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Market Potential and Regional Economic Growth in Spain, 1860-1930

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Abstract:

In this paper we employ parametric and nonparametric techniques to analyse the effect of the changes registered on regional market potential on the growth of Spanish regions during the period 1860-1930. The study of the Spanish experience during these years conforms a case study that allows analyzing whether the construction of new transport infrastructure, as well as the changes in trade policy, that affected the relative market potential of the Spanish regions, ended up shaping regional growth trajectories. In order to carry out the analysis we make use of new evidence on regional inequality patterns in the long term based on recent estimations of per capita GDP for NUTS III Spanish regions (provinces) and an *a la Harris* measure of regional market potential that takes into account the economic distance between territories according to the changes registered in transport networks, the variations in the actual transport costs and the tariff policy followed over the period. Our results show a clear positive influence of market potential on regional economic growth, particularly along the years 1900-1930.

Keywords: market potential, New Economic Geography, regional growth, economic history

JEL codes: R0, N9, O18, N64, F14

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1. Introduction

Regional income inequality shows a persistent pattern in apparently well integrated economies such as the European Union. As pointed out by Puga (2002), in 1995 nearly a quarter of European citizens lived in regions with a per capita GDP below 75% of the European average. It could be argued nonetheless that the full integration of the European space is still a work in progress and that, in the long term, these differences will tend to diminish. However, the magnitude and persistence of regional imbalances are yet a matter of concern in national economies that could be treated as long lasting episodes of political and economic integration. In these circumstances, the study of the trends and the determinants of regional income inequality along the enduring processes of national market integration in the past could help to identify what the main forces at work are and to shed light on the evolution of regional inequality in current experiences of economic and political integration such as the European Union.

From a theoretical point of view, international and regional economics have explained income disparities on the basis of differences between regions in their endowments of natural resources, factors of production, infrastructure, or technology (Barro and Sala-i-Martin, 1991). In this context, the removal of obstacles to the movement of goods and/or factors would by itself cause the convergence of factor returns and living standards. Yet, as it has been posed by the New Economic Geography literature (henceforth, NEG) there are relevant forces, such as agglomeration economies, missing from the traditional analysis which can affect regional disparities -even without large differences in the underlying characteristics of the regions-, and prevent convergence.

Empirical historical economics has suggested that economic growth in the context of the integration of different regions could initially lead to an increase in regional per capita incomes disparities. The fundamental reasons would be related to regional specialization and structural change, two processes associated with growth and economic integration. Williamson (1965) provided evidence in this sense analyzing both the evolution of income in a cross-section of countries and the long-term evolution of regional inequality in the US. He posed first the hypothesis that regional inequality within national economies could follow an inverted U-pattern throughout the process of economic growth, with growing inequality during the 19th century and convergence from then on. He concluded that structural change and specialization were responsible of the observed increase in inequality during the first stages of economic growth. However, the advance in the process of structural change and integration, with associated increases in capital movements and internal migrations, would explain the reduction in income disparities across regions and over time.

Kim (1998) analyzed this hypothesis in depth through the study of the evolution of regional inequality across US States in the long term. He confirmed the existence of a U-inverted evolution and, in addition, he pointed out that specialization and divergence in economic structures would be on the base of the increasing segment of this curve during the second half of the 19th century. Conversely, in the 20th century, further progress in the process of growth and national market integration was accompanied by a reduction in regional income inequality. The homogenization of economic structures and productivity convergence across the states may have played a central role in the process. In a similar vein, Combes et al. (2011) studied the long term evolution of economic disparities across French *departéments*. These authors conclude that the concentration of the spatial distribution of manufacturing and services traced a U-inverted curve starting in the mid-nineteenth century. Interestingly, in line with the arguments proposed by New Economic Geography literature, they pointed out that the existence of agglomeration economies would be a relevant factor for the understanding of regional incomes evolution in France from 1860 to 1930.

With regard to the Spanish case, Rosés et al. (2010) have shown that during the early stages of the integration process of the Spanish economy, a long phase of growing regional disparities took place. In these early years, from 1860 to 1900, the emergence of large

differences in production structures across regions favored the upswing in regional economic inequality. However, since the beginning of the 20th century, a gradual convergence in regional production structures served to halt the advance of regional inequality. Nonetheless, the persistence of differences in productivity between regions prevented the appearance of a real process of regional convergence. These authors point out that regional differences in productivity may be due to the presence of agglomeration economies in industrial production processes.

In line with these works, this article aims to go deeper in the analysis of the proximate causes of regional income inequalities following an empirical framework that encompasses the main economic factors at work (Ottaviano and Pinelli, 2006). The authors start from a NEG model and derive an empirical strategy based on the estimation of growth regressions where, along with the variables typically used in the traditional growth literature, market potential is also included as a key variable to explain disparities in the regional rates of economic growth.[1] Here, we make use of this methodology to study the determinants of regional inequality in Spain during the period 1860-1930 as an illustrative case of study.

The analysis of the Spanish experience of market integration and economic growth offers a threefold contribution. First, it is a cross-regional analysis. This element gives to the analysis two basic advantages. One is related to the fact that the study analyzes growth trajectories of territories that share a common institutional framework, thus minimizing the differential impact that institutional differences could have on growth. The reason is that, in contrast to cross-country studies, there is no obvious variation in institutions across regions within a national context (Redding, 2010). Besides, as posed by Head and Mayer (2006), regional analysis allows grasping with greater clarity the effects resulting from the presence of agglomeration economies, given that interregional transport costs tend to be lower than international ones.

Secondly, the study of the years going from 1860 to 1930 is particularly interesting. These years conform a period that, in the Spanish case, was characterized by the acceleration in the

[1] Their study analyzed the Finnish regions in the period 1977-2002, considering the impact of the external shock that represented the collapse of the neighboring Soviet Union on regional economies.

process of integration of regional markets as a result of the enormous advances in the construction of transport networks. In this respect, different works show that during these years, in a growingly integrated economy, market access acted as a key factor among the determinants of the location of industry, the intensity and direction of migration flows, or regional wage levels (Martinez-Galarraga, 2012; Pons et al., 2007; and Tirado et al., 2013, respectively). Hence, the period seems especially suitable for the analysis of the impact of market potential on regional economic disparities.

Besides, given the design of the new transport networks and the changes experienced in the Spanish trade policy, the integration of markets altered in an asymmetric way the market potential of the participating regions. The presence of this asymmetrical impact confers to the study of the Spanish case a particularly appealing feature. As pointed out by Redding (2010), the study of the effects of market access on the remuneration of factors faces an important empirical problem: it is difficult to disentangle the effects of market access from other determinants of comparative economic development such as locational fundamentals, so that the results of a great bulk of empirical analyses are subject to a problem of indeterminacy of the causality of the found relationships. The literature has suggested the analysis of this type of relations in the context of exogenous changes in the relative market size of regions or territories, analyzing then the impact of these changes on factor remuneration as a way of validating the causal nature of the relationships. Examples of this type of approach can be found in Hanson (1996), Wolf (2007), Davis and Weinstein (2002) or Redding and Sturm (2008). In this sense, therefore, the study of the Spanish experience during this period conforms a case study that allows analyzing whether the construction of new transport infrastructure, as well as the changes in trade policy, that affected the relative market potential of the Spanish regions, ended up shaping regional growth trajectories.

The third contribution of the study refers to the construction of the measure of market potential. In the absence of data on bilateral trade flows between the territories (Redding and Venables, 2004), NEG empirical literature has tended to use an *á la Harris* measure of the regional market potential based on the consideration of income levels of the regions and the geodesic distances between them as representative of regional market access. However, and especially when applied to history, the consideration of bilateral transport costs instead of

geodesic distances in the calculation of the domestic market potential presents some clear advantages. For instance, different transport modes like railways or coastal shipping can be included, the exact routes used in the transportation of commodities by transport 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 the substitution for traditional ones, 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. If we consider that the progress in the construction of transport infrastructure or the changes experienced in trade policies altered asymmetrically the economic distance between regions, it does seem advisable to use a measure of the regional market potential that takes into consideration these changes. Therefore, this article makes use of an *a la Harris* measure of regional market potential taking into account the economic distance between territories according to the changes registered in transport networks, the variations in the actual transport costs and the tariff policy followed over the period.

The remainder of the paper is structured as follows. First, we offer a brief summary of the historical process of market integration and economic growth of the Spanish economy, presenting new evidence on regional inequality patterns in the long term based on recent estimations of per capita GDP for NUTS III Spanish regions (provinces) between 1860 and 1930 (Rosés et al., 2010). In section 3, the proposed measure of regional market potential is detailed. In section 4 we carry out a nonparametric analysis on the relation between market potential and regional economic growth. Section 5 is devoted to the presentation of the empirical (parametric) analysis and to the discussion of the main results. Finally, section 6 concludes. Additionally, Appendix 1 describes the theoretical model proposed originally in Ottaviano and Pinelli (2006). According to this model, regional per capita GDP growth is explained by a pool of variables encompassing the factors both highlighted by traditional international and regional economics as determinants of economic growth differentials across regions (infrastructures, human capital, etc…), and those posed by NEG literature such as differences in the market potential of regions. Appendix 2 presents the data and the sources employed in the analysis.

2. Market integration, industrial location and regional inequality in Spain, 1860-1930

From a historical point of view, major advances were produced in the integration of the national markets and industrialization during the 19th century. The reduction in trade costs within countries was, on the one hand, linked to the elimination of institutional obstacles that hindered the free movement of goods and factors between regions and, on the other, to the fall in transport costs derived from the technological improvements made during the Industrial Revolution and their application to transport. In the case of Spain, the integration of the domestic market ran in parallel with an increase in the spatial concentration of manufacturing and in regional income inequality. Along this section, the main evidence regarding these issues for the Spanish case is reviewed.

