} \qquad (6)$$

where the term ϕ_{rs} measures the accessibility of the goods from r into market s as a function of transport costs, which are represented by $\phi_{rs} \equiv \tau_{rs}^{-(\sigma-1)}$.

Once this expression of RMP has been derived from an NEG model, it is possible to establish the relationship between the latter and the market potential equation defined by Harris. To do this, three assumptions have to be made: first, it has to be assumed that the share of each good within the total consumption does not vary between regions, so that $\mu = 1$.[13]; second, an important aspect is the inclusion in the RMP of the price index $P_s^{\sigma-1}$ (something that is missing in Harris's equation), thus, assuming that there is no variation in the price indices from one region to another; finally, we have to accept that $\phi_{rs} = d_{rs}^{-\delta}$, where d_{rs} is the distance between locations r and s, and the exponent δ corresponds to the estimated parameter for distance in the gravity equations that analyse the determinants of the volume of bilateral trade.

13 "*This simplifying assumption may be deemed acceptable when working with the consumption of final goods. However, regarding the consumption of intermediate goods, this assumption becomes more problematic, as it implies that either all sectors consume the same amount of each factor, or regional sectoral compositions are the same*". Combes et al. (2008, 305).

This final point deserves further exploration. In line with Combes et al. (2008, 111), the impact of distance on trade increased from a value of approximately 0.5 in 1870 to 1.5 in the year 2000. This rise, which would seem counterintuitive in a context marked by increasing globalisation, is a recurring result in the empirical literature, which also shows a considerable increase in the impact of distance on trade in the post-WWII era. However, it should be stressed that the estimation of gravity equations has generated values that are very often close to one for parameter δ.

Disdier and Head (2008) attempted to quantify the magnitude of the effect of distance on international trade by compiling a total of 1,467 distance coefficients derived from the estimation of gravity equations in various studies. The authors reported a distance coefficient of 0.9 for the post-WWII period, meaning that a 10% increase in distance between two countries would reduce trade between them by 9%. This is a very similar finding to that reported in Head and Mayer (2011) for an international sample of countries between 1960 and 2003. Other studies, including Hummels (1999), Anderson and van Wincoop (2003), and Redding and Venables (2004), corroborate the proximity of the distance coefficient to one. Therefore, available empirical evidence supports the assumption regarding a coefficient for distance close to one, so that, as Head and Mayer (2004a) claim, Harris's assumption of an inverse distance relation, where $\phi_{rs} = 1/d_{rs}$, appears to be a reasonable approximation to reality.

However, things might have been somewhat different in the second half of the 19th and the first decades of the 20th centuries. Estevadeordal et al. (2003) analysed the period between 1870 and 1939, reporting distance coefficients that are slightly lower, oscillating between -0.64 and -0.79 depending on the specifications employed[14]. To conclude, bearing these three assumptions in mind, it is possible to obtain Harris's (1954) equation using the expression of real market potential.

[14] Flandreau and Maurel (2001) estimate a distance value between 0.79 and 0.99 for Europe at the end of the 19th century. López-Córdova and Meissner (2003), by contrast, report a value of 0.661 for the period 1870 to 1910 in an international sample that includes between 14 and 28 countries depending on the year. For this same period, Mitchener and Weidenmier (2008) offer an estimation for the distance coefficient of around 0.56. In the interwar years, Eichengreen and Irwin (1995) report a decreasing impact with values varying between 0.51 and 0.78 in 1928 to 0.33 and 0.57 in 1938. Jacks et al. (2011) obtain lower values, between 0.31 and 0.38 for the period 1870-1913, and even lower ones for the interwar years (1921-1939), ranging from 0.15 to 0.20.

3. The construction of provincial market potential in Spain, 1867-1930

3.1. Definition and selection of 'nodes'

Market accessibility or market potential is measured using Harris's (1954) equation, in accordance with the following expression:

$$MP_r = \sum_s \frac{M_s}{d_{rs}} \tag{7}$$

Based on this equation, the market potential of a province *r* can be expressed as the ratio between M_s, a measure of economic activity in province s (typically GDP), and d_{rs}, the distance or bilateral transport costs between r and s. This indicator can be interpreted as the volume of economic activity to which a region has access after having subtracted the necessary transport costs to cover the distance to reach all the other provinces. The total market potential, in turn, can be broken down into the domestic market potential (DMP_r) and the foreign market potential (FMP_r). In the case of the former, the economic potential of any Spanish province depends on the GDP of each of the other provinces adjusted by its proximity to these provinces measured here in terms of transport costs, plus the internal market potential of that province or its *self-potential* (SP_r). Likewise, a province's foreign market potential, which includes Spain'a main international trade partners, needs to be added to its domestic market potential.

More specifically, the market potential (MP_r) of a province r can be expressed as the sum of its domestic and foreign market potentials:

$$MP_r = DMP_r + FMP_r \tag{8}$$

where the domestic market potential for each province r is calculated as follows:

$$DMP_r = \sum \frac{M_r}{d_{rs}} + SP_r \tag{9}$$

where d_{rs} is the result of multiplying the distance between province r and s (θ_{rs}) by the average transport freights, and being

$$SP_r = \frac{M_r}{d_{rr}} \tag{10}$$

the measure of the self-potential of each province r, where d_{rr} is calculated taking a distance θ_{rr} equivalent to a third of the radius of a circle with an area equal to that of the province:

$$\theta_{rr} = \frac{1}{3}\sqrt{\frac{(areaoftheprovince_r)}{\pi}} \tag{11}$$

In turn, the foreign market potential of province r is obtained according to the following expression:

$$FMP_r = \sum \frac{M_f}{d_{rp}} \cdot Distance_{pf}^{\delta} \cdot Tariffs_f^{\gamma} \tag{12}$$

where M_f is the size of the foreign market; d_{rp} captures the transport costs from the inland provincial node to the nearest Spanish sea port p; $Distance_{pf}$ is the distance between the Spanish sea port and the international node f; $Tariffs_f$ are the mean tariffs applied in the foreign country f; and, δ and γ are the elasticities obtained in international trade gravity equations associated with the coefficients for distance and tariffs, respectively. Here, if r is a coastal province, then d_{rp} takes a value of 1 and $Distance_{rf}$ equals $Distance_{pf}$; in turn, $d_{rp} = d_{rs}$ if r is an inland province. Hence, the total market potential (MP_r) of a province r can be finally expressed as the sum of three terms, the first two corresponding to the domestic market potential (including the self-potential of province r), and the last one capturing the foreign market potential:

$$MP_r = \sum \frac{M_r}{d_{rs}} + SP_r + \left[\sum \frac{M_f}{d_{rp}} \cdot Distance_{pf}^{\delta} \cdot Tariffs_f^{\gamma}\right] \tag{13}$$

with d_{rp} conditioned to the coastal or inland nature of province r. Next, the detailed information required for obtaining each of these components is provided.

The calculation of the market potential requires the adoption of a city or a 'node' within each province to serve as its unit of reference[15]. The node assigned to each province is, in most instances, its administrative capital. However, there are some exceptions. The geography of the Iberian Peninsula is such that a good number of its provinces enjoy direct access to the sea, a characteristic that necessarily influences its transport costs (Rappaport and Sachs, 2003), and not just those with the other Spanish provinces but also those with foreign ports. In the case of the coastal provinces of Murcia, Oviedo and Pontevedra, where the provincial capitals do not lie on the coast, alternative provincial nodes are chosen in order to capture the coastal location of these provinces: Cartagena, Gijón and Vigo, respectively. In all cases these cities are major centres of population and economic activity within the province and, furthermore, they possess a commercial port. By contrast, in the case of the provinces of Girona, Granada, and Lugo, three provinces with a coast but whose capital, once more, is not beside the sea, there do not exist other centres of important activity or any large ports. Thus, these three provinces are considered as inland provinces.

As for the exterior nodes, the first step is to select the countries that played an important role as trading partners for the Spanish economy over the period considered. This selection is based on the geographical distribution of Spanish exports, which reveals a high concentration in export markets (Prados de la Escosura, 1982; Tena, 2005). On the basis of this information, countries that accounted for at least 5% of Spain's exports are selected as foreign markets[16]. Thus, four countries are considered in the calculation of the foreign market potential: Great Britain, France, Germany and the United States[17]. Having decided on which countries to include in the sample, the next step involves selecting a node to represent each of the four markets. In the case of Great Britain, London - the

[15] The territories lying outside the Peninsula have not been included (the Balearic Islands, the Canary Islands and the autonomous cities of Ceuta and Melilla). The study includes a total of 47 provinces.

[16] Two exceptions include Cuba, a market that received a high percentage of Spanish exports, above all in the mid-19th century (18.5% of the total but only 5.3% in 1913 and 2.1% in 1930), and Argentina, whose market exceeded the 5% threshold in the eve of the First World War. They are excluded due to data restrictions regarding GDP at current prices. However, it ought to be the case that the limited size of their markets and, especially, the great distance separating them from the Peninsula would minimize the cost of their exclusion.

[17] Overall, these four countries accounted for 62.4% of Spanish exports in 1865/69, 57.8% in 1895/99, 58.0% in 1910/13 and 58.9% in 1931/35, being France and Great Britain the main markets.

capital and economic centre of the country – is selected[18]. For the USA, the choice is New York, while in the case of Germany, for questions of geographical access and the size of its port, the city of Hamburg is taken as the node. However, in the case of France the way of proceeding must differ. As a consequence of its geographical location in relation to that of the Iberian Peninsula, the French market can be accessed both via the Atlantic and the Mediterranean seaboards. Therefore, localizing the French market in a single node would mean penalising the regions on one or other of these two seaboards. For this reason, the French market, as it will be explained, is divided so as to capture the various routes along which the Spanish provinces can access it. Thus, three regional nodes are considered: Le Havre and Nantes on the Atlantic seaboard and Marseille on the Mediterranean.

3.2. Domestic market potential

3.2.a. GDP of the Spanish provinces: The provincial GDP figures are obtained from Rosés et al. (2010). These authors adopt the methodology outlined in Geary and Stark (2002) and the refinement suggested by Crafts (2005a) to obtain the nominal GDP at factor costs for Spain's NUTS3 provinces in 1860, 1900, 1910, 1920 and 1930.

