Department of History and Civilization

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HEC No. 2000/2

EUI WORKING PAPERS

EUROPEAN UNIVERSITY INSTITUTE

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

DEPARTMENT OF HISTORY AND CIVILIZATION

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BADIA FIESOLANA, SAN DOMENICO (FI)

Printed in Italy in November 2000
European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

Economic integration and industrial location

The case of Spain before WWI*

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* The authors gratefully acknowledge Carles Sudrià's useful comments and suggestions. They also thank participants at the research seminar of the Departament d'Història i Institucions Econòmiques, Universitat de Barcelona, especially Ramon Ramon. Part of this research has been carried out while Daniel Tirado enjoyed a research stay at the European University Institute thanks to financial support from the Spanish Ministry of Education and Culture, under grant SM1999-0004.The authors also thank CICYT for the grants under projects PB98-1187 and SEC99-0432.

Abstract

During the second half of the nineteenth century, Spain's industrial geography changed radically. In Jordi Nadal's words, 'Catalonia became Spain's factory'. This process of geographical concentration of industrial activity took place while Spain was becoming an integrated economy. The purpose of this paper is to analyse the determinants of the localisation of industrial activity in Spain during the second half of the nineteenth century and the effects of economic integration in Spain's industrial geography. To this end, we first review the historical analysis of these changes. Second, we summarise the theories that explain industrial location patterns. Third, we construct different measures of industrial specialisation and geographical concentration. And finally, we perform an econometric analysis of the determinants of industrial location at two points in time, 1856 and 1893, using the techniques of spatial econometrics. Our results are consistent with trade theories. During the second half of the XIX century, Spain becomes an integrated economy, labour and capital mobility are favoured and hence, relative differences in factor endowments lose importance in explaining the pattern of industrial concentration. On the contrary, economic integration increased the importance of scale economies and proximity to the market as forces favouring the agglomeration of economic activities.

1. Introduction

During the second half of the nineteenth century, Spain's industrial geography changed radically. In Jordi Nadal's words, 'Catalonia became Spain's factory'.[1] This process of geographical concentration of industrial activity has been analysed often by economic historians. Nevertheless, an empirical analysis of the determinants of industrial location or its possible changes during this period is still lacking.

At the same time, the major changes in the industrial map of Spain occurred while the majority of peninsular markets were becoming interconnected by the rail network. Therefore, it seems reasonable to assume that this increased economic integration could have contributed to their genesis. From this perspective, this historical analysis is directly linked to a current theoretical and empirical debate, that of the effects of economic integration in the EU on the continent's industrial geography.

Integration implies a reduction in transaction costs between different economies which could, theoretically, change their productive specialisation. However, the various theoretical arguments that compete to offer an explanation of the determinants of productive specialisation, do not share a common vision of the direction of the changes in the geographical concentration of activities caused by economic integration. In view of this absence of a theoretical definition, the study of historical examples, like the Spanish industrialisation in the second half of the nineteenth century, constitutes a way of evaluating the empirical consistency of the predictions of the different theoretical models. An analysis of this kind considers in a broad sense the consequences of a process of economic integration.

Therefore, the article seeks first to identify the determinants of the localisation of industrial activity in Spain during the second half of the nineteenth century, second, to

determine whether there were relevant changes in the relative importance of the factors that explain industrial location during the period analysed, and finally, to study the effects of economic integration on Spain's industrial geography.

With this aim in mind, the paper is organised as follows. Firstly, we review the evidence on the Spanish market integration during the second half of the nineteenth century and the historical analysis of the determinants of industrial localisation in Spain. Secondly, we summarise the theories that explain industrial location patterns and we analyse the implications of these theories concerning the effects of economic integration in the geographical concentration of industries. Thirdly, we carry out an empirical analysis of the changes in Spanish industry during the period 1856-1893. In particular, we calculate activity concentration indices by sectors and specialisation and industrial intensity indices by regions. Fourthly, we perform an econometric analysis of the determinants of industrial location at two points in time: the first, 1856, prior to the construction of the railways and hence, prior to the Spanish market integration; the second, 1893, when the railway network was established. From the comparison of the results obtained for each year, we obtain indirect evidence of the changes in the determinants of productive localisation caused by integration. Finally, we summarise the main conclusions.

2. Economic History: the facts

The analysis of the geographical localisation of the Spanish industry during the nineteenth century has evidence both conclusive and synthetic. In a study published in 1987, Jordi Nadal, relying on fiscal data, presented industrial intensity indicators for all the Spanish regions in 1856 and 1900.[2] The results of this exercise were very clear: excluding Navarra and the Basque Country, in 1856, Catalonia and Andalusia were far

above the Spanish industrial intensity average.[3] In 1900, the Spanish industrial map was even more polarised: Catalonia's industrial intensity more than doubled the average Spanish figure. Of the other regions, only Valencia had a share in the Spanish industrial product that was proportional to its total population.[4] Catalonia was Spain's factory.