First, the economic integration of the various regional economies was completed during the second half of the 19th century. Before that date, during the '*Antiguo Regimen*' (Ancient Regime), the Spanish market was fragmented into various local and regional markets that were largely unconnected. Historians have stressed two key elements to account for this situation: on the one hand, the persistence of institutional obstacles to interregional trade and, on the other, the fact that, Spain, a country which has traditionally had to confront serious geographical obstacles, experienced a relative backwardness linked to the deficiencies suffered by Spain's transport system (Ringrose, 1970). Yet, the second half of the 19th century was witness to a progressive integration of the domestic market thanks to the institutional reforms undertaken by the various liberal governments, and to the progress of the transport system. These improvements proved to be a determining factor for the integration of the Spanish market, thanks both to the introduction of the railway and the advances made in other modes of transport (road and coastal shipping) which favoured a steep fall in transport costs.

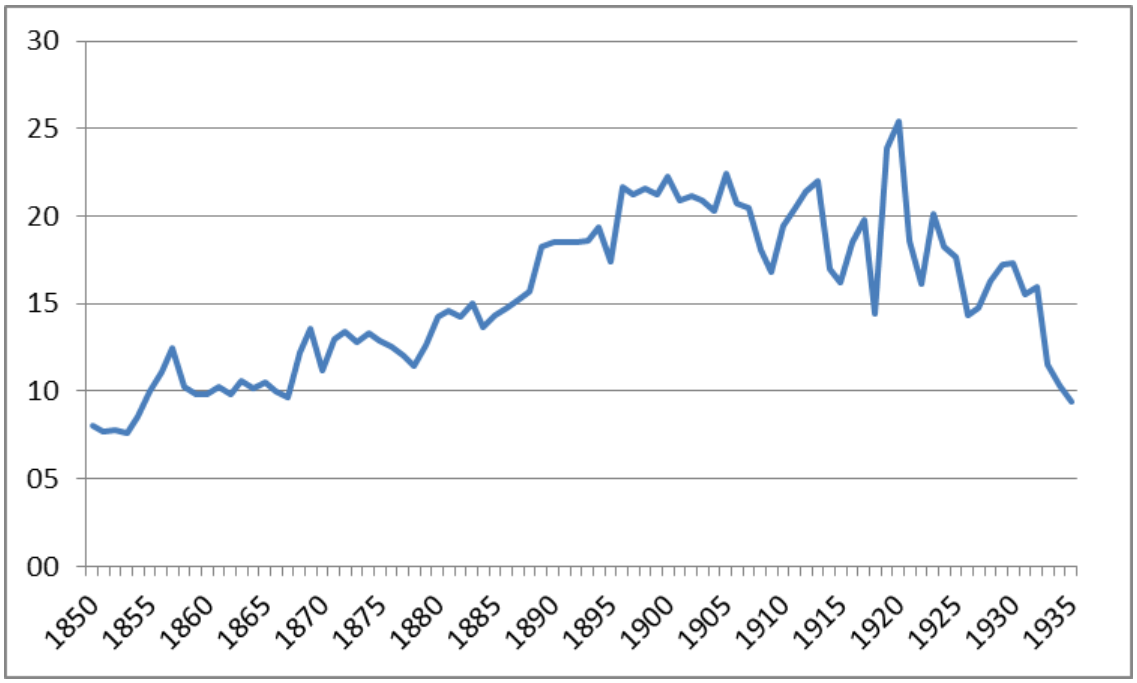
The outcome was the gradual integration of the national market for goods for the main traded products, an integration that was characterised by the convergence in regional prices. Various studies have proved the gradual convergence of regional grain prices from the beginning of the 18th century until its culmination in the second half of the 19th century

(Peña and Sánchez-Albornoz, 1983; Barquín, 1997; Matilla, Pérez and Sanz, 2008). In addition, the integration of the markets for capital and labour underwent marked advances as well. In the case of the capital markets, the main events that affected the monetary and banking systems (Castañeda and Tafunell, 1993; Sudrià, 1994; Tortella, 1973) favored the reduction in interest rates differentials across regions. Particularly, Castañeda and Tafunell (1993) showed that interregional short-term interest rate differentials registered an intense decline after 1850. Lastly, Spain's labour market integration, measured in terms of disparities in regional real wages across regions, has also been extensively analyzed. In this respect, Rosés and Sánchez-Alonso (2004) showed that PPPs-adjusted rural and urban wages converged across different locations prior to World War I, despite low rates of internal migration.[2]

In addition, from 1869 onwards, this context of internal market integration was accompanied by a progressive economic openness towards neighboring countries (Tena, 1999). The reduction in tariff protection levels reached its maximum at the end of the 1880's, when Spain signed several trade treaties with its main trading partners. Nevertheless, the last decade of the century witnessed an important change in terms of the Spanish economy integration in the external markets. On the one hand, in 1883, the gold convertibility of the peseta was abandoned, thus debilitating Spain's position in the international capital markets. On the other, from 1892 on, the return to protectionism posed a serious threat to external integration. The return to protectionist policies was generalized across countries in the last decades of the 19th century as a reaction to the challenges raised by the First Globalization wave. In addition, many countries started adopting at that time protectionist measures as a part of the strategy to develop their manufacturing sectors as a way to compete in the international markets with the British goods. All this generated a U-inverted evolution of Spanish international trade along these years. The rate of openness for the Spanish economy showed an increasing trend during the second half of the 19th century which began to be reversed in the last decade of that century (see Figure 1).

[2] A more detailed description of these processes can be found in Rosés et al. (2010).

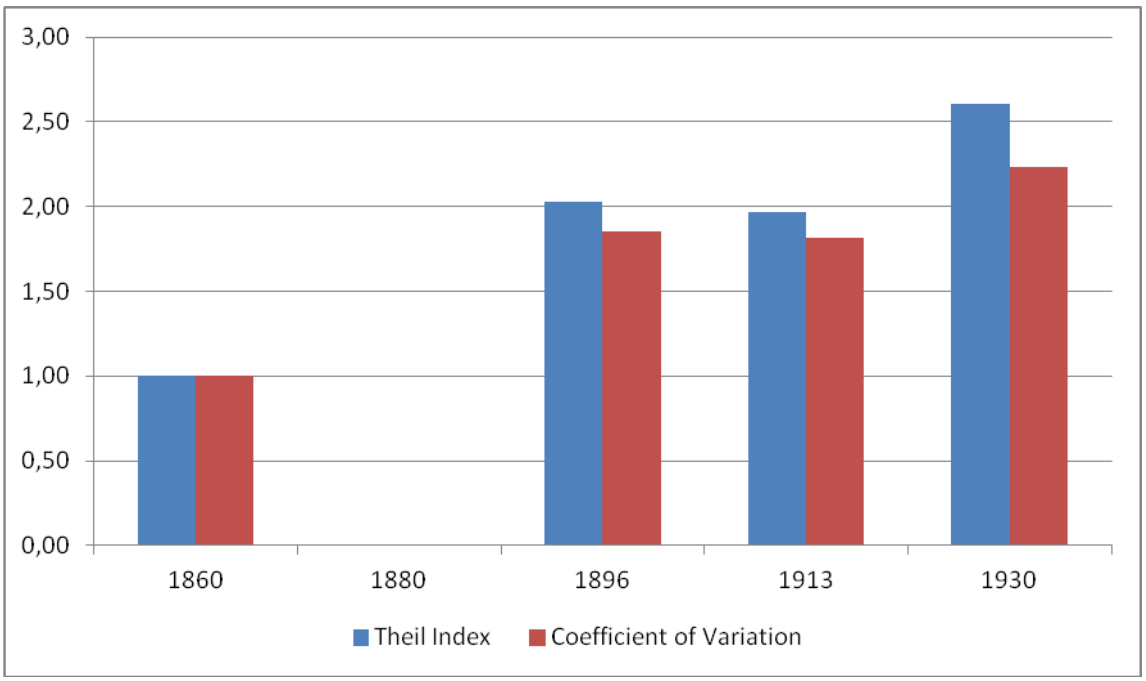
Figure 1. Openness rates (%). Spain, 1850-1935



Source.- 1850–1913: data for exports and imports from Prados de la Escosura (2010); 1914–1935, Tena (2005); GDP figures from Prados de la Escosura (2003)

The advances registered in the integration of Spanish national markets for goods and factors drove an intense process of regional specialization. In respect of the industrial sector, from the middle of the 19th century to the outbreak of the Civil War (1936-1939), production gradually agglomerated in a small number of provinces, a development that is well documented by the historiography (Nadal, 1987, Paluzie et al., 2004). A recent estimation of regional GVA in Spain's industry, conducted in the context of the reconstruction of regional GDP series (Tirado and Martinez-Galarraga, 2008), allows analysing the evolution of the geographical concentration of manufacturing activities over the period studied through two alternative inequality indexes (Figure 2). The general pattern described is one of an increase in the concentration of industry across Spain's provinces up to the 1930s. This dynamics is similar to that experienced in other countries like the United States (Kim, 1995) and France (Combes et al., 2011), that also experienced an upsurge of agglomeration of industrial production along the first stages of the process of national market integration and industrialization.