3.2.b. Inter-provincial transport costs: In the mid-19th century, the Spanish railway was still very much in its infancy. However, the first basic phase in the construction of the country's rail network had been completed by 1866, with all the main population nuclei and centres of economic activity joined up. Thus, by this date, 32 provincial capitals formed part of the network, which is the reason why 1867 has been chosen as the first year in this study[19]. Yet, given that a significant number of provinces remained unconnected to the rail network, it is necessary to consider an alternative means of land transport to that of rail for this particular year: namely, road haulage. In addition, the geography of the peninsula implies that *cabotage*

[18] Crafts's (2005a) gives disaggregated information for regional GDP in Great Britain. Hence, it is possible to calculate the market potential, not by assigning all the economic activity in Britain to London but rather by distributing it between the nodes selected for each of the 12 regions. However, this approach sheds similar results.

[19] Given that the GDP estimation corresponds to 1860, it is assumed that the structure in the territorial distribution of GDP in 1860 would have been maintained seven years later - the date chosen for computing transport costs and market potential. This assumption carries with it a high degree of uncertainty, since the early years of the 1860s were a period of growth in the Spanish economy.

(coastal shipping) between the Spanish ports chosen as connecting nodes for the coastal provinces must also be included. As for the country's inland waterways, their role within the transport system was only minor, and so this means of transport is not incorporated in the calculation of market potential[20].

Therefore, the estimation of transport costs in 1867 requires data for inter-provincial distances as well as for the rates applied to the transport of goods by rail, road and coastal shipping. By contrast, by 1900 all the provincial nodes had been connected up to the rail network[21]. Hence, beyond this date it is assumed that all inland commodity transport used either this mode of transport[22] or both, rail and cabotage between the coastal provinces. Although in the interwar years the motorisation of road transport was initiated, no great advances were made in Spain until the thirties, and for this reason it too is excluded from the analysis[23]. Given that the coastal provinces could use both rail and cabotage to transport goods, it becomes necessary to know the respective volumes transported by each of these modes between the 1860s and the 1930s[24]. This information (Table 1) is taken from Frax (1981). The complete distance matrixes by means of transport used for 1867 and for 1900-1930 can be consulted in Appendix I.

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20 "*Navigable waterways always played a very small role in Spain's transport system in comparison with those of other countries […] Moreover, when speaking about the use of canals for inland navigation, the historical literature has concluded that its impact was much greater in areas such as the generation of energy and the irrigation of farm land than in transport*" [Own translation]. Herranz (2005, 186).

21 In fact, Teruel was not connected to the network until the 28th of June 1901, with the conclusion of the stretch that linked Puerto Escandón and Calatayud (Wais, 1987), but given the relative proximity of the date, and in order to simplify the calculations, it is considered as having been connected in 1900.

22 The roads continued to be used for the transport of commodities between neighbouring provinces. However, road haulage rates were higher than those charged on the railway and thus road transport only became an advantage over short distances thanks to the possibility of door-to-door deliveries.

23 "*The 1930s would witness the beginning of the substitution of the train by the lorry, a process that would be temporarily interrupted during the post-war years but which was renewed with greater force in the 1950s*" [Own translation]. Herranz (2005, 198-199).

24 The structure of the railway line was such that in the Atlantic seaboard rail and cabotage complemented each other, with the ships making good the lack of trains. However, in the Mediterranean, the trains ran right along the coast so that the competition between the ferry and railway companies must have been greater. Gómez Mendoza (1982, 82-83).

Table 1. Distribution of the volume of traded goods by coastal shipping and rail (%)

		Coastal shipping	Rail
1867	1867-1870	20.73	79.27
1900	1896-1900	12.38	87.62
1910	1911-1916	14.64	85.36
1920	1916-1920	15.69	84.31
1930	1926-1930	15.62	84.38

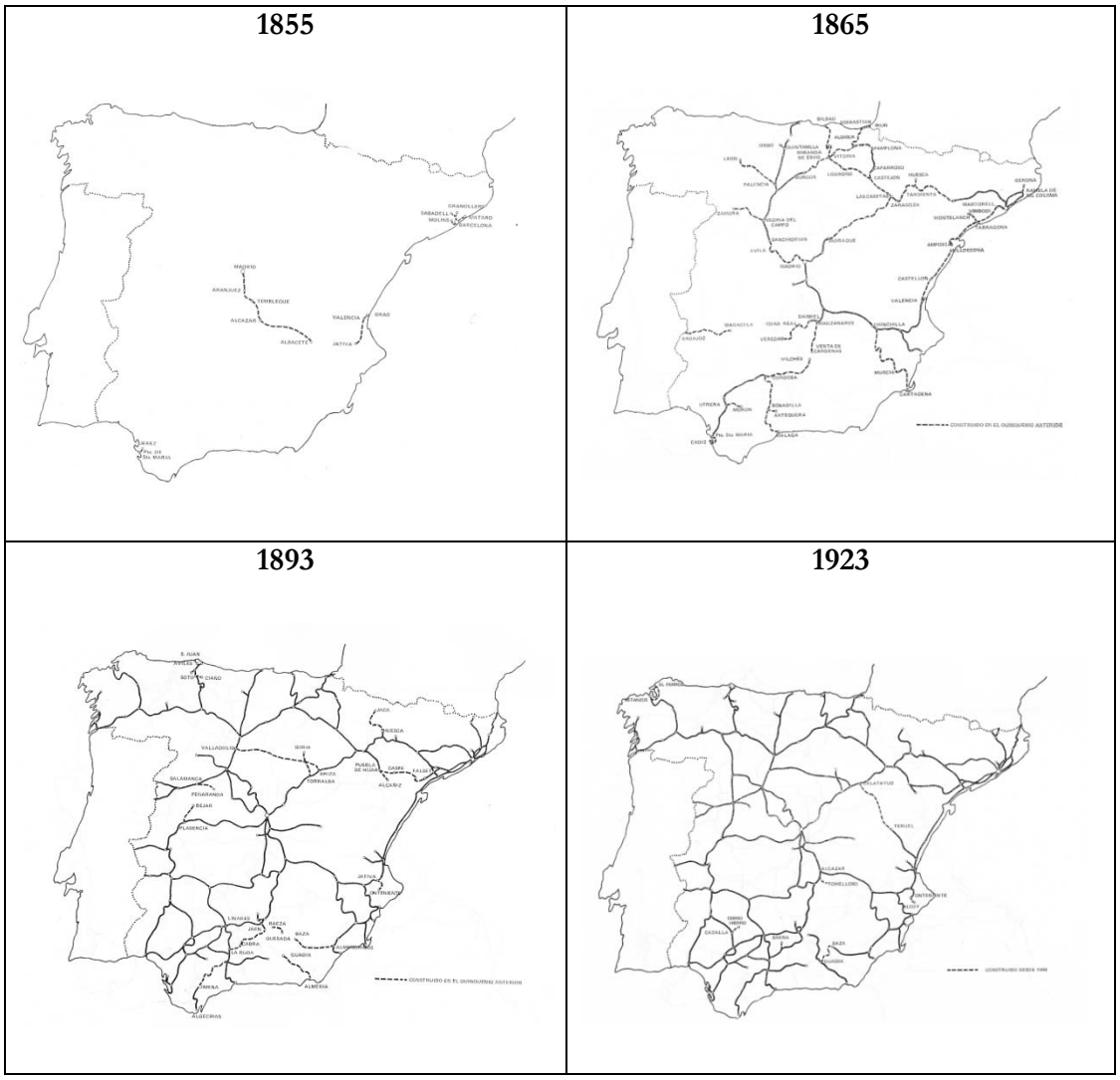
Source: Frax (1981, 40). Although the *Estadísticas de Cabotaje* stopped being published in 1920, Frax provides figures for the total amount of merchandise transported by *cabotage* since that date drawing on data published in the *Estadística del Impuesto de Transportes por Mar y a la entrada y salida de las fronteras*. If to this information, the volume of merchandise transported by rail, which is taken from Anes Álvarez (1978, 492), is added, it is possible to calculate the mean percentage that the volume traded by *cabotage* represented with respect to rail in 1926-30.

All distances need to be ascertained according to the mode of transport under consideration: first, the distances by rail between the 32 provinces connected to the network; second, the distances by road for the 15 provinces unconnected to the railway to the closest rail link; and finally, the distances by sea between the 17 ports chosen as nodes for the coastal provinces from where coastal trade was plied.

The distances by rail in 1867 can be obtained from information gathered by Wais (1987), who reports the distances and the dates when the wide gauge stretches of the track were laid. By aggregating the various stretches of track it is possible to reconstruct the total distances between the 32 provincial capitals with a connection to the rail network. To calculate the distances by rail in 1900 – the year by which all the provincial nodes had been connected to the network –, an alternative source is used: *Ministerio de Obras Públicas* (1902)[25].

[25] The linking with Cartagena, Gijón and Vigo is undertaken using the data supplied by Wais (1987).

Figure 1. Expansion of the railway network in Spain (1855-1923)



Source: Cordero and Menéndez (1978)

The expansion of the rail network between 1900 and 1910 meant that by this final date a number of small changes had been made to some routes of the network. The newly opened up stretches affected primarily the connection between Murcia and Granada via Guadix in the southeast of the country. As the reduction in the distances between provincial nodes was quite considerable, the distances for 1900 have been corrected in accordance, once more, with the data supplied by Wais (1987). Finally, given that between 1910 and 1930 the rate of expansion of the rail network fell markedly, the same rail

distances as those used for 1910 are employed in 1920 and 1930[26]. Based on these assumptions, a railway distance matrix can be built for each of the five years studied.

The distances by road in the 1860s - the only year for which they are necessary in this study - were obtained primarily from the *Dirección General de Obras Públicas* (1861) by comparing the routes and the distances with the road network map included in *Ministerio de Fomento* (1856). Where the distance by road between two provincial nodes was unavailable, an electronic atlas was consulted. In the case of coastal shipping, the time-invariant distances by sea between the ports of the peninsula (corresponding to the nodes of the provincial capitals) were obtained from various web pages[27].

The transport freight rates are calculated using the mean rates applied to the transport of commodities by each of the modes of transport: rail, road and cabotage, expressed in pesetas/tonne-kilometre (pts/t-km). The mean rates charged by the railway companies for goods transport at current prices have been calculated by Herranz (2005)[28]. According to this information, during the second half of the 19th century a marked fall was recorded in the prices of rail transport. However, in the early decades of the 20th century, this fall was reversed. In the interwar years, the highly inflationary context in Spain's economy affected the prices of rail transport pushing upward the rates.

Table 2. Mean freight rates charged by the railway companies for the transport of commodities (current pesetas/t-km)

1867	0,111
1900	0,078
1910	0,080
1920	0,102
1930	0,106

Source: Herranz (2005)

[26] "*After 1914, […] the Spanish railway could not expand anymore, due to the low traffic expectations on the routes that had yet to be linked to the network*" [Own translation]. Herranz (2005, 197).
[27] www.dataloy.com, www.distances.com.
[28] Unpublished data kindly provided by the author. This information served as the basis for the construction of Graph 3 in Herranz (2005, 192).