Although Nadal's work explained the changes in industrial sectors that coexisted with this evolution in the contribution of each region to total industrial production, he left some questions open. Firstly, the analysis of two points in time does not provide a clear vision of the dynamics of the process. Secondly, the growth in the relative share in total production of some regions does not necessarily mean an increase in the geographical concentration of industrial activity.

Nadal's own work and that of other researchers like Carreras, Prados de la Escosura and Maluquer de Motes, presented provisional answers to the first question posed.[5] Nadal offered data about Catalan industry's share in total Spanish industrial production. Carreras, Prados and Maluquer produced indices of industrial production for Spain and Catalonia. With these data, we can represent a vision- albeit slightly biased- of the evolution over time of Catalan industry's weight in total Spanish industrial production.[6] We present the results of this exercise in graph 1. The image reflected is very clear: Catalonia's weight in total Spanish industrial production grew continuously from the end of the 1860's to the beginning of the 1890's. From here on the process seems to stop, and the share of Catalan industry in the Spanish total in 1913 was not very different from the level observed in 1893.

But does this evidence confirm the increase in the geographical concentration of industry? In this respect, the appraisals of economic historians are unanimous. Regional histories emphasise the industrial stagnation of the majority of Spanish territories during the second half of the nineteenth century.[7] The only exceptions are Catalonia and the

Basque Country. Hence, in relative terms, Spanish industry was concentrated in these regions. Sánchez Albornoz summarised this situation clearly: the industrialisation of the periphery put a brake on the industrialisation of central regions such as Castile.[8] Later on, we will present evidence that proves this perception.

Economic history has also given arguments that help to understand the causes of this process. In general, there are two kinds. The first points to the locational advantages maintained by Catalonia at the beginning of the period analysed. The second class appraises the elements that played an important role in increasing the advantage held by Catalonia over the rest of the Spanish regions.

As has been pointed out, Catalonia based her relative advantage in the industrial sector in processes whose roots were submerged in the past. Colonial trade had generated capital, basic in a sector which, unlike the agrarian sector, was capital intensive.[9] However, the existence of this commercial capital did not ensure the development of an incipient manufacture in consumer goods. The development of consumer goods production in the eighteenth century was made possible by the fairly equal Catalan income distribution which allowed the benefits of the export-oriented agriculture to be spread among a large human group.[10] The potential market for this manufacture was thus larger in Catalonia than in other regions. At the time, consumption in the rest of the state was not the most important component in the manufactured goods' demand, probably, because of the high transportation costs.[11] From this perspective, it has been noted that the success of Catalan manufacturing in the 1700s permitted a factor accumulation (in qualified labour or in experience in the distribution and commercial network), which was to be key in the generation of the region's comparative advantages in industrial production in the 1800s.[12]

These initial advantages were reinforced by the technical and institutional progress of the second half of the nineteenth century. On the one hand, the Spanish internal market became increasingly integrated due in part to the construction of the railway.[13] Technical improvements in maritime transportation came later than in other countries and their impact was less marked; nonetheless, they also contributed to the reduction of the economic distance between the regions.[14]

Furthermore, institutional changes in the money and banking sectors may also have contributed to the reduction in the transaction costs even though historiography has not emphasised the effects of these changes in market integration. In this regard, the unification of the monetary system around the peseta and the establishment of the Bank of Spain in all provincial capitals, together with the transfer system established by this central bank after 1885, should also be considered in the analysis of the Spanish market integration.[15]

The results of this process leave economic historians in little doubt. Both the analysis of the volume of trade between Spanish regions and the analysis of price fluctuations between different locations confirm the growth in the integration of the Spanish market during this period.[16] The potential market of the industrial regions had increased; Catalan industry was able to take over the traditional markets of the weak Castilian, Aragonese, Galician and Andalusian manufactures.[17]

Technological change and industrial diversification also contributed to this process. New technologies allowed a better exploitation of scale economies. Diversification in the industrial structure meant the relative growth of sectors in which these economies were more important, and the consolidation of agglomeration economies that favoured the formation of industrial districts.[18] In these circumstances,

the key to understanding the relative increase in the concentration of Spanish industry in Catalonia lies in the region's initial advantage.

Catalan industrialisation in the nineteenth century could be analysed as a paradigmatic example of a cumulative causation process in which historical factors favoured the initial industrialisation in one region and, once the process is underway, scale economies and sufficiently low transport costs consolidated this region's initial advantage. Eventually, the region ends up concentrating the majority of industry.