Figure 2. Inequality in the distribution of industrial GVA in Spain at province level, 1860-1930 (1860=1)



Source.- Based on Tirado and Martinez-Galarraga (2008)

Economic historians have extensively investigated the roots and causes of this notable increase in the spatial concentration of manufacturing before the Spanish Civil War, looking at the role played by the factors stressed by the two major explanations in the literature: traditional trade theory (comparative advantage in a Heckscher-Ohlin setting) and new economic geography. What explains the location of industry in Spain? Rosés (2003), following Davis and Weinstein (1999, 2003) found evidence of a 'home market effect' behind the early Catalan industrialization (around the 1860s). In turn, Tirado et al. (2002), in line with Kim (1995), identified scale economies and market size as the determinants of the industrial geography of Spain in mid-19th c. At the end of the century, these NEG elements would have increased their explanatory power in parallel with the advance in the process of economic integration. Recently, Martinez-Galarraga (2012) adopting the approach developed by Midelfart-Knarvik et al. (2002) has confirmed and extended the previous findings by Tirado et al. (2002).[3] As the domestic market became integrated and industrialization

[3] This methodology has extensively been used in economic history research. Wolf (2007) analyzed re-unified Poland after WWI during the interwar years; Crafts and Mulatu (2005, 2006) studied the Victorian period in

progressed in Spain during the second half of the 19th c., NEG forces grew to be the main determinant of the industrial map in Spain. In particular, although comparative advantage factors were present in the Spanish case, the scale effects suggested by Krugman (1991), captured by the interaction between economies of scale and market potential, played a decisive role as industries with increasing returns tended to concentrate in provinces with a better access to demand up to the 1930s.

The research has also tested empirically, in the context of the Spanish economy, first, the wage equation, i.e., the existence of higher wages in regions that have greater market potential resulting from the agglomeration of manufacturers in core regions (*backward linkages*), and second, the attraction of these wages for generating migratory flows of workers (*forward linkages*). These are some of the centripetal forces stressed by New Economic Geography (Krugman, 1991) and which might be responsible for agglomeration in the early stages of economic development. Firstly, following the influential work by Hanson (1998, 2005), based in turn on the Krugman wage equation, the existence of a spatial structure in industrial nominal wages in the 1920s in Spain has been examined in Tirado et al. (2013). The results verify that wages were higher in regions with greater market potential and prove the existence of a wage gradient centred in Barcelona, the main industrial centre in interwar Spain. In addition, this work confirms that domestic market potential became more relevant as the Spanish economy and the main European markets increased protectionism during the 1920s while the wage gradient centered on Barcelona declined.[4]

Secondly, Pons et al. (2007) established, following Crozet (2004), a direct relationship between migration decisions and the market potential of the host regions during the 1920s, thus verifying the presence of forward linkages in the internal migrations between Spain's provinces in the interwar years. Yet, although the Spanish workers were attracted by industrial agglomerations, this attraction was limited to relatively close-lying zones. This would explain the apparently low intensity of internal migrations in Spain until the 1920s and

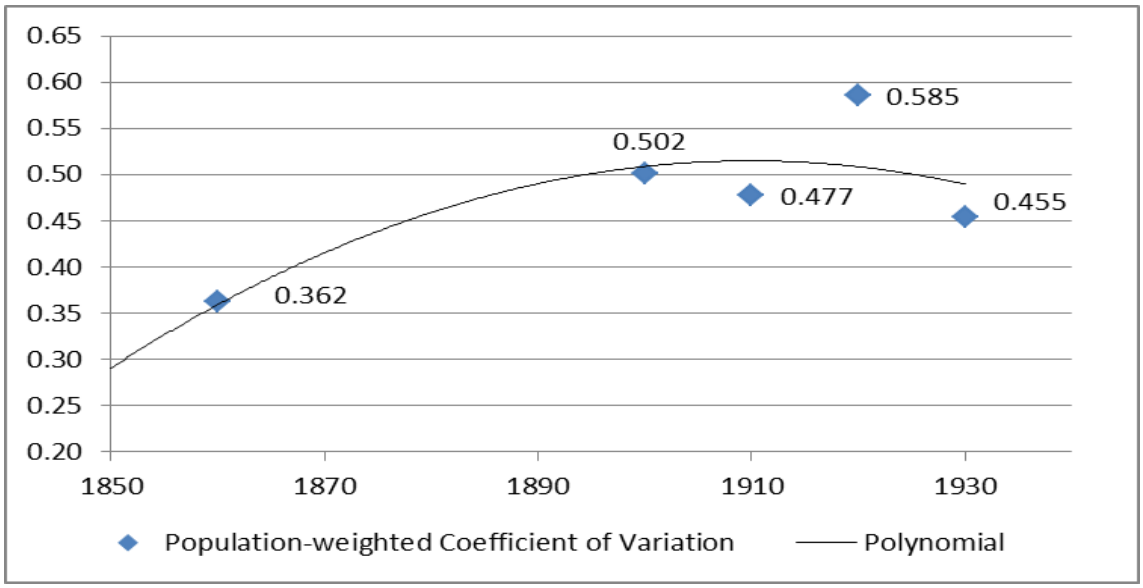
Britain; and Klein and Crafts (2012) applied this approach to re-examine the manufacturing belt in the US between 1880 and 1920.

[4] This exercise thus contributes to the existing theoretical and empirical NEG debate about the effects of international integration on the internal geography of countries (Hanson, 1997; Krugman and Livas, 1996; Crozet and Koenig, 2004). A similar long-term analysis for Italy can be found in A'Hearn and Venables (2011).

the geography of these migrations in the interwar years. The migratory flows to the main industrial centers did not originate from the poorest regions in the south of the peninsula which lay furthest from these industrial centers and this was due to the migration costs that grew in relation to the distance that the workers had to travel.

Once described the evidence gathered at the manufacturing sector level, the next step is to look at regional inequality in terms of per capita GDP (Rosés et al. 2010). To begin with, taking the population-weighted coefficient of variation as a measure of inequality, Figure 3 plots the long-term evolution of regional income per capita disparities at a province level (NUTS3). In the Spanish case, the second half of the 19th century witnessed a remarkable increase in regional income inequality. Then, in the first decades of the 20th century, this process came to a halt and a tendency towards the stabilization of income per capita inequality is observed.

Figure 3. Regional per capita GDP inequality, Spanish NUTS III (1860-1930)



Source.- Rosés et al. (2010)

What are the determinants of this evolution? The evidence presented so far shows that NEG forces were behind the agglomeration process observed in the manufacturing sector in Spain from the mid-19th c. to the outbreak of the Spanish Civil War. But was the impact of geography limited to the manufacturing sector? Did NEG-type mechanisms have an effect

at a more aggregate level when income per capita is considered? In other words, did market potential and its evolution have an impact on regional inequality during the early stages of economic growth in Spain? In order to answer these questions, a sound measure of regional accessibility has to be constructed. The next section is thus devoted to present our market potential indicator.

3. Measuring regional market potential in Spain, 1860s-1930

In NEG multi-regional models, the capacity of different locations to attract firms and workers varies according to their relative position in space. Although in NEG papers the Harris market potential equation usually relies on geodesic distances between locations, there are fundamental reasons to consider bilateral transport costs, especially in historical studies.[5] In the period analysed in this paper, there were remarkable changes in transport technologies like the expansion of railways 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). Traditionally, inland transport had been conducted by road and 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 could benefit earlier than others from railway transportation. And in the particular case of Spain, a radial railway network with a hub in Madrid, the geographical centre of the country, was decided. As regards the transport of goods between coastal provinces by coastal shipping, key advances, like the transition in navigation from sail to steam or the improvement in port facilities, took place. Overall, these changes often present a regionally asymmetric pattern, thereby unevenly affecting regional transport costs and accessibility.

[5] 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 the distances and the freight rates, are the various alternatives used in empirical studies. A review of the literature from an NEG perspective can be found in Combes and Lafourcade (2005) and Lafourcade and Thisse (2008).

In order to analyse the potential relationship between market potential and regional income growth we have gathered two different types of empirical evidence. On the one side, we make use of the new estimations of regional GDP constructed in Rosés et al. (2010). On the other, we present a new estimation of the market potential of Spanish regions along the five benchmarks considered. The proposed regional market potential measure comes from the so-called 'nominal market potential' or Harris' market potential equation, defined as: [6]

$$MP_r = \sum \frac{M_s}{d_{rs}} \ ,$$

where M_s is a measure of the size of province[7] s (GDP) and d_{rs} is the distance, or as in this case, bilateral transport costs between provinces r and s.

Following this expression, Martinez-Galarraga (2013) offered a measure of Spanish NUTS3 market potential for the years 1867, 1900, 1910, 1920 and 1930 based on the study by Crafts (2005).[8] Market potential figures are obtained as follows. First, the market potential of a Spanish province *r* is disaggregated into two components: the domestic market potential (DMP_r) to which each province's self-potential (SP_r) is incorporated, and the foreign market potential (FMP_r) between the provincial and the international node. Hence, the market potential of a province *r* (MP_r) is calculated as the sum of the domestic and foreign market potential:

$$MP_r = DMP_r + FMP_r \ .$$

[6] This measure of market access suggested by geographers and widely adopted by economists could be considered an *ad hoc* indicator given that it has not been built upon a solid theoretical foundation or it has not been derived from a structural estimate. However, the advances made by New Economic Geography (NEG) models help overcome this lack of theoretical foundation for this empirical measure of market potential. Particularly, Combes et al. (2008) derive an expression for the Real Market Potential (*RMP*) that establishes a relationship with Harris' (1954) equation. Notwithstanding, from an empirical perspective, when compared to structural estimates of the market potential, Head and Mayer (2004) express a favourable judge on the Harris equation's performance.

[7] Provinces are Spanish NUTS3 regions. The insular territories have not been included, giving a total of 47 provinces.

[8] See Martinez-Galarraga (2013) for a detailed description.