In the case of the mean freight rates charged by cabotage, the data come from *Ministerio de Hacienda* (1867) and Nadal (1975). These studies report prices in pts/t paid in the transport of Asturian coal from the port of Gijón to eleven other Spanish ports in 1865. In order to obtain the price in pts/t-km, a potential fit was performed on the maritime distance data from Gijón to these ports[29]. This fit gives the following equation: $y=0.643x^{-0.5352}$. Substituting the distance between each pair of ports (x) the transport costs for cabotage between the coastal nodes are obtained. These mean freight rates for coastal shipping are applied to the year 1867. For the other years included, a number of modifications are needed. The advances made in maritime shipping have to be incorporated in the calculation of the cabotage prices, correcting the average for the 1867 freight rates for the years 1900-1930: "*In 1867 there was clear predominance of sailing ships over steam ships. However, the use of iron hulls for shipbuilding and the replacement of sails by steam meant the freights could be reduced. In 1860, 96 per cent of the tonnage transported by the merchant navy was done so by sailing ships. A quarter of a century later, this percentage had fallen to 27 per cent […] In addition, improvements to port facilities, including those made in the ria of Bilbao, Barcelona and Gijón, allowed boats of greater tonnage to dock in these ports without having to anchor outside. All these factors helped reduce mean fixed shipping costs and, as a result, freight rates*" (Gómez Mendoza, 1982, 86 [Own translation]).

In recent decades there has been considerable international debate regarding the reduction in maritime transport costs in the years leading up to the First World War, a period in which the world economy experienced a strong globalizing force (O'Rourke and Williamson, 1999). Among the various indices of ocean freight rates present in the literature, here the most recent is used: the index devised by Mohammed and Williamson (2004)[30]. This is a nominal index that includes information for a large number of routes between Europe and the rest of the world[31].

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[29] The potential fit shows a higher R^2 than other options, including linear, logarithmic and exponential fits, which explains its adoption. Alternative estimations of *cabotage* rates can be found in Gómez Mendoza (1982) and Barquín (1999).

[30] This index shows a fall in the size of the transoceanic freight rates of more than 50% between 1869 and 1900. Alternative indexes have been calculated by Isserlis (1938), North (1958) or Harley (1988).

[31] Based on the information supplied by Angier (1920). It should be borne in mind, therefore, that here, an ocean transport cost index is used to approximate the fall in cabotage freight costs. In this regard, "*it is well-known that technological innovation in the maritime shipping industry reduced long-haul freight rates more than short-haul ones*". Jacks and Pendakur (2008, 4). These authors also question the impact of the fall in transport costs on trade prior to the First World War.

Finally, the lack of information on road freight rates in the middle of the 19th century is a feature that is frequently highlighted by Spanish economic historians. In this instance, as discussed earlier, only information concerning the rates in force around 1867 is required. First, Barquín (1999) has undertaken an estimation of road transport costs based on various sources for the period 1848-1884[32], differentiating between the prices paid for three different types of product: liquids 0.63 pts/t-km; coal 0.46 pts/t-km; and other products 0.30 pts/t-km[33]. These different prices have to be weighted to obtain a single mean price for 1867: the weighting criterion is based on obtaining a mean freight rate as a function of the volume transported by railway for each of these three groups of products in 1869, the nearest year for which data are available[34]. Subsequently, this same distribution is applied to road transport. The resulting mean freight rate for transport by road in 1867 is 0.36 pts/t-km[35].

3.2.c. The self-potential of each province: The computation of this component of the domestic market potential is based on the ratio between the GDP of a province r and the estimated intra-provincial transport costs in that province (d_{rr}). In this case, determining the internal distance θ_{rr}, which is used to obtain the transport costs, is particularly relevant. This question is a highly controversial one among geographers and economists given that the final results of market potential are highly sensitive to the measure adopted[36]. Most studies have adopted an expression in which the internal distance of each area under consideration takes the form of a circle in which all the economic activity is located at its centre. In line with Keeble et al. (1982), θ_{rr} is calculated using the expression:

$$\theta_{rr} = 1/3\sqrt{\frac{(areaoftheprovince_r)}{\pi}} \qquad (14)$$

[32] "*As might be expected given the absence of significant technological changes in the sector […] there does not appear to have been any great reduction in road haulage rates between the middle and end of the 19th century*" [Own translation]. Herranz (2005, 196).

[33] Barquín (1999, 339-341). Transport by cart, excluding pack animals.

[34] Anes Álvarez (1978, 496-501). Information for the companies MZA and Norte. Of the total volume transported by these companies in 1869, 10.94% corresponded to liquids, 15.51% to coal and 73.55% to other products.

[35] Alternative transport prices by road have been estimated by Gómez Mendoza (1982), Herranz (2002, 2007) and Madrazo (1984).

[36] Frost and Spence (1995).

Thus, a value for the internal distance of each province that is equivalent to a third of the radius of a circle with an area equal to that of the province is taken. To obtain the market self-potential of each province in the Spanish case requires the following information. First, the market size of each province is measured using the GDP figures estimated by Rosés et al. (2010) as described above. Second, to calculate θ_{rr}, the area of each province is needed – data is obtained from the *Instituto Nacional de Estadística*. Finally, given that transport costs are needed, the intra-provincial distance, θ_{rr} has to be multiplied by the railway freight rates in force in each of the years considered. However, in 1867, in the provinces that had not been yet connected to the rail network, transport is assumed to be by road and the intra-provincial transport costs are obtained by multiplying the component θ_{rr} by the haulage rates applied in that year.

3.3. Foreign market potential

Here, an alternative strategy to that adopted above in calculating domestic market potential is used. The strategy selected also differs in a number of ways from the method used for calculating foreign market potential in both Crafts (2005b) and Schulze (2007). In these two papers, external transport costs were obtained by using the ocean freight costs provided by Kaukiainen (2003) for grain and coal trade since 1870. These figures take a constant fixed cost for the work at the terminal, which includes the cost of loading and unloading the cargo as well as other port activities, and a variable cost linked to every 100 miles travelled. Tariffs are then added to these costs, since their existence represents an additional barrier to trade between countries and which, as such, must be considered an additional cost in the equation. Tariffs are included via the elasticities obtained for distance and tariffs in the gravity equations in Estevadeordal et al. (2003). These elasticities allow them to convert tariffs to equivalent transport costs that are then added to the fixed component of Kaukiainen's equation.

In this case, an alternative methodology is adopted, based primarily on the results of the gravity equation developed by Estevadeordal et al. (2003). The option chosen by Crafts (2005b) and Schulze (2007), in which the GDP of foreign countries is divided by transport costs, implicitly assumes an elasticity of *-1* for the component d_{rs}. As discussed earlier, the gravity models are associated with distance coefficients that do not differ significantly from this value. In fact, in calculating the domestic market potential of Spain's

provinces, when dividing the provincial GDP by the transport costs an elasticity equal to *-1* is also assumed. However, the gravity equations for international trade allow us to estimate these elasticities more precisely. In order to exploit the quality of this information, here the elasticities obtained in Estevadeordal et al. (2003) are used for calculating foreign market potential[37].

The gravity models seek to account for the volume of bilateral trade by using an equation that relates this variable with, among other factors, market size, distance and the tariff protection in the selected countries. Thus, the intensity of trade flows between two countries is positively related with the respective size of the economies yet negatively with the distance and tariffs that separate them. Hence, shorter distances and lower tariffs will result in a greater attraction between two economies, thereby favouring their trade relations. The estimation of this equation in Estevadeordal et al. (2003) generates coefficients for both variables, which, taken as an average for different specifications, show an estimated elasticity of *-0.8* for distance and *-1.0* for tariffs. On the basis of these results, the foreign market potential of Spain's provinces can be calculated, differentiating between coastal and inland provinces. First, coastal provinces are estimated as follows. Taking a simplified version of the gravity equation, the volume of trade between a Spanish coastal province and a foreign node f would depend on the size of the foreign market (GDP_f), which is then modified according to the distance between both nodes $(Distance_{rf})$ and the mean tariffs operating at the foreign country $(Tariffs_f)$.

Thus, the foreign market potential represented by country f for a coastal province would depend on these variables in accordance with the following equation:

$$\varphi_{rf} = GDP_f\left(Distance_{rf}^{\delta}\right)\left(Tariffs_f^{\gamma}\right) \quad (15)$$

so that

$$FMP_r = \sum \varphi_{rf}, \quad (16)$$

[37] Note that Estevadeordal et al. (2003) equation makes use of panel data for the years 1913, 1928 and 1938, from a sample of 40 countries, which in some instances are reduced to 28 countries.

where the distance and tariff coefficients would take the values $\delta = -0.8$, and $\gamma = -1.0$, respectively. Thus, we can suppose an extreme case in which if the distance between ports to the foreign country were zero and there were no tariffs, the foreign market potential would be represented by the GDP in the foreign country (GDP_f). Then, any increase in distance and in the tariffs would bring about a reduction in the foreign GDP in line with the estimated elasticities. This way of proceeding allows considering the market size represented by each trading partner having subtracted, simultaneously, the effect of distance and tariffs on the volume of activity measured via the GDP. For the seventeen coastal provinces thus, the procedure described has been used to obtain the foreign market potential, where the distances are calculated from the port of origin to the international port of destination.

For the remaining thirty inland provinces considered the method is slightly modified. It is necessary to add the costs of transporting commodities from the inland provincial node r to the nearest Spanish port p. To do this, first, it is necessary to calculate the lowest transport costs from each inland provincial node to the nearest Spanish port. This is done by reducing the GDP of the country of destination (M_f) by the internal transport costs (d_{rp}), as was done previously for the domestic market potential. Second, the part of the foreign GDP that remains in the Spanish port of origin is deducted on the basis of the reduced expression derived from the gravity equation and the elasticities in Estevadeordal et al. (2003), following the methodology used with the coastal provinces, but starting this time with a lower foreign GDP as the internal transport costs from the inland province r to the corresponding Spanish port p have been deducted.

$$FMP_r = \sum \frac{M_f}{d_{rp}} \cdot Distance_{pf}^{\delta} \cdot Tariffs_f^{\gamma} \qquad (17)$$

Thus, internal transport costs from inland provinces to the nearer Spanish port (d_{rp}) have to be computed (see eq.13 for an complete description of Foreign Market Potential including both coastal and inland provinces). The ports taken for these inland provinces in 1867 and 1900-1930 have been selected on the basis of the lower transport costs implied taking into account the accessibility to foreign markets by both the Mediterranean Sea and the Atlantic Ocean.