In the following sections, we analyse this hypothesis derived from the historians' appraisals. To do so, we first clarify which variables are relevant in the analysis of industrial location from a theoretical point of view and in particular discuss the implications of economic integration on industrial location according to each theory.

3. Economic integration, productive specialisation and concentration of industrial activity

Classical international trade theory explains trade between countries or regions in terms of differences in their underlying characteristics (factor endowments in the Heckscher-Ohlin model, technology in the Ricardian model). In this context, economic integration leads regions to specialise according to their comparative advantage. Differences in resource endowments or in technology account for the unequal localisation of industrial activity.

However, in the Heckscher-Ohlin model, the assumption of factor immobility is crucial. So, if interregional factor mobility increases, interregional differences in resources decrease and, consequently, the growing similarity between regions will reduce their specialisation. In other words, if there are no underlying differences in

resources or technology between regions, classical models of trade, characterised by constant returns to scale and perfect competition, predict an even distribution of economic activities across space. But this prediction is not borne out by reality. In fact, regions that are similar in terms of factor endowments often have very different production structures. Therefore, there must be other forces that favour industrial specialisation and explain the magnitude of economic geographic concentration that exists in the real world.

In the context of the regional development theory of the 1950's, Myrdal and Hirschman furnished the intuitive idea that explains these larger geographical economic inequalities. On the one hand, cumulative causation theory (Myrdal 1957) criticises the idea of equilibrium implicit in the theory of international trade and considers that the play of the market forces does not work towards equality in the retributions to factors of production and incomes. In this theory, economic development is a process of circular and cumulative causation which tends to favour regions that are already well endowed and thwart those lagging behind. Backwash effects will outweigh spread effects and therefore growth in one region will have backsetting effects in less developed regions. Hirschman (1958) uses a similar analytical structure to study the process of development. In his analysis, development needs to be geographically polarised in its early stages, concentrated in 'growing points'. Polarisation effects and trickling down effects are the equivalent to Myrdal's backwash and spread effects but Hirschman does not consider that negative effects will necessarily surpass positive effects. So in his view, government needs to encourage unbalanced growth, targeting development efforts on key industries with strong linkages to other parts of the economy. These inducement mechanisms that explain the concentration of industrial activity are of two kinds: backward linkages, and forward linkages. Backward linkages or demand effects appear

because every non primary economic activity will induce attempts to supply the inputs needed in that activity through domestic production. Forward linkages or cost effects on the other hand appear because every activity that is not exclusively devoted to final demand will induce attempts to utilise its outputs as inputs in some new activities.

Thus, the economic development theory of the 1950's brought the idea that strategic complementarity had a key role in the process of development.[19] External economies arise from a circular relation in which the decision to invest in large scale production depends on the size of the market, and the size of the market depends on the investment decision.

More recently, the so-called 'new economic geography' has formalised these cumulative causation mechanisms[20]. This field, pioneered by Paul Krugman and Anthony J. Venables, emerged in the 1990s as an evolution of the new trade theory of the previous decade, which makes use of the ideas such as linkages and cumulative causation processes analysed by the regional development theory, and offers an acceptable explanation for the large inequalities observed in the spatial distribution of economic activity.

First, the new trade theory of the 1980s offered a new explanation for the existence of trade and gains from trade. Scale economies give countries an incentive to specialise and trade even in absence of differences in their technology or factor endowments. Equilibrium in these models is affected by market size: a larger market would allow the survival of more firms than a smaller market. These models therefore have a locational implication derived from this home market effect, which is the tendency to concentrate production near large markets.

The problem of new trade theory models is that they assume from the beginning the existence of both large and small markets but do not explain this initial division. The

evolution of these models towards a formalisation of the cumulative causation mechanism which explains the existence of agglomerations has given rise to a new field: "new economic geography". In "new economic geography" models, trade costs and increasing returns interact in a monopolistic competition framework to explain the settlement of industrial agglomerations. The mechanisms that give rise to the endogenous formation of centre-periphery structures are the centripetal forces, the forward and backward linkages that reinforce an industrial agglomeration once in place. In regional models such as Krugman (1991), labour mobility acts as the destabilising force that generates the linkages involved in the cumulative causation process. In an international context, as in Krugman and Venables (1995), where barriers to labour mobility might limit the role of migration, input-output linkages between firms create the tendency for manufacturing agglomeration à la Hirschman. When input-output linkages between firms in the same sector are stronger than between firms in different sectors, economic integration leads each country to specialise in the production of one sector, as in Krugman and Venables (1996).