Following this expression, the domestic market potential for each one of the 47 provinces *r* is calculated as follows:

$$DMP_r = \sum_{1}^{s=46} \frac{M_s}{d_{rs}} + SP_r$$

being

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

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:

$$\theta_{rr} = \frac{1}{3}\sqrt{\frac{(area\ of\ the\ province_r)}{\pi}}$$

In turn, the foreign market potential of province *r* (FMP_r) is obtained according to the next expression, where d_{rp} captures the distance from the inland provincial node to the nearest Spanish port:

$$FMP_r = \sum_{1}^{f=4} \frac{M_f}{d_{rp}} \cdot Distance_{pf}^{\delta} \cdot Tariff_f^{\gamma}$$

with $d_{rp} = 1$ if *r* is a coastal province, and $d_{rp} = d_{rs}$ if *r* is an inland province. In this case, 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; $Tariff_f$ are the mean tariffs applied in the foreign country *f*; δ and γ are the elasticities obtained in international trade gravity equations associated to the coefficients for distance and tariffs, respectively.

Hence, the total market potential of province r (MP_r) is obtained as the sum of the following 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:

$$MP_r = \sum_{1}^{s=46} \frac{M_r}{d_{rs}} + SP_r + \left[\sum_{1}^{f=4} \frac{M_f}{d_{rp}} \cdot Distance_{pf}^{\delta} \cdot Tariff_f^{\gamma} \right], \qquad (1)$$

with d_{rp} conditioned to the coastal or inland nature of province *r*.

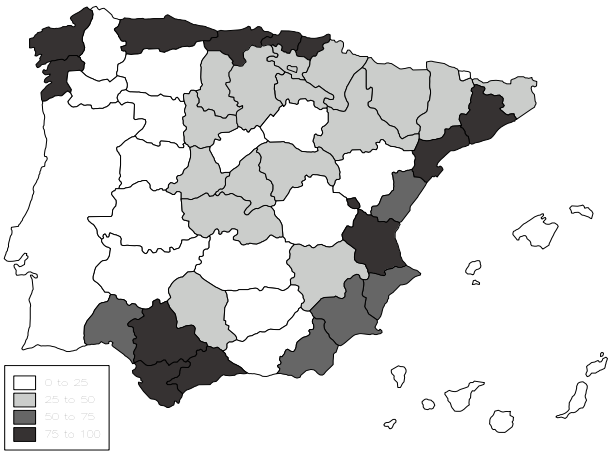
The size of the provincial markets (M_r) is measured by the aggregate income. Data on nominal GDP at a NUTS3 level are obtained from Rosés et al. (2010). For measuring d_{rs}, transport costs are considered. In such a case, data on distances and average transport rates for commodities are needed. Internal transport is assumed to be by railway and coastal shipping. For railway distances, the sources are *Ministerio de Obras Públicas* (1902), and Wais (1987). For distances between ports, electronic atlases provide information on the length of sea journeys.[9] As regards transport costs, data on railway rates come from Herranz (2005). Coastal shipping rates in 1865 have been obtained from Nadal (1975). In order to consider the reduction in sea transport costs, the data have been corrected with the freight rate indices calculated by Mohammed and Williamson (2004). However, in the first benchmark year in the 1860s only 32 out of the 47 provinces considered were connected to the railway network. For that reason, road transport was also included in the internal market potential estimates at that time.[10] Distances by road were taken from *Dirección General de Obras Públicas* (1861). For road transport prices, the information in Barquín (1999) has been used. Finally, the relative weight of each transport mode in the coastal provinces is obtained from Frax (1981).

[9] www.dataloy.com and www.distances.com.

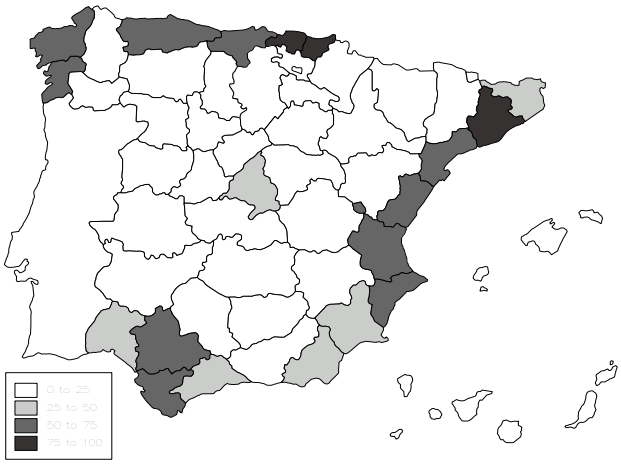
[10] On the contrary, by 1930 road transport still was not playing an important role, and therefore, it has not been considered. Herranz (2005).

Figure 4. Market potential in Spain's provinces, 1867-1930 (Barcelona=100)

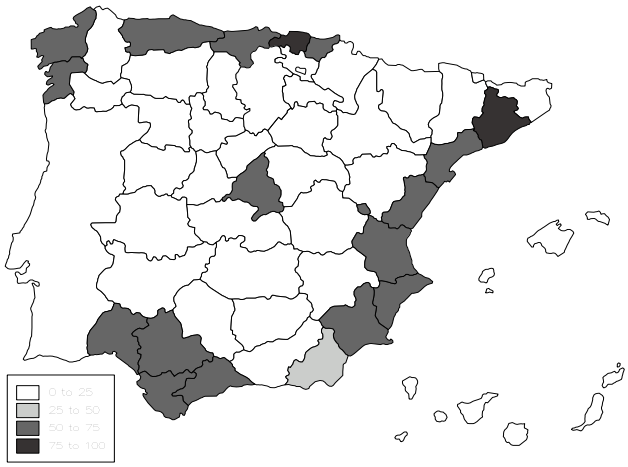
1867



1900



1930



Source.- Martinez-Galarraga (2013)

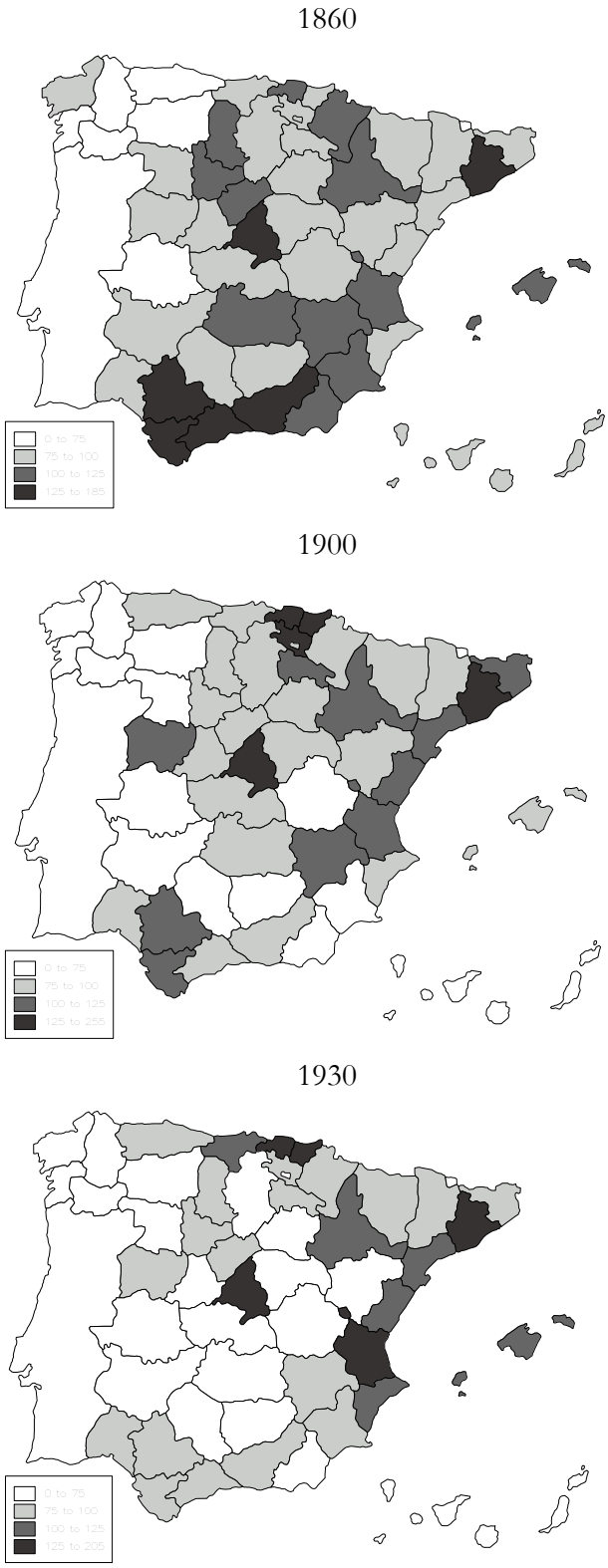
The construction of the foreign market potential is based on the gravity equation for international trade estimated by Estevadeordal et al. (2003). The elasticities obtained for distance and tariffs (-0.8 and -1.0, respectively) are used to reduce the size of foreign markets. Nominal GDP of the main trading partners for Spain (France, United Kingdom, Germany and United States) is obtained from Crafts (2005) based on the estimates of Prados de la Escosura (2000). Prevailing exchange rates have been applied to convert GDP figures from pounds to pesetas. Maritime distances are once again obtained from an electronic atlas and finally, tariffs come from O'Rourke (2000) and Mitchell (1998a, 1998b).

Figure 4 allows us to examine the geographical pattern of regional accessibility and its evolution between the 1860s and 1930. Throughout the period of study Barcelona stands out as being the province with the greatest market potential and therefore maps are expressed in relative terms with respect to this province. The evidence gathered shows that the most significant changes in the relative accessibility of the Spanish provinces occurred in the second half of the 19th c. in parallel with the integration of the domestic market. A centrifugal tendency is observed and the geographical structure evolved towards a clear division between inland and coastal provinces with the latter showing a higher market potential than their inland counterparts, with the sole exception of Madrid. It is possible to hypothesize that the expansion of the railway (all province capitals were connected to the railway network by 1901) could account for a large share of the changes described in the pattern of market potential. Once this dual structure was established at the end of the 19h c., the division between inland and coastal provinces showed a high degree of persistence in the first decades of the 20th c.