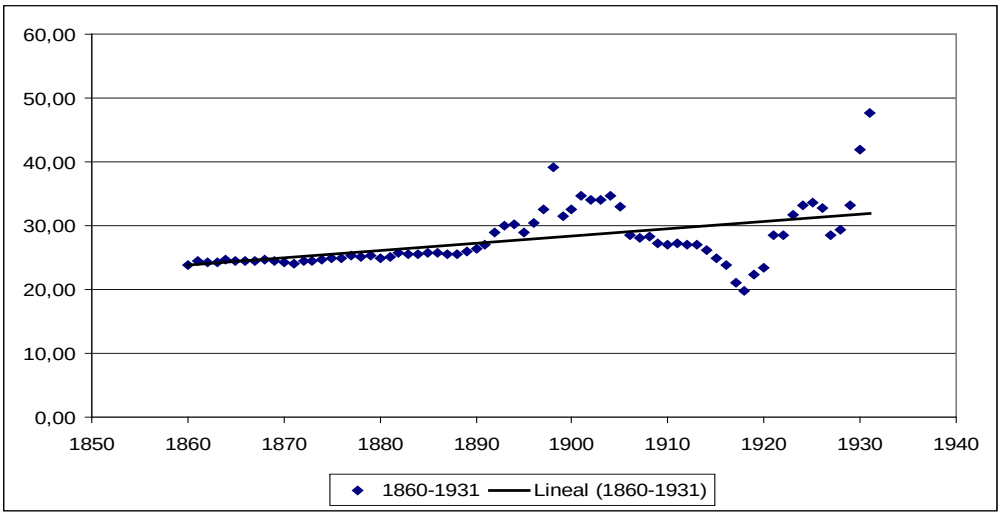
3.3.a. Size of foreign markets: The size of the foreign markets is calculated on the basis of the respective GDPs of four countries (Great Britain, France, Germany and the United States) for 1871, 1901, 1911, 1921 and 1931. These figures, which are drawn from Crafts (2005b), are based, in turn, on the estimations made by Prados de la Escosura (2000). Given that the GDP figures reported by Crafts are expressed in millions of pounds sterling at current prices, the first step to be taken is the conversion of these figures to pesetas at current prices. To do this, the nominal exchange rate between the peseta and pound sterling in Martín Aceña and Pons (2005, 703-706) is used. The adoption of the nominal exchange rate to make this conversion is usual in studies of this kind, given that it is these rates that mattered to the agents at each of these points in time. However, the size of the foreign markets, in this case measured in terms of their GDP, is highly sensitive to the exchange rate chosen. Actually, the value of the peseta with respect to the pound suffered considerable fluctuations in the years selected for this study.

Table 3 (column 1) shows that between 1871 and 1901 the value of the peseta depreciated against that of the pound. This fall in value actually began in 1892, with the peseta reaching its lowest point in 1898, reflecting the inflationary effects of financing the Cuban war. After this date, a period of gradual recovery in value was initiated as a result of the financial reform measures implemented by the respective governments. However, the 1920s ushered in a new period of depreciation of the Spanish currency. That situation was accentuated during the last few years of that decade, initially, by the deflation abroad as a result of the reintroduction of the gold standard and, later, in the early stages of the Great Depression, by the fact that the pound remained on the gold standard. As this deflationary effect did not occur in the Spanish economy, the relative depreciation of the peseta was great, and in 1931 the value of the currency recorded an historical low.

Thus, these major variations in the exchange rate between the peseta and the pound sterling have marked effects on the calculation of the relative size of the foreign markets considered here. In order to ensure that these observations, which in some years might be considered anomalous, do not have an extreme impact on the determination of foreign GDP expressed in pesetas at current prices, the option selected is to capture the trajectory of the value of the currency by examining its trend throughout the period of study. The Purchasing Power Parity (PPP) theory holds that in the long term it is the goods markets, through relative national and foreign prices, that determine currency values, recognizing,

however, certain short-term deviations[38]. The linear estimate of nominal exchange rates between the peseta and pound sterling between 1860 and 1931 provides the coefficients to calculate the exchange rate value for the years being studied.

Figure 2. Peseta/pound sterling exchange rate, 1860-1931



Source: Own elaboration based on Martin Aceña and Pons (2005, 703-706)

Table 3. Peseta/pound sterling exchange rate

	(1) Actual	(2) Estimated [a]
1871	23.97	25.00
1901	34.78	28.45
1911	27.24	29.60
1921	28.51	30.75
1931	47.64	31.90

Source: data from Martín Aceña and Pons (2005, 703-706).
[a] Linear fit in accordance with the following equation: y=0.115x-190.17

[38] The cointegration analyses show that the peseta fulfils the PPP theory in the long term. Serrano et al. (1998), Aixalá (1999), and Sabaté et al. (2001).

Having obtained the GDP in pesetas at current value for the four trading partners considered in this study and for the chosen years, it is time to address a further issue –one already discussed earlier, and which affects the French market. The geography of the Iberian Peninsula means that the French market can be accessed both from the Atlantic and Mediterranean coasts, giving certain Spanish provinces a location advantage on the basis of their position with respect to this market. In order to capture the different possibilities of accessing France, here it is divided in three main markets (two in the Atlantic seaboard and one in the Mediterranean), each of which is assigned a node of economic activity: Le Havre, Nantes and Marseille, respectively. The division of the French GDP is based on the regional population data contained in the Population Censuses for 1872, 1901, 1911, 1921 and 1931[39]. By proceeding in this way it is possible to present the foreign GDP figures used in this study:

Table 4. Foreign GDP (millions of pesetas at current prices)

	1871	1901	1911	1921	1931
United Kingdom	30.194	58.284	68.956	157.845	139.030
France (North)	8.807	15.633	22.061	45.188	35.268
France (East)	7.137	11.874	16.465	33.014	25.370
France (West)	7.337	11.485	15.399	30.285	21.291
Germany	17.392	50.473	73.301	158.208	130.878
United States	36.775	115.694	196.250	584.167	623.975

Source: Based on Crafts (2005b), see text

3.3.b. International distances: Most international trade studies that use gravity equations measure the distance variable between countries in terms of the geodesic distance, also known as the 'great circle distance'. This procedure involves calculating the distance in nautical miles as the crow flies while taking into consideration the curvature of the earth's sphere, which means including the longer distance that this curvature supposes. Yet,

[39] The three large areas are built by aggregating the population in the NUTS1 regions as follows: North France (Île-de-France, Bassin Parisien, Nord-Pas-de-Calais); East France (Est, Centre Est, Méditerranée); and West France (Ouest, Sud Ouest). Corsica and its overseas territories excluded. http://www.insee.fr.

choosing this option here would give rise to a number of distortions in the results. For example, the geodesic distance between the ports of Bilbao and Le Havre would be similar to that between Bilbao and Marseille. However, to complete the latter route it is necessary to skirt around the peninsula on a much longer journey. In order to exploit our precise knowledge of the commercial routes, in this study the maritime distances between ports are considered. In this case, the mode of transport used to calculate the foreign market potential is exclusively shipping; hence, the external nodes are all located on the coast[40].

Table 5. Maritime distances between ports (in nautical miles)

	US	Germany	France			UK
	New York	Hamburg	Le Havre	Nantes	Marseille	London
Alicante	3.506	1.914	1.456	1.285	402	1.620
Almería	3.356	1.764	1.306	1.135	548	1.470
Barcelona	3.721	2.129	1.671	1.500	188	1.835
Bilbao	3.147	1.024	659	282	1.551	730
Cádiz	3.155	1.559	1.101	930	759	1.265
Cartagena	3.443	1.851	1.393	1.222	458	1.557
Castellón	3.616	2.024	1.566	1.395	317	1.730
Coruña	2.912	1.024	657	387	1.303	730
Gijón	3.022	987	622	304	1.428	693
Huelva	3.135	1.541	1.083	912	806	1.247
Málaga	3.269	1.677	1.219	1.048	641	1.383
San Sebastián	3.192	1.042	677	279	1.596	748
Santander	3.109	1.001	636	274	1.515	707
Sevilla	3.193	1.597	1.139	968	819	1.303
Tarragona	3.687	2.095	1.637	1.466	232	1.801
Valencia	3.593	2.001	1.543	1.372	345	1.707
Vigo	2.914	1.123	665	494	1.207	829

Source: www.dataloy.com

[40] Exports would also have arrived on the French market by rail, but their share as a percentage of all the trade between Spain and France seems to have been limited in that period.

3.3.c. Tariffs: Finally, information about the tariffs operating in the trading partners considered in this study needs to be obtained. The mean tariffs are calculated as the percentage income from the tariffs with respect to total import volume. This indicator has been widely used in the international trade literature to measure a country's level of tariff protection[41]. In this case, the calculation of mean tariff rates for the four countries included in the study sample is based on information drawn from O'Rourke (2000) and Mitchell (1998a, 1998b)[42].

Table 6. Mean tariffs (% respect to imports)

	1860-64	1895-99	1910-14	1920-24	1926-30
UK	10,05	4,8	4,8	9,97	9,9
France	6,3	10,4	8,9	6,08	8,9
Germany	5,67	9,3	7,0	7,83	9,0
US	22,78	22,7	18,3	11,71	14,6

Source: O'Rourke (2000) and Mitchell (1998a, 1998b)

[41] O'Rourke (2000, 461-464). Other studies for the years analysed here include Bairoch (1989), League of Nations (1927), Liepmann (1938), and Estevadeordal (1997).

[42] The estimations use values for tariffs and total volume of exports relative to the five-year means between 1860-64, 1895-99, 1910-14, 1920-25 and 1926-30, respectively. For 1860-64 no data for Germany is available. German figures are estimated on the basis of the mean tariff rates in France (1875-1914).

4. Results

In this section, a brief description of the main results is presented[43]. First, Figure 3 plots the market potential of Spain's provinces in 1867, 1900 and 1930. Provinces are ranked on the basis of their market potential in 1867. Based on this evidence, a clear distinction can be drawn in terms of accessibility between Spain's coastal and inland provinces, with the former showing a higher market potential than their inland counterparts. The only exception is Madrid, an inland region located at the geographical centre of the Peninsula but with a market potential similar to that of the coastal regions. An asymmetric variation in accessibility over time can also be observed. At the top of the ranking, while provinces such as Vizcaya, Guipúzcoa and Valencia had improved their relative position by 1930, other provinces such as Santander, Cádiz and Málaga had lost ground. Among the inland provinces, the main advances in relative accessibility seem to be concentrated in those located near the large markets of Madrid and Barcelona (the case of Toledo and Segovia, and Lleida, respectively) or lying between them (the case of Zaragoza).