4. Market potential and economic growth in Spain, 1860-1930: nonparametric evidence

From this evidence the work seeks to analyze whether the observed changes in relative market potential of the Spanish regions acted as an explanatory element of regional economic inequality. That is why, as a first step in the analysis, in what follows nonparametric evidence on the relationship between regional per capita GDPs and Market Potential is presented. To begin with, Figure 5 shows the evidence regarding the geography of regional inequality at three points in time analyzed, 1860, 1900 and 1930.

Figure 5. Per capita GDP in Spain's provinces, 1860-1930 (Spain=100)

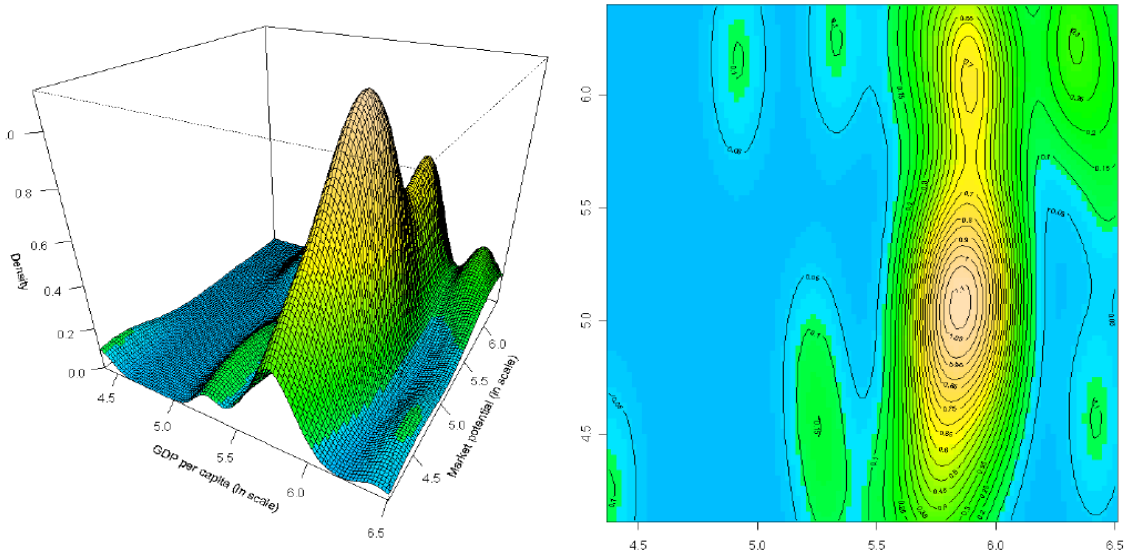


Source.- Rosés et al. (2010)

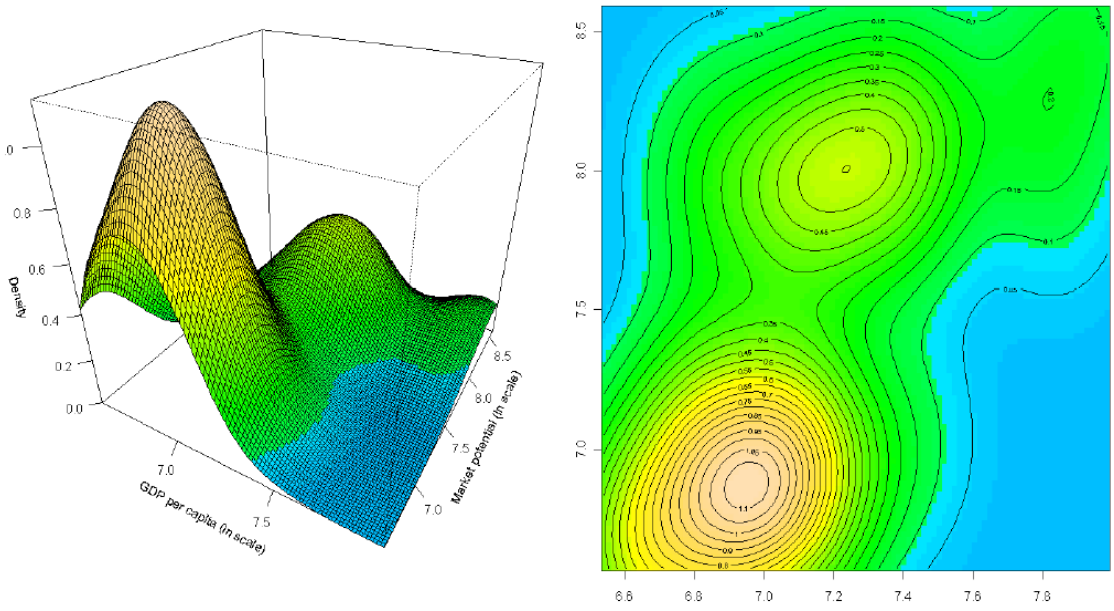
The evidence showed in the maps illustrates the apparent presence of a relationship between the relative market access of regions and the corresponding regional per capita GDP levels. The centrifugal pattern observed is similar to the evolution of regional market potential (Figure 4), although in the case of per capita GDP the division between inland and coastal provinces is not so marked. In order to go deeper in the analysis of these hypotheses, we test the relationship between regional market potential and per capita GDP . To do this, we look at the distribution of regional market potential and the distribution of per capita GDP at the same date, and then we study how they are related (Ioannides and Overman, 2004). Figure 6 shows the stochastic kernel estimations of the distribution of regional market potential conditional on the distribution of per capita GDP at the beginning and at the end of our period of study. In order to make the interpretation easier, the contour plots are also shown. In 1860, both distributions are clearly independent and regions with similar levels of per capita GDP show very different values of market potential. However, in 1930 this relationship has changed and become positive: regions with high per capita GDP are also regions with high market potential. This result points to the appearance of a significant positive relationship between market potential and regional per capita GDP at the end of the period analyzed, 1930.

Figure 6. Stochastic kernel estimates of the relationship between regional market potential and per capita GDP

1860, market potential to GDP per capita:



1930, market potential to GDP per capita:

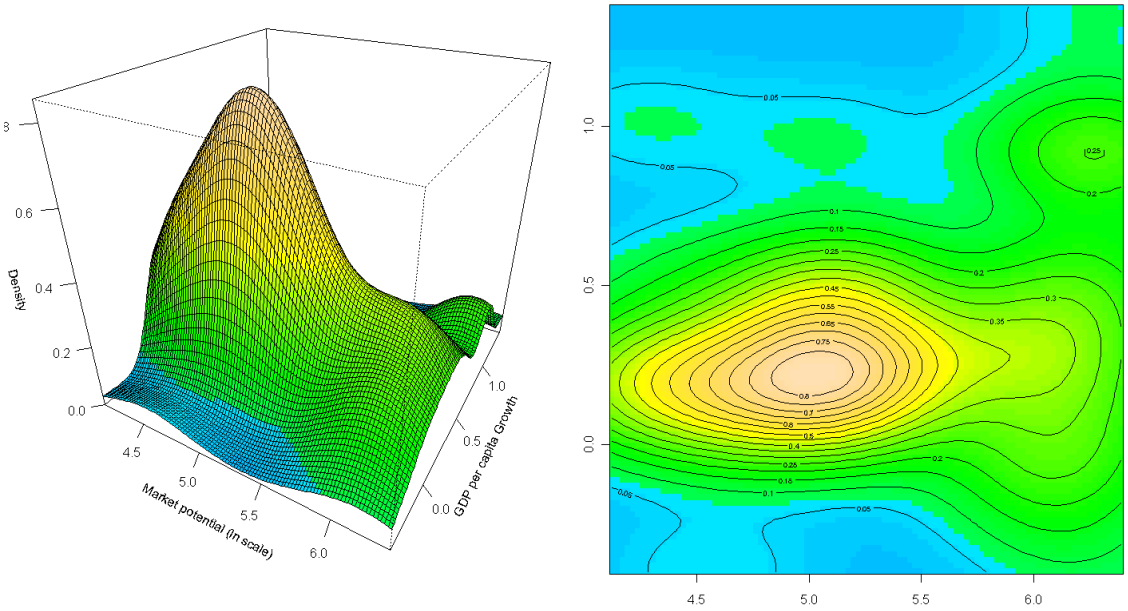


Given this change in the relationship between market potential and per capita GDP, we expect to find a similar relationship between market potential and per capita GDP growth rates. Figure 7 offers the stochastic kernel estimation of the distribution of regional market potential conditional on the subsequent per capita GDP growth rates. Indeed, the results point in the same direction: in 1860 initial market potential and per capita GDP growth between 1860 and 1900 are independent for most of the distribution, while a clear positive relationship can be deduced for the period going from 1900 to 1930. Thus, a higher market potential implies a higher GDP growth rate in 1930, but not in 1860. Overall, these figures indicate a steep change in the relationship between market potential and per capita GDP over time, from independence to a positive influence of market potential on GDP, especially in data corresponding to the period 1900-1930, and particulaly in the years 1920-1930. [11]

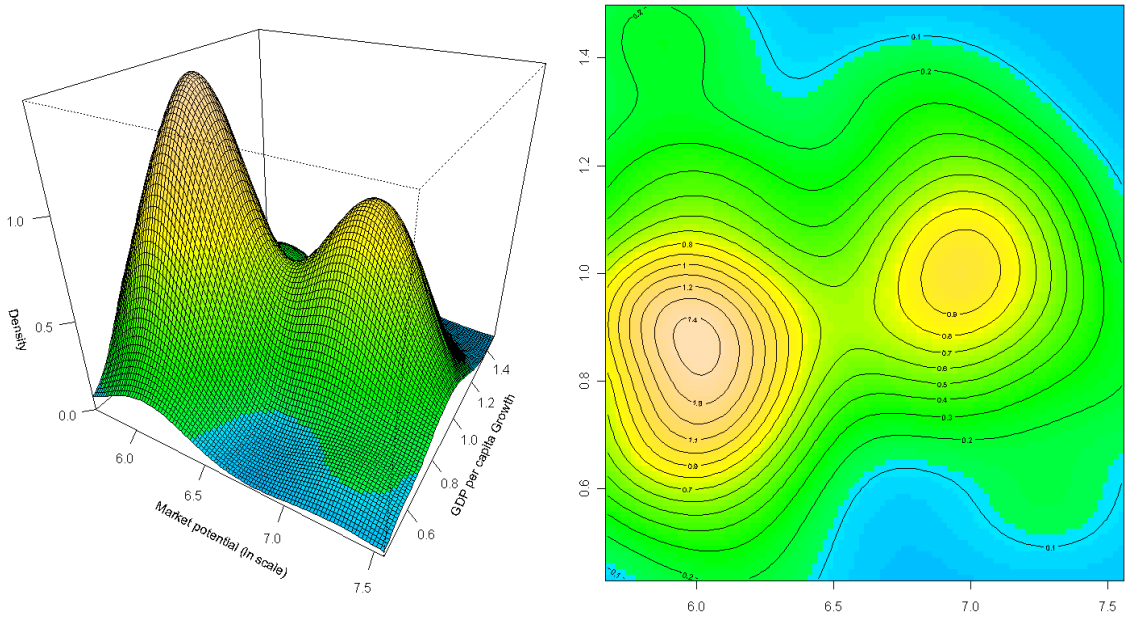
[11] Figures for all the intermediate periods between 1860 and 1930, not shown to save space, are available from the authors upon request.

Figure 7. Stochastic kernel estimates of the relationship between regional market potential and per capita GDP growth

1860-1900, market potential to per capita GDP growth rates:

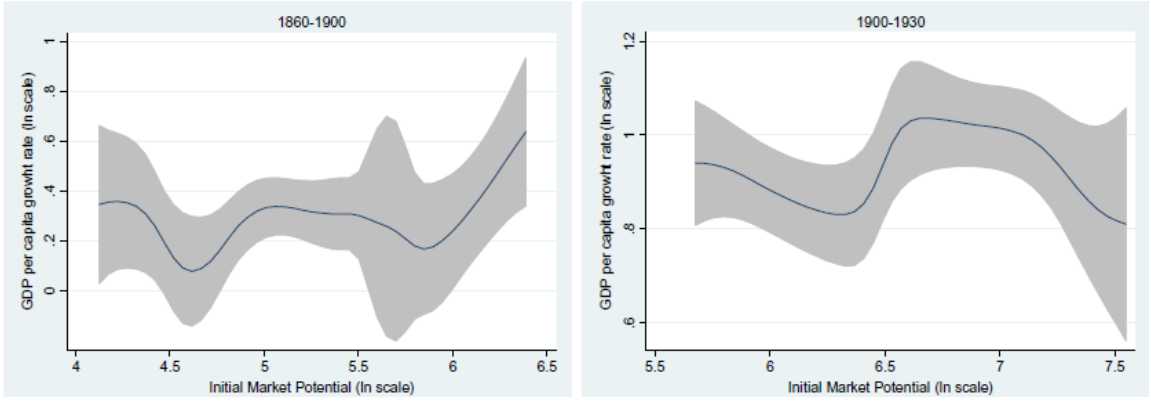


1900-1930, market potential to per capita GDP growth rates:



Next, we conduct a nonparametric estimation of the effects of market potential on regional per capita GDP growth. To do this, we estimate the nonlinear relationship between initial market potential and growth using a local polynomial smoothing for the two main sub-periods in our sample (1860-1900 and 1900-1930).[12] Figure 8 shows the results, including the 95% confidence bands. These graphs are complementary to Figure 7; thus, in the 1860-1900 period growth can be approximated as a flat line around the value 0.3 for most of the initial market potentials. The relationship is only positive for the highest market potentials, but Figure 7 reveals that the density (the number) of regions with the highest market potential is low. Therefore, although a positive relationship between market potential and regional per capita income growth emerges in the two periods we have split our sample, there is a temporal evolution pointing to the increasing influence of market potential over time. Particularly, when focusing on regions with a low initial market potential, the effect on mean per capita GDP growth ranges from 0.2 to 0.4 between 1860 and 1900, and from 0.8 to 0.9 between 1900 and 1930. A similar pattern is observed for regions with a high initial market potential, although the effect on regional economic growth tends to be higher in these high market potential regions. It ranges from 0.4 to 0.6 in 1860-1900 and from 0.8 to 1 in the period 1900-1930. Moreover, Figure 7 shows that the density (the number) of regions with the highest market potential also substantially increased over time.

Figure 8. Non parametrical estimation of the relationship between Regional Market Potential and per capita GDP Growth



[12] The local polynomial smoother fits the growth rate $g_{it} = \left(\ln pcGDP_{it} - \ln pcGDP_{it-1}\right)$ to a polynomial form of $(\ln MP_{it-1})$ via locally weighted least squares. We use the *lpolyci* command in STATA with the following options: local mean smoothing, a Gaussian kernel function to calculate the locally weighted polynomial regression and a bandwidth determined using Silverman's (1986) 'rule-of-thumb'.

On the basis of this nonparametric evidence it is possible to identify the existence of a relationship between regional market potential and regional inequalities. Besides, this relationship was more important in the period 1900-1930, once the main changes in the relative market potential of regions were established after the construction of the railway network and the changes experienced in external tariff policies at the end of the 19th century. This result is in line with the evidence provided in Rosés et al. (2010). The authors found that differences in economic structure and productivity acted together in explaining the upswing of inequality. According to their results, Heckscher-Ohlin forces were the main driver behind the unequal regional development, given that *between-sector* differences accounted for the lion's share of regional differences in labour productivity. Notwithstanding, w*ithin-industry* differences were also significant in this first phase of Spanish economic growth and market integration, and therefore NEG-type forces could be in the base of the important regional inequalities arising during these years. Hence, being the first decades of the 20th century the key period in the relationship studied, the rest of the paper aims to dig deeper in the analysis of this relationship making use of the theoretical and empirical method proposed in Ottaviano and Pinelli (2006).

5.- Empirical analysis

In the parametric analysis, we exploit the panel structure of our data for the years where we have identified the existence of a strong relationship between market potential of regions and their respective per capita GDP growth rates. Therefore, we study the period 1900–1930 using panel data and consider the following sub-periods: 1900-1910, 1910-1920 and 1920-1930. We depart from the estimation of standard growth regressions derived from the model presented in Appendix 1 over a set of explanatory variables including a measure of market access. The baseline equation, which is similar to that proposed by Ottaviano and Pinelli (2006), adopts the following form:

$$\ln(w_t) - \ln(w_{t-1}) = \alpha + \beta \ln(w_{t-1}) + \gamma \ln(access_{t-1}) + \delta \ln(controls_{t-1}) + \varepsilon_t, \qquad (2)$$

where the independent variable, the measure of regional economic performance, the logarithmic growth rate of per capita GDP at the province level, is regressed on a set of explanatory variables usually employed in the growth literature. In this respect, it is important to note that, in contrast to cross-country studies, as far as regions in the same country tend to share the same institutional framework, this exercise does not include a set of institutional variables. Among the explanatory variables, three sets of variables traditionally considered in the growth literature are included:[13] proximate sources of growth (*physical capital, human capital, knowledge capital and infrastructures*), structural change variables (*gross value added in mining and the regional share of manufacturing in total employment*)[14], and second nature geography or NEG variables (*market access*). We also include regional fixed-effects to control for other regional characteristics not accounted for in the specification (for example, first nature causes and geography). The dataset and sources are detailed in Appendix 2.

The main explanatory variable in our analysis is regional market potential. In this case, the cross-sectional measure of market potential is normalized by the contemporaneous average market potential to avoid that later periods can overpower effects in earlier ones through absolute growth in market potential (Black and Henderson, 2003). Regional relative market potential (mp_{it}) can therefore be defined as:

$$mp_{it} = \frac{MP_{it}}{\frac{1}{n_t}\sum_{1}^{n_t} MP_{jt}}.$$

We use alternative measures of market potential, corresponding to the different components of the market potential considered (see Eq. 1): total, domestic and foreign market potential, and also a measure that excludes each province's self-potential to reduce some endogeneity concerns (more on this below).

[13] See, e.g. Temple (1999).

[14] As far as it has been pointed out that different paces of structural change could affect regional per capita GDP levels along the process of economic industrialization and integration of Spanish economy, the empirical analysis attempts to control for this effect through the inclusion of variables that capture the productive structure of regions.

First, we estimate Eq. (2) by OLS correcting for heteroskedasticity by using White's method. Nevertheless, an important component of the Harris market potential measure is the contribution to the potential of region *i* of its own GDP, also known as self-potential. Therefore, by construction, the explanatory variable market potential and the dependent variable (per capita GDP growth) influence each other at the same time and could be simultaneously determined. Besides, due that we consider that the infrastructures are a key element to explain the changes in the market potential for regions, our main concern relates with the role played by these infrastructures. Policy makers tend to improve infrastructures in the most developed regions, but these infrastructures (roads, railways, etc.) undoubtedly also increase the market access of these locations (Holl, 2012), generating endogeneity and problems with our specification.