To examine the geographical pattern further, maps of the evolution of market access were drawn (Fig. 4). Throughout the period of study, Barcelona stands out as being the province with the greatest market potential and, as such, the maps are expressed in relative terms with respect to this province. The picture that emerges from the maps confirms the existence of a dual structure. In addition, the maps show that the main variations in the spatial distribution of market potential were experienced in the second half of the 19th century, a period characterised by a marked centrifugal tendency. By 1900, the division between coastal and inland provinces had been further strengthened. The geographical periphery of Spain had become the core in terms of economic potential, and, in turn, inland central provinces suffered an increase in their relative remoteness. Once established, this dual structure showed a considerable degree of persistence during the first decades of the 20th century.

In order to explore this finding in more detail, Figures 5a, b and c illustrate the market potential disaggregated by components for the same three years. The divide between coastal and inland provinces was already apparent in 1867 and it was further reinforced in 1900 and 1930. The graphs also show that foreign market potential (FMP) was responsible for the clear lead enjoyed by coastal provinces in terms of accessibility throughout this period. Coastal provinces, situated in the geographical periphery of Spain,

[43] A map of Spain's provinces is included in Appendix II. The complete dataset in Appendix III.

had a locational advantage when accessing foreign markets, especially those located in the north of the country on the Atlantic seaboard. Conversely, the FMP of the inland provinces represented a very small share of their total market potential (TMP).

Thus, in order to complete the picture, an exploratory analysis centred exclusively on domestic market potential (DMP) was also conducted, given that the fall in transport costs (both in railway and in coastal shipping freights), the timing of provincial connections to the railway network, the network design, the size of markets (represented by their self-potential) and the spatial location of economic activity are key elements from an NEG viewpoint. The relative weight of the DMP by year can also be consulted in Figure 5 and is further complemented with the spatial distribution of DMP depicted in the maps in Figure 6. The divide between coastal and inland provinces found for TMP is now not so marked. In 1867, some inland provinces were among those with the highest market potential: in particular, provinces lying close to the large markets and located along the first railway lines constructed during the early expansion of the railways. As expected, an early connection to the railways represented an advantage in terms of access for these inland provinces. In turn, the DMP of some coastal provinces, mainly in the northwest and southeast of Spain was not so high. And matters were even worse in seven inland provinces (Cáceres, Lugo, Soria, Ourense, Cuenca, Teruel and Salamanca), which were undoubtedly hindered in terms of their accessibility due to their late connection to the railway network.

By 1900, this geographical pattern had changed. The lead in DMP corresponded to Barcelona, Vizcaya and Madrid, the two main industrial centres and the capital city, respectively. Moreover, the relative position of these provinces was to be further reinforced over the next few decades, especially in the case of Madrid, the hub of the railway network. However, the rest of the country was characterised by a lower level of DMP, a trend that was to continue up to 1930. In that year, instead of a clear coastal-inland divide, a more uniform pattern of relative provincial accessibility emerges. Nonetheless, some areas became increasingly remote: this is the case of the northwest and west of the country along the Portuguese border, and the southeast (together with Cuenca, Huesca and Teruel). Interestingly, some of these provinces remain today among Spain's least dynamic economic areas.

Taking this descriptive evidence into consideration, it can be argued that market integration in Spain led to major changes in the relative accessibility of the provinces. But what was it that underpinned this evolution? Among the potential elements affecting

market access, an initial tentative explanation might be offered centred on the role played by various factors that account for the relative improvement in the accessibility of coastal provinces during the second half of the 19th century, each related to various components of market potential.

First, the expansion of foreign markets during the first globalisation conferred a significant advantage on the provinces that enjoyed direct access to the sea (Rappaport and Sachs, 2003). Second, in relation to the domestic market, the advance in the construction of the radial rail network seems to have been crucial for the evolution of market potential. The extension of the railway, which by around 1900 linked up all the provincial capitals of Spain, favoured a significant fall in transport costs. In addition to this, major advances were made in coastal shipping thanks to such technological improvements as the use of iron for shipbuilding, the transition from sail to steam, and the progress made in the infrastructure of the ports. At the same time, the competition between the railway and coastal shipping, in their respective bids to attract a higher volume of trade, generated an overall reduction in transport freight rates. Finally, in the context of NEG, the reduction in transport costs may have generated the emergence of agglomeration forces (Krugman, 1991), mainly in the manufacturing sector where increasing returns and monopolistic competition tend to be most present. In this context, the integration of the domestic market and the asymmetric changes in the relative accessibility of the provinces triggered an agglomeration of economic activities. The share that self-potential represents over TMP may shed some light on this result (see Figure 4). In 1900 and 1930, industry tended to concentrate increasingly in a limited number of provinces, most of them located in the geographical periphery of Spain: Barcelona, Vizcaya, Guipúzcoa and Valencia, but also in the inland capital city: Madrid. Overall, the size of the market of these provinces was in comparative terms remarkably high, expanding at a rapid rate throughout the period analysed.

Figure 3. Market potential in Spain's provinces, 1867-1930

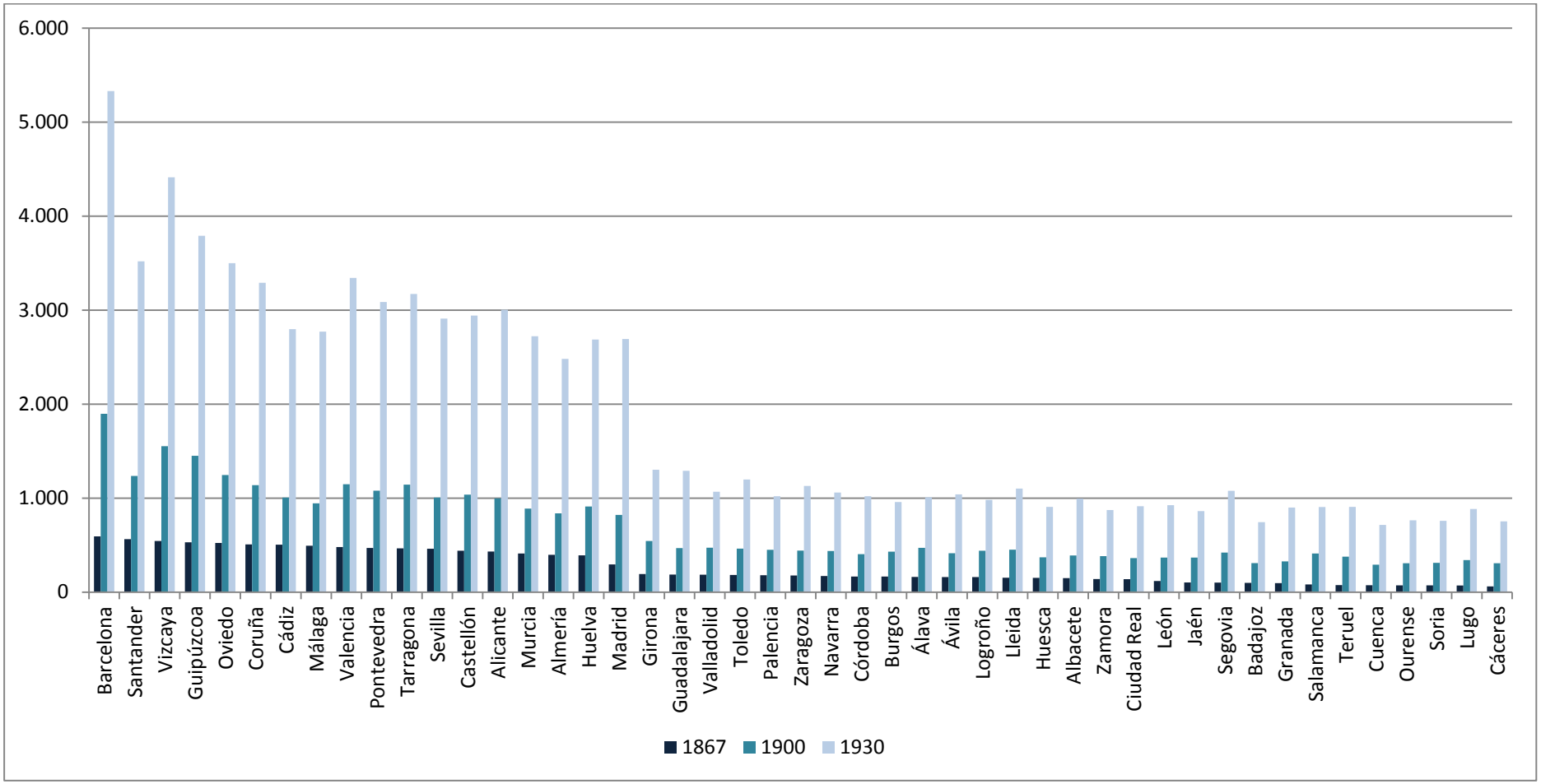


Figure 4. Total market potential by provinces (BCN=100)