To deal with these two issues, we proceed as follows. First, in some estimations we use a measure of market potential excluding each region's self-potential; by doing so, changes in regional infrastructures can affect per capita GDP growth in region *i*, but we exclude the possible effect of infrastructures on region *i* market potential. Besides, purging the self-potential we avoid possible simultaneity problems. Second, in order to tackle the potential endogeneity problem, we re-estimate Eq. 2 using instrumental variables (IV). Thus, we need to instrument the market potential variable in the first stage regressions of the IV estimation. We use two instruments: the (log) distance to the nearest main industrial centre (Madrid, Barcelona or Bilbao) and the lagged regional population density. Population can serve as a good measure of market potential, and in some papers it is used directly instead of GDP (Black and Henderson, 2003; Ioannides and Overman, 2004; Henderson and Wang, 2007). To be cautious, we use the lagged value of the regional population density; thus, values from 1860 are used to estimate market potential in 1900, and so on.

Table 1 shows the results of the OLS estimation of Eq. 2. The first column corresponds to an unconditional convergence regression; the estimated coefficient is clearly significant and negative, indicating convergence across the Spanish regions. In the rest of columns, we find that convergence is stronger when all the controls are added. In addition, only one of the four different measures of relative market potential is significant, the domestic market potential. However, as explained, these OLS estimations are not robust. Thus, we instrument

the market potential variables using the lagged regional population density and the (log) distance to the nearest main industrial centre and we estimate the second stage regressions by GMM. These results are reported in Table 2, which also shows some statistics from the first stage regressions. Our instruments seem to perform well, as the R^2 in the first stage regressions exceeds 0.8 in all of the specifications, the weak instruments hypothesis is always rejected using the Stock-Yogo test, and all the models pass the overidentification test (Hansen J statistic) for any significance level.[15]

Table 1. Regional Growth Regressions (OLS)

Variables	(1)	(2)	(3)	(4)	(5)
Initial per capita GDP	-0.282***	-0.887***	-0.898***	-0.858***	-0.895***
Literacy rate		0.839***	0.826**	0.742**	0.815**
Number of patents per capita		0.736***	0.746***	0.798***	0.746***
GVA in mining		-0.017***	-0.017***	-0.012*	-0.017***
Share of manufacturing in total employment		-3.373***	-3.268***	-4.590***	-3.274***
Total stock of infrastructures		0.322***	0.345***	0.229**	0.341***
Relative market potential		0.003			
Relative market potential without self-potential			-0.058		
Relative domestic market potential				0.204*	
Relative foreign market potential					-0.028
Regional fixed-effects	No	Yes	Yes	Yes	Yes
R^2	0.141	0.629	0.632	0.641	0.631
Observations	141	141	141	141	141

Note: Dependent variable: per capita GDP growth rate (ln scale). All variables in logarithmic scale, except rates and relative market potentials. Significant at the *10%, **5%, ***1% level. All the specifications include a constant.

As regards the control variables, we first focus on the proximate sources of growth. The coefficients associated to the human capital stock, proxied by provincial literacy rates, knowledge capital, proxied by the number of patents per capita, and the provincial stock of infrastructures, are always significant (with the exception of the stock of infrastructures in regression 1) and show the expected signs. That is to say, they confirm the presence of a positive relationship between the relative stocks of these cumulative factors and regional growth.

[15] The complete results of the reduced regressions, first stage regressions and all the tests, not shown for size restrictions, are available from the authors on request.

Nevertheless, results also show the presence of a negative and significant relationship between the structural change variables (share of manufacturing in total employment and GVA in mining) and regional economic growth. Although this result could seem counterintuitive, it is worth noting that, as showed in point 2, in the Spanish case, the years 1860 to 1900 witnessed a dramatic increase in regional inequality associated to the divergence of regional economic structures. So, regions experiencing a fast transformation of their economic structures grew faster than those territories where this process was less impressive. In contrast, from 1900 onwards, it started a tendency towards the stabilization of regional income per capita inequality levels, propelled by the progressive convergence in economic structures of Spanish regions (Rosés et al., 2010). The estimated negative relationships between structural change values in 1900 and regional economic growth during the period 1900-1930 fall in line with this kind of narrative.

Table 2. Regional Growth Regressions (IV, GMM)

Variables	(1)	(2)	(3)	(4)
Initial per capita GDP	-0.798***	-0.819***	-0.808***	-0.829***
Literacy rate	0.853***	0.940***	0.682**	1.062***
Number of patents per capita	0.733***	0.666***	0.797***	0.654***
GVA in mining	-0.012*	-0.015**	-0.008	-0.017**
Share of manufacturing in total employment	-5.151***	-3.999***	-5.279***	-4.035***
Total stock of infrastructures	0.130	0.184*	0.173*	0.182*
Relative market potential	0.369***			
Relative market potential without self-potential		0.395**		
Relative domestic market potential			0.290*	
Relative foreign market potential				0.229**
Regional fixed-effects	Yes	Yes	Yes	Yes
First stage, Uncentered R^2	0.950	0.926	0.983	0.868
First stage, F-test (p-value)	24.15 (0.000)	17.39 (0.000)	19.48 (0.000)	17.50 (0.000)
Hansen J statistic (p-value)	0.598	0.421	0.012	0.524
Uncentered R^2	0.714	0.663	0.774	0.665
Observations	141	141	141	141

Note: Dependent variable: Per capita GDP growth rate (ln scale). All variables in logarithmic scale, except rates and relative market potentials. Significant at the *10%, **5%, ***1% level. All the specifications include a constant.

The IV results confirm the positive effect of initial market potential on per capita GDP growth. The estimated coefficients of the four measures of market potential are significant and positive, and the estimated values are not very different (around 0.3), although there are

small differences. The greater coefficient corresponds to the relative market potential excluding self-potential, 0.395, although that value is not far from that of the relative market potential (0.369). The result is noteworthy as the regression using the market potential that excludes each province's self-potential should be especially robust, because by excluding the self-market of the region we avoid some potential endogeneity and simultaneity concerns.

Interestingly, the coefficient associated to the domestic market potential variable shows a higher value than that obtained for the foreign market potential, being both significant. This result has to be analyzed in the context of the implementation by successive Spanish governments of a protectionist trade policy since the late 19th c., and its reinforcement up to the 1920s, as explained in section 2. As protectionism was consolidated, the domestic market potential became more relevant than foreign markets as a driver of regional per capita growth rates. This result confirms the evidence obtained in previous analyses of the industrial sector in Spain during the interwar years (Tirado et al., 2013).

6.- Conclusions

Regional income inequality shows a persistent pattern in apparently well integrated economies such as the European Union. In fact, as it has been pointed out in the introduction, although income differences across Member States have fallen over the past fifteen years, inequalities between regions within each Member State have persisted. So, albeit a great amount of resources have been devoted to reduce this divergence, regional inequality is still a matter of concern for European policy-makers. In these circumstances, we have pointed out that the empirical analysis of the determinants of regional income inequality in the long lasting experiences of growth and integration, internal and external, of national economies could be of great help to understand the determinants of the differences in economic growth across territories.

From a theoretical point of view, international and regional economics have explained income disparities on the basis of differences between regions in their endowments of natural resources, factors of production, infrastructure, or technology. In this context, the removal of obstacles to the movement of goods and/or factors would by itself cause

convergence of factor returns and living standards. However, as it has been posed by New Economic Geography literature (henceforth, NEG) there are relevant forces missing from the traditional analysis, which can affect regional disparities -even without large differences in underlying characteristics- and prevent convergence. NEG theoretical models suggest that the interaction between transport costs, increasing returns and size of market under a monopolistic competition framework can lead to spatial agglomeration of economic activity and to the upsurge of income differences across regions (Krugman, 1991).

In order to contribute to this empirical debate, in this paper we analyze the determinants of regional inequality in Spain during the period 1860-1930. We believe that the Spanish experience could be an illustrative case of study for, at least, two reasons. On the one hand, in Spain more than 150 years of economic and political integration have not been followed by the disappearance of per capita GDP differences across regions. On the other, this kind of long term analysis would consent us to examine whether the effects of the factors highlighted by NEG models (market access) on regional economic growth were relevant during the first stages of economic growth and the process of integration of the Spanish national market.

For doing that, first, we make use of an empirical model that, following Ottaviano and Pinelli (2006), allows to analyze in the same framework the role played by the different factors highlighted both by Solow-type growth and NEG literature on regional Spanish economic growth in the long term. Second, we use the new evidence on regional Spanish per capita income and on market potential for the years 1860-1930 offered by Rosés et al. (2010) and Martinez-Galarraga (2013), respectively. To complete our dataset, we have also gathered the data commonly used in growth regressions in order to identify the main forces explaining regional growth in Spain between 1860 and 1930.

Overall, the results of the empirical analysis indicate that geography matters when explaining regional asymmetric growth, especially during the period 1900-1930. During the second half of the 19th century agriculture was still the predominant sector in the Spanish economy and industry had developed only in a limited number of regions. Nevertheless, our results show that since the beginning of the 20th century NEG forces, through market potential, had a

positive influence on provincial growth differentials even when the proximate causes of growth are controlled for. The emergence of agglomeration forces would be the outcome of the interaction between increasing returns to scale and transport costs once the Spanish industrialization proceeded during the second half of the 19th century, the completion of the railway network and the subsequent reduction in the transport costs, propelled the integration of the Spanish economy.

Our results can also be analyzed in a context where the evolution of regional inequality depends on the magnitude of the impact of structural change and agglomeration forces. While the second half of the 19th century was characterized by the upswing of regional inequality due to increasing provincial differences in structural change, the first decades of the 20th century witnessed a stabilization of per capita income disparities. This period of history was characterized by a convergence in the economic structures of Spain's provinces as industrialization spread to more territories. This evolution counterbalanced the tendency to agglomeration unleashed by the presence of NEG-type mechanisms. In addition, the protectionist turn of the Spanish trade policy since the late 19th century, favoured the role played by the domestic market as a factor explaining differences in the economic growth of regions.