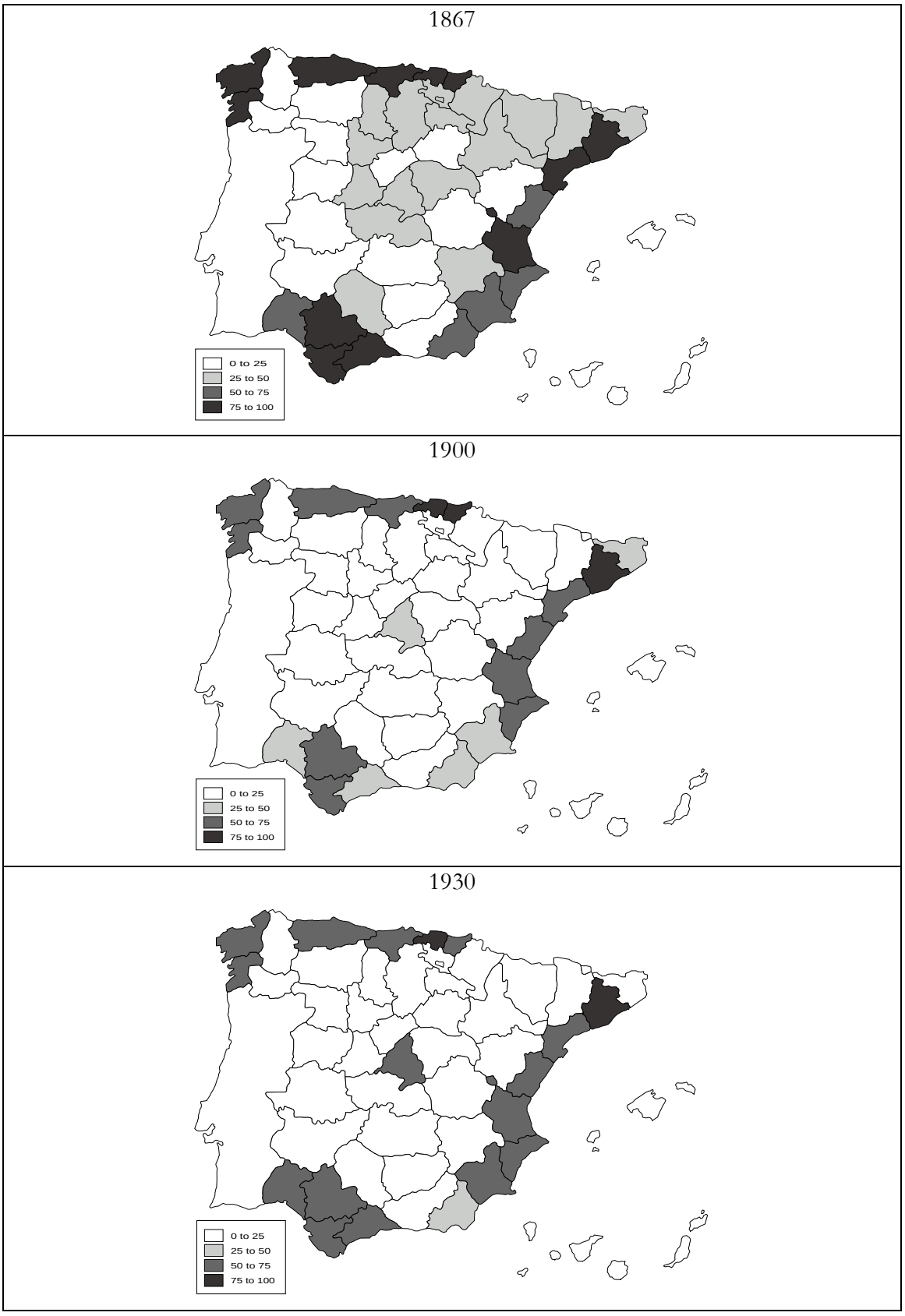


Figure 5a. Market potential disaggregated by components, 1867

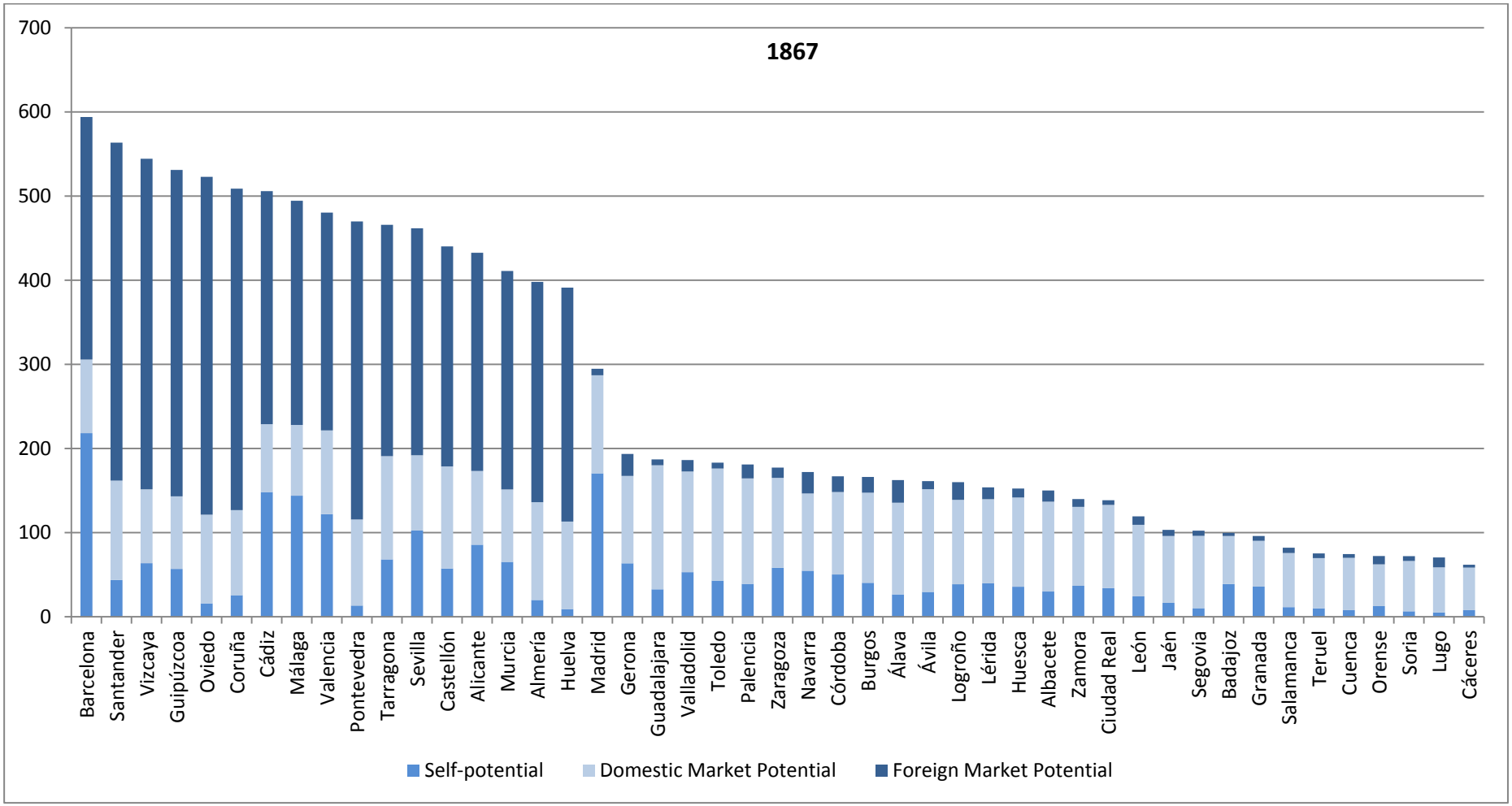


Figure 5b. Market potential disaggregated by components, 1900

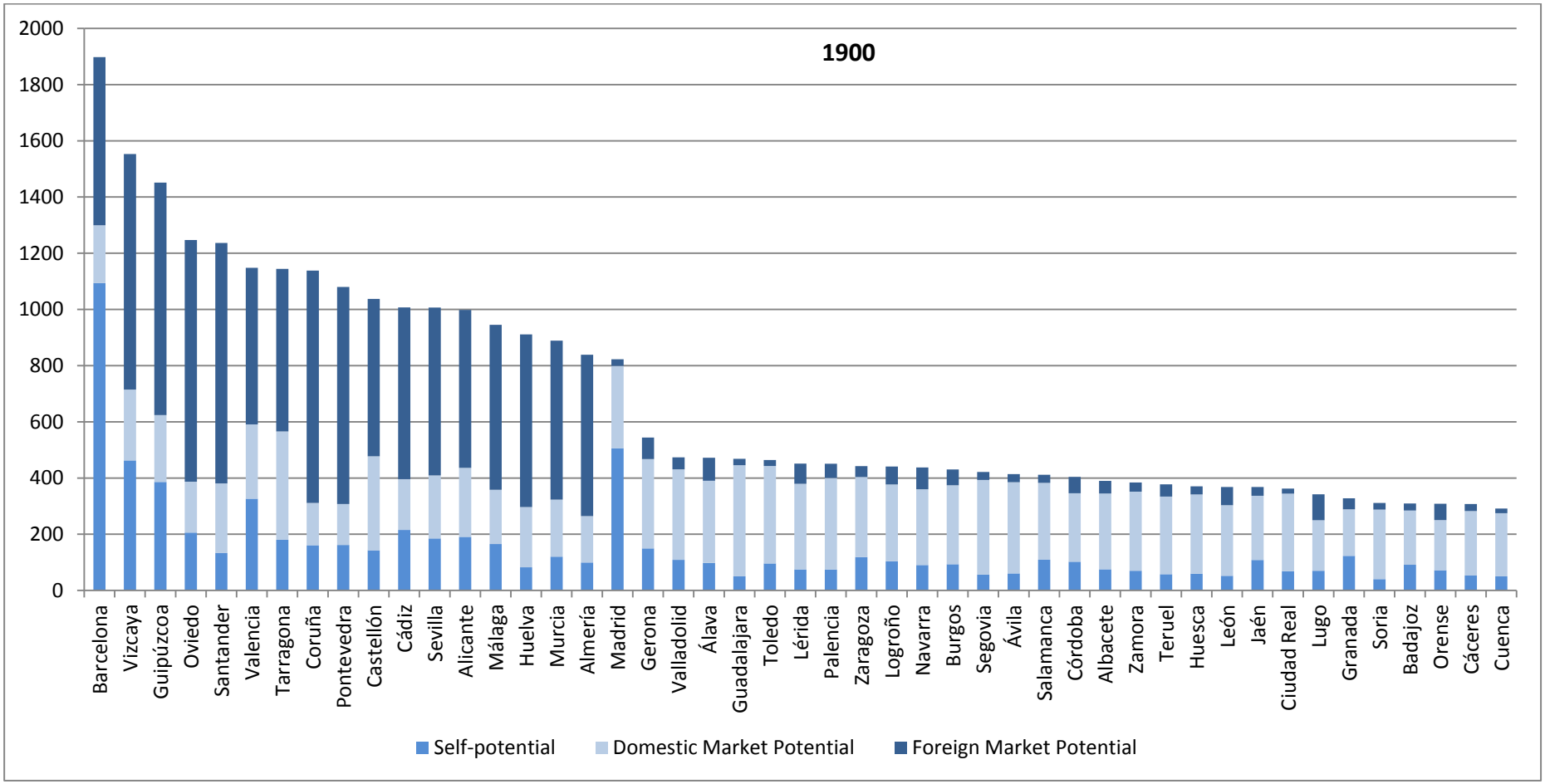


Figure 5c. Market potential disaggregated by components, 1930

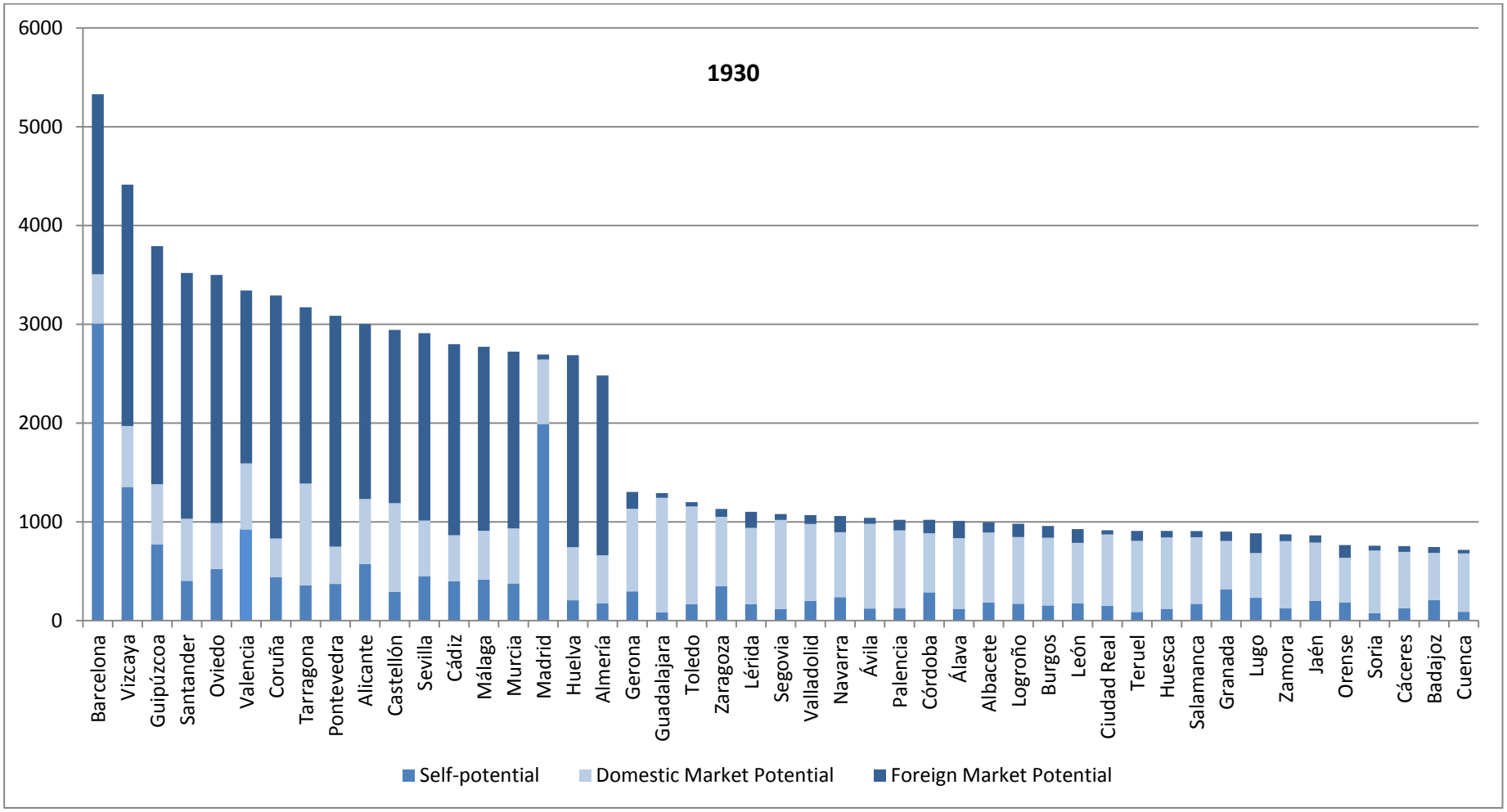
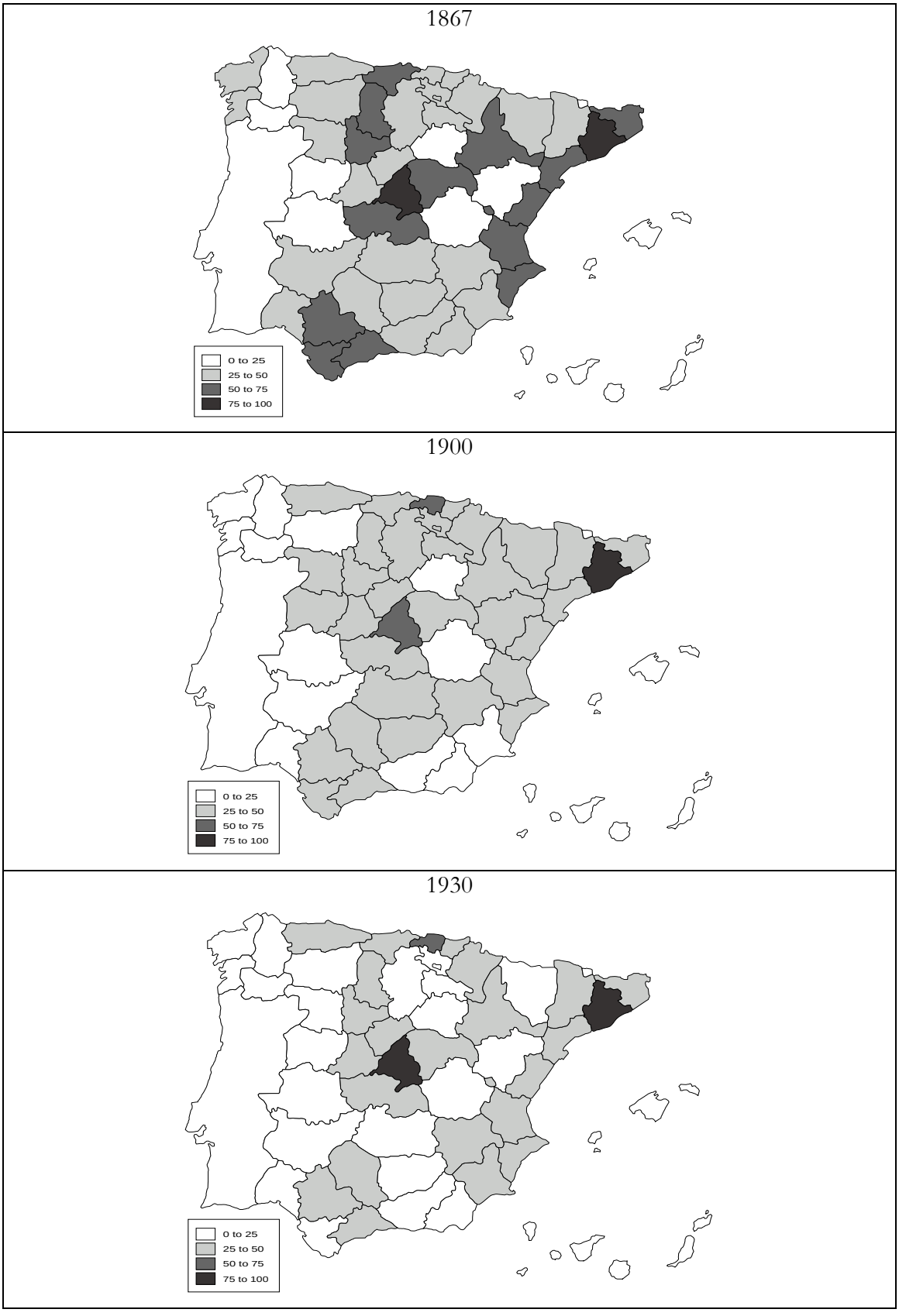


Figure 6. Domestic market potential by provinces (BCN=100)



5. Concluding remarks

In this paper the methodology employed to construct market potential estimates for Spain's provinces between 1867 and 1930 has been explained in detail. First, the results obtained for Spain show that significant changes in regional accessibility occurred in parallel to the expansion of the railway network and the integration of the Spanish market. Second, the availability of market potential estimates is a key tool for empirical exercises in order to examine through the lens of NEG different features of the Spanish economy, including, the remarkable increase in the spatial concentration of manufacturing activities (Martinez-Galarraga, 2012), the equally notable upswing in regional income inequality (Martinez-Galarraga et al., 2013), the effects of the intensification of protectionism on regional wages (Tirado et al., 2013) and city growth (González-Val et al., 2013) at that time.

NEG models highlight transport costs and access to demand or market potential as drivers of the economic forces leading to the spatial concentration of economic activity. Just where this agglomeration will occur, however, is not determined in these models; yet, changing accessibility may have an impact on it. Here, the focus has been placed on a study of the case of Spain during a particular period of its history. The early stages of Spain's economic development are a relevant period because it was then when increasing returns (economies of scale in the manufacturing sector during early industrialization), monopolistic competition and market integration (fall in trade costs) were gaining significance. In this context, the integration of the domestic market, the expansion of the railway network, the fall in the freight rates both for railway and coastal shipping, the emergence of large industrial centres, the expansion of foreign markets and even the trade policy implemented by the Spanish governments may have had an asymmetrical effect on the relative access of the different territories across Spain. Moreover, these changes in market potential can be considered as being a factor that turned out to have persistent effects on the spatial distribution of economic activity and, hence, on the evolution of regional inequality. These questions deserve further attention and, as such, are on the research agenda.