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Appendix 1.- The theoretical model

This section reproduces Ottaviano and Pinelli (2006). Their NEG model is obtained by extending the set-up of Redding and Venables (2004) by introducing labour mobility and land à la Hanson (1998) and Helpman (1998). The economy consists of *i=1,…, R* regions. On the demand side, in region *j*, the representative worker consumes a set of horizontally differentiated varieties and land services ('*housing*'). Her utility function is:

$$U_j = \left(X_j\right)^{\mu}\left(L_j\right)^{1-\mu},\ 0 < \mu < 1$$

where *Lj* is land consumption and

$$X_j = \sum_{i-1}^{R}\left\{\int_0^{n_i}\left[x_{ij}(z)\right]^{\frac{\sigma-1}{\sigma}}dz\right\}^{\frac{n-1}{n}} = \sum_{i-1}^{R}\left(n_i x_{ij}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{1-\sigma}}$$

is a CES quantity index of the $\sum_{i-1}^{R} n_i$ varieties available in region *j* with *xij* labelling the consumption in region *j* of a typical variety produced in region *i*. The associated exact CES price index is:

$$P_j = \sum_{i-1}^{R}\left\{\int_0^{n_i}\left[p_{ij}(z)\right]^{\frac{1-\sigma}{1}}dz\right\}^{\frac{1}{1-\sigma}} = \sum_{i-1}^{R}\left(n_i {p_{ij}}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

where p_{ij} is the delivered price in region *j* of a typical variety produced in region *i*. In the above expressions, the second equality exploits the fact that in equilibrium quantities and prices are the same for all varieties produced in country *i* and consumed by country *j*. Utility maximization gives the demand in *j* for a typical variety produced in *i*:

$$x_{ij} = p_{ij}^{-\sigma} E_j P_j^{\sigma-1} \qquad \text{(A1)}$$

where E_j is expenditures on X_j, which is a fraction μ of income I_j, while σ>1 is both the own and the cross price elasticity of demand. On the supply side, each variety is produced by one and only one firm under increasing returns to scale and monopolistic competition. In so doing, the firm employs labour, land and, as intermediate input, the same bundle of differentiated varieties that workers demand for consumption. Specifically, in region *i*, the total production cost of a typical variety is:

$$TC_i = P_i^{\alpha} r_i^{\beta} w_i^{\gamma} c_i (F + x_i), \ \alpha, \beta, \gamma > 0, \ \alpha + \beta + \gamma = 1$$

where x_i is total output, r_i and w_i are land rent and wage, while c_i and $c_i F$ are marginal and fixed input requirements respectively.[16] Trade faces iceberg frictions: for one unit of any variety to reach destination when shipped from region *i* to region *j*, τ_{ij}>1 units have to be shipped. Hence, $x_i = \sum_{j-1}^{R} x_{ij} \tau_{ij}$. Firm profit maximization yields the standard CES mark-up pricing rule:

$$P_i = \frac{\sigma}{\sigma - 1} P_i^{\alpha} r_i^{\beta} w_i^{\gamma} c_i, \ P_{ij} = \tau_{ij} p_i \qquad \text{(A2)}$$

Free entry then implies that in equilibrium firms are just able to break even, which happens when they operate at scale $\bar{x} = (\sigma - 1)F$. Together with (A1) and (A2), that allows us to write the free entry condition in region *i* as:

$$(FE)\bar{x}\left(\frac{\sigma}{\sigma - 1} r_i^{\beta} w_i^{\gamma} c_i\right)^{\sigma} = MA_i SA_i^{\frac{2\sigma}{\sigma - 1}}$$

where $MA_i = \sum_{j-1}^{R} \tau_{ij}^{1-\sigma} E_j P_j^{\sigma}$ is the 'market access' of region *i*. This is a measure of customer competitor proximity ('*demand linkages*') that predicts the quantity a firm sells given

[16] In the cross-country study by Redding and Venables (2004), the parameter c_i is allowed to vary to capture Ricardian productivity advantages across countries. This interpretation is hard to defend within the same country, so its variation across regions will be interpreted as the outcome of localized technological externalities. These will be introduced as controls in the empirical analysis.

its production costs. The term $SA_i = P_i^{1-\sigma} = \sum_{j-1}^{R} n_j P_j^{1-\sigma} \tau_{ji}^{1-\sigma}$ is, instead, the 'supplier access' of region *i*, a measure of supplier proximity. This inversely predicts the prices a firm pays for its intermediate inputs ('*cost linkages*') and a worker pays for her consumption bundle ('*cost-of-living linkages*') when located in a certain region. Workers work and consume in the region where they reside and can pick their residence freely. This implies that in equilibrium they are indifferent about location as they would achieve the same level of indirect utility *V* wherever located. Given the chosen utility, if it is further assumed that the land of a region is owned by locally resident landlords, free mobility then gives:[17]

$$(FM)\ \frac{w_i}{SA_i^{\frac{\mu}{1-\sigma}} r_i^{1-\mu}} = V$$

After log-linearization, conditions (*FE*) and (*FM*) are depicted in Fig. A1, which measures the logarithm of regional nominal wages (*w*) along the vertical axis and the logarithm of regional land rents (*r*) along the horizontal one. Downward sloping lines are derived from (*FE*) and depict the combinations of wages and rents that make firms indifferent about regions. Their downward slope reflects the fact that firms can break even in different regions provided that higher wages correspond to lower rents and vice versa. Upward sloping lines are derived from (*FM*) and depict the combinations of wages and rents that make workers indifferent about regions. Their upward slope reflects the fact that workers can achieve the same utility ('*real wage*') in different regions provided that higher rents correspond to higher wages and vice versa.

The exact positions of the two lines depend on regional market access and supplier access. Better market access (larger *MA*) shifts FE up, increasing both wages and land rents. Better supplier access (larger *SA*) shifts both *FE* and *FM* up, also increasing rents. The effect on wages is, instead, ambiguous: they increase (decrease) if the shift in *FE* dominates (is dominated by) the shift in *FM*. This theoretical ambiguity makes it pointless to try to

[17] This assumption is made only for analytical convenience. What is crucial for what follows is that the rental income of workers, if any, is independent of locations and, thus, it does not affect the migration choice. The alternative assumptions of absentee landlords or balanced ownership of land across all cities would also serve that purpose.

disentangle the effects of *MA* and *SA* on equilibrium wages and rents. What we can do, instead, is to check whether their combined effect is indeed positive on rents as predicted by the model. In addition, we can use information about migration flows. Since land values capitalize the attractiveness of a place, land rents rise also because immigration increases the demand for land. More interestingly, we can also check whether the combined effect of MA and SA is positive or negative on wages, which would point at a dominant impact on firms (point B) or on workers (point C), respectively. Demand and cost linkage would dominate in the former case, cost-of-living linkages in the latter.

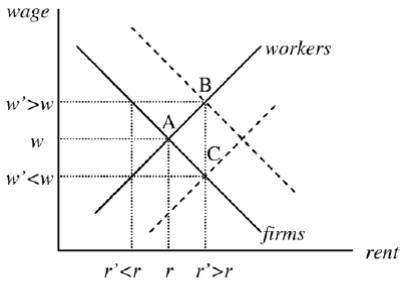

Fig. 1. The geographical equilibrium.

Growth regressions

The discussion in the previous section suggests identifying the combined effects of MA and SA on productivity and amenity through their impacts on the levels of wages, rents and migration flows using panel techniques. However, for the Spanish case, only the combined effects of MA and SA on the level of wages are going to be studied. Under the assumption that regions have been fluctuating around a balanced growth path (BGP) during the observed period, the panel estimation of those impacts can be interpreted as their long-run effects along the BGP. Thus, we estimate standard growth regressions over a set of explanatory variables including some measure of market and supplier access:

$$\ln(w_t) - \ln(w_{t-1}) = \alpha + \beta \ln(w_{t-1}) + \gamma \ln(access_{t-1}) + \delta \ln(controls_{t-1}) + \varepsilon_t \qquad \text{(A3)}$$

where the growth rate of regional wages (pcGDP) on the left hand side is regressed on its initial value and other 'initial conditions' including our measure of accessibility, market potential.

Appendix 2.- Regression variables: Data and sources.

Regional performance measures

Data on Spanish GDP at a NUTS3 level of aggregation between 1860 and 1930 come from Rosés et al. (2010). Population by province is obtained from Population Censuses.

Explanatory variables

Proximate sources of growth

a) Physical capital. The regressions include the initial level of per capita GDP to control for decreasing returns to capital accumulation.

b) Human capital. The stock of human capital in each province is proxied by data on literacy rates coming from Núñez (1992).

c) Knowledge capital. The stock of knowledge capital is measured by the number of patents per capita. Unfortunately, only the number of patents registered at a NUTS2 level of aggregation based on the information provided by Sáiz (2005) is available. Therefore, NUTS2 data have been applied to each one of the provinces within each NUTS2 region. Data on population are again collected from the Population Censuses.

d) Infrastructures. In order to capture the provincial stock of infrastructures, two alternative measures are used: the total stock of infrastructures and the infrastructure density of the Spanish provinces. This information is provided by Herranz (2008). Infrastructure's density is measured as the provincial stock of infrastructures per square km. Data on the provinces' area comes from www.ine.es.

Structural change variables

e) Gross Value Added in mining comes from Rosés et al. (2010).

f) Regional Share of manufacturing in total employment comes from Rosés et al. (2010).

Market Access or Second Nature Geography

g) Market Potential. In this case we make use of alternative measures of regional Market Potential based in the variable construction described above and Martinez-Galarraga (2013).