Appendix I. Distance matrix by means of transport for 1867

	Inland with railway (20)	**Coastal with railway (12)**	**Coastal without railway (5)**	**Inland without railway (10)**
Inland with railway (20)	Railway [20x20]	railway [20x12]	coastal shipping + railway [20x5]	road + railway [10x20]
Coastal with railway (12)	railway [12x20]	(% railway) railway + (% coastal shipping) coastal shipping [12x12]	(% railway) [coastal shipping + railway] + (% coastal shipping) coastal shipping [5x12]	road + railway [10x12]
Coastal without railway (5)	railway + coastal shipping [20x5]	(% railway) [railway + coastal shipping] + (% coastal shipping) coastal shipping [12x5]	*ATL: coastal shipping *MED: (% railway) [railway +coastal shipping] + (% coastal shipping) coastal shipping *ATL-MED: (% railway) [railway + coastal shipping] + (% coastal shipping) coastal shipping [5x5]	*ATL: road + railway + coastal shipping *MED: road + railway + coastal shipping [10x5]
Inland without railway (10)	railway + road [20x10]	railway + road [12x10]	*ATL: coastal shipping + railway + road *MED: coastal shipping + railway + road [5x10]	road + railway + road [10x10]

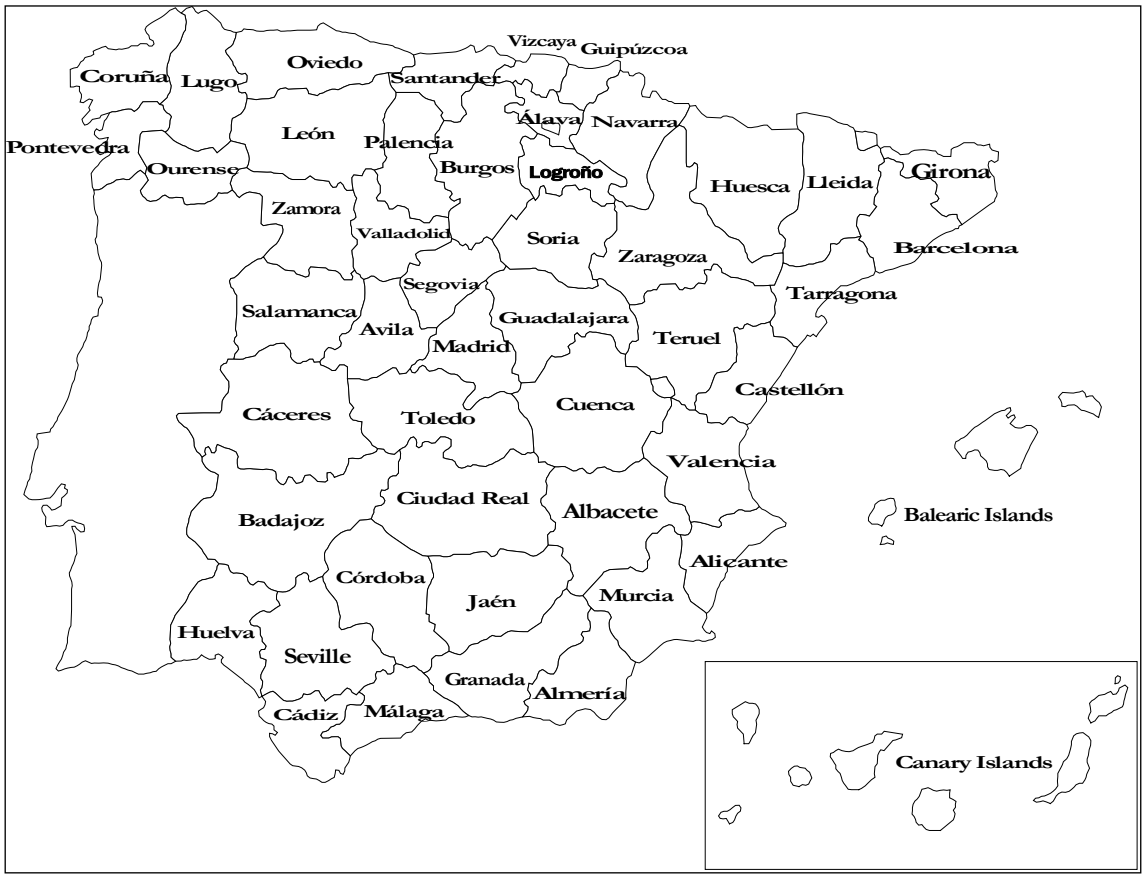
Note: For the % of commodities traded by railway and coastal shipping in 1867, see Table 1. Full details in Martínez-Galarraga (2010, 124-221), Annex 1.

Appendix I (continued). Distance matrix by means of transport, 1900-1930

	Coastal provinces (17)	Inland provinces (30)
Coastal provinces (17)	(% railway) railway + (% coastal shipping) coastal shipping [17x17]	railway [17x30]
Inland provinces (30)	railway [30x17]	railway [30x30]

Note: All provincial 'nodes' connected to railway. For the % of commodities traded by railway and coastal shipping in 1900-1930, see Table 1. Full details in Martínez-Galarraga (2010, 221-222), Annex 1.

Appendix II. Spain's provinces



Appendix III

Market potential (million pesetas, current prices)

Provinces	1867	1900	1910	1920	1930
Álava	163	472	482	1.005	1.010
Albacete	150	390	435	929	996
Alicante	433	998	1.304	3.114	3.003
Almería	398	839	1.147	2.680	2.482
Ávila	161	414	459	940	1.040
Badajoz	100	310	354	711	745
Barcelona	594	1.898	2.330	6.358	5.330
Burgos	166	430	457	991	959
Cáceres	62	307	350	680	754
Cádiz	506	1.007	1.391	2.990	2.799
Castellón	440	1.037	1.313	3.060	2.943
Ciudad Real	138	363	411	858	914
Córdoba	167	404	478	994	1.020
Coruña	509	1.138	1.543	3.531	3.291
Cuenca	74	292	313	655	716
Girona	193	544	690	1.324	1.303
Granada	96	328	453	950	901
Guadalajara	187	468	509	1.084	1.291
Guipúzcoa	531	1.451	1.771	3.947	3.792
Huelva	391	911	1.229	2.788	2.687
Huesca	152	370	410	908	907
Jaén	103	368	430	858	863
León	119	368	419	931	926
Lleida	154	451	517	1.136	1.101
Logroño	160	441	462	952	981
Lugo	70	342	413	853	885
Madrid	295	823	905	2.414	2.693
Málaga	495	945	1.322	2.873	2.772
Murcia	411	889	1.201	2.841	2.723
Navarra	172	437	485	1.113	1.059
Ourense	72	308	374	702	765
Oviedo	523	1.247	1.578	3.818	3.500
Palencia	181	451	482	981	1.021
Pontevedra	470	1.080	1.421	3.234	3.087
Salamanca	82	412	447	904	906
Santander	564	1.237	1.601	3.772	3.520
Segovia	102	422	457	953	1.079
Sevilla	462	1.007	1.339	3.088	2.910
Soria	72	311	347	710	759
Tarragona	466	1.144	1.443	3.447	3.172
Teruel	75	378	419	885	908
Toledo	183	464	510	1.098	1.199
Valencia	480	1.148	1.450	3.533	3.343
Valladolid	186	473	512	1.053	1.068
Vizcaya	544	1.553	1.860	5.111	4.413
Zamora	140	384	414	857	874
Zaragoza	177	442	501	1.188	1.130

Appendix III (continued)

Market potential, excluding '*self-potential*' (million pesetas, current prices)

Provinces	1867	1900	1910	1920	1930
Álava	136	374	416	858	890
Albacete	120	315	361	732	811
Alicante	347	807	1.091	2.542	2.429
Almería	378	739	1.046	2.444	2.308
Ávila	132	353	387	797	919
Badajoz	61	218	250	483	538
Barcelona	376	804	1.094	2.505	2.320
Burgos	126	337	371	752	804
Cáceres	54	254	287	563	629
Cádiz	358	792	1.088	2.547	2.401
Castellón	383	894	1.182	2.741	2.651
Ciudad Real	104	294	328	664	764
Córdoba	117	302	360	677	733
Coruña	483	977	1.333	3.109	2.850
Cuenca	67	242	269	548	627
Girona	130	395	456	998	1.006
Granada	60	205	278	532	583
Guadalajara	154	418	461	989	1.207
Guipúzcoa	474	1.065	1.415	3.298	3.020
Huelva	382	829	1.131	2.620	2.481
Huesca	117	311	349	743	788
Jaén	87	260	304	594	661
León	95	316	352	701	752
Lleida	114	377	431	911	935
Logroño	121	338	375	782	811
Lugo	65	272	325	621	653
Madrid	124	316	347	669	703
Málaga	351	780	1.090	2.499	2.356
Murcia	346	769	1.056	2.472	2.347
Navarra	117	347	385	787	822
Ourense	59	237	274	539	583
Oviedo	507	1.041	1.408	3.260	2.976
Palencia	142	377	414	838	894
Pontevedra	457	918	1.258	2.949	2.716
Salamanca	71	302	332	666	737
Santander	520	1.103	1.462	3.395	3.116
Segovia	92	365	401	829	961
Sevilla	359	822	1.123	2.577	2.458
Soria	66	271	300	617	682
Tarragona	398	964	1.270	2.953	2.814
Teruel	65	320	361	757	820
Toledo	140	368	407	853	1.033
Valencia	358	822	1.097	2.548	2.423
Valladolid	133	364	396	798	870
Vizcaya	481	1.090	1.445	3.308	3.060
Zamora	103	314	346	684	750
Zaragoza	119	323	356	733	780

Appendix III (continued)

Domestic market potential (million pesetas, current prices)

	1867	1900	1910	1920	1930
Álava	136	390	370	797	835
Albacete	137	345	372	809	891
Alicante	173	436	491	1.140	1.231
Almería	136	265	317	659	661
Ávila	152	385	420	868	980
Badajoz	96	284	319	643	685
Barcelona	306	1.300	1.466	4.293	3.507
Burgos	147	374	381	849	839
Cáceres	59	283	315	613	696
Cádiz	229	396	510	845	864
Castellón	179	477	503	1.099	1.189
Ciudad Real	133	345	386	810	872
Córdoba	148	346	397	837	884
Coruña	127	311	375	757	831
Cuenca	70	275	290	612	680
Girona	167	468	583	1.122	1.131
Granada	90	289	396	840	806
Guadalajara	180	446	478	1.028	1.243
Guipúzcoa	143	624	608	1.206	1.381
Huelva	113	296	344	633	743
Huesca	142	341	369	831	842
Jaén	96	337	387	775	790
León	109	303	330	767	787
Lleida	140	380	417	945	938
Logroño	139	377	375	791	845
Lugo	59	250	287	617	683
Madrid	287	799	873	2.355	2.644
Málaga	228	358	456	807	910
Murcia	151	323	382	850	933
Navarra	146	360	380	918	894
Ourense	62	250	294	551	636
Oviedo	121	387	369	966	987
Palencia	164	400	412	852	913
Pontevedra	116	308	325	612	749
Salamanca	76	383	408	831	845
Santander	162	381	399	942	1.032
Segovia	96	393	418	882	1.019
Sevilla	192	409	478	987	1.012
Soria	66	288	315	651	710
Tarragona	191	566	606	1.437	1.387
Teruel	70	334	358	768	807
Toledo	176	443	481	1.046	1.156
Valencia	221	591	643	1.578	1.592
Valladolid	173	431	454	946	979
Vizcaya	151	715	681	2.334	1.971
Zamora	131	351	370	775	804
Zaragoza	165	403	448	1.092	1.051

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