Therefore, both the determinants of industrial specialisation and location and the effects of economic integration in the concentration of activity are different in each of these theories. According to traditional trade theory, differences in relative factor endowments or technology give rise to comparative advantages in the production of some goods and hence allow us to explain industrial specialisation and location. However, economic integration, by facilitating factor mobility or technological diffusion, can reduce the advantages arising from factor endowments or technological differences, favouring a more even geographical distribution of economic activity. In contrast, new trade and new economic geography theories emphasise the importance of scale economies and proximity to large markets as determinants of industrial

specialisation and location. According to this view, greater economic integration, by favouring resources mobility and access to large markets, might generate a larger specialisation and geographical concentration of industrial activity, offering an adequate explanation for the formation of large industrial agglomerations.

4. Industrial concentration and location in Spain

In the following section, we present a first characterisation of the patterns of location and concentration of Spanish industry during the second half of the nineteenth century. First, we analyse the Gini indices of geographical concentration in 1856 and 1893. These indices give, for each sector, a measure of the inequality in the regional distribution of the production with respect to what would be a homogeneous distribution of the activity in the territory.[21] The Gini index varies in the interval [0,1] and can be represented graphically through the Lorenz curve because it corresponds to twice the area between the Lorenz curve or the 45° line which represents perfect equality. If industrial production were distributed equally among the different geographical areas, the index would take the value 0. In contrast, in the case of maximum inequality, that is, when all activity is concentrated in a single region (province in our case), the index would take the value 1.

In table 1, we present the Gini indices for each of the 9 sectors in which we have disaggregated industrial activity at the two points in time. We also present a global Gini for the industry as a whole. These results bear out the hypothesis of the historiography. In 1893, the most geographically concentrated sector was the textile industry, the least geographically concentrated were the food and the china, glass and ceramics sectors. However, the principal conclusion we can derive from the calculation of this index is

that there is a considerable increase in geographical concentration between the two points in time considered. If we observe the sectors individually, we can see how in all of them (except paper, and wood and cork) the geographical concentration of activity increases in the period analysed.

Table 1

Gini indices of geographical concentration of industry (1856 and 1893)

	1856	1893
Food	0.34	0.43
Textiles	0.80	0.91
Metallurgy	0.71	0.79
Chemistry	0.63	0.66
Paper	0.76	0.71
China, glass and ceramics	0.48	0.54
Wood and cork	0.86	0.72
Tanning and leather	0.61	0.70
Others	0.71	0.79
GLOBAL	0.44	0.61

Source-See appendix

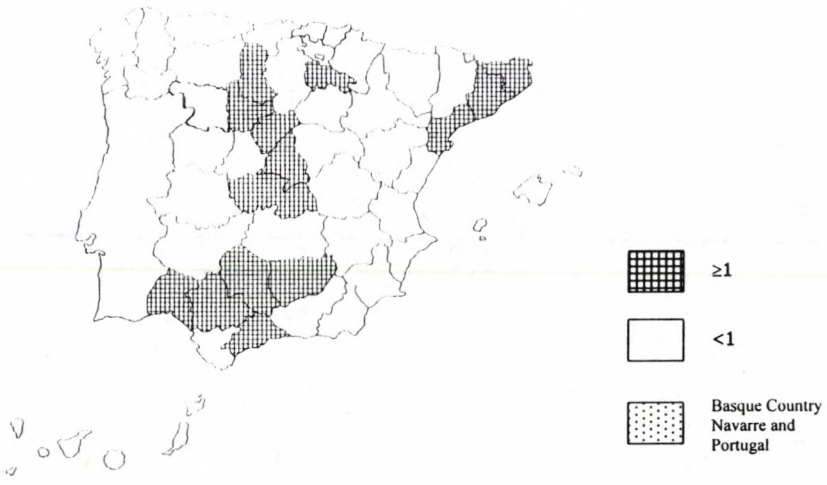
Secondly, we calculated the same kind of indicator at the provincial level, in order to analyse the activity concentration by sectors in each province.[22] The comparison between 1856 and 1893 will offer us a measure of the evolution of sectorial specialisation in each province. The results of this exercise are not homogeneous, even though, in general terms, they show a reduction in the province's industrial specialisation. In other words, the values taken by the Gini index confirm the historiographical perception of a process of diversification experienced by Spanish industry during this period.

Finally, we analysed another key aspect in the study of territorial distribution of activities: the degree of industrial specialisation of the provinces. To this end, we define an index of industrial specialisation or intensity for each province. This index is calculated as the ratio between the proportion of industrial activity that takes place in each territorial unity and the proportion of total population living in this unit.[23] Hence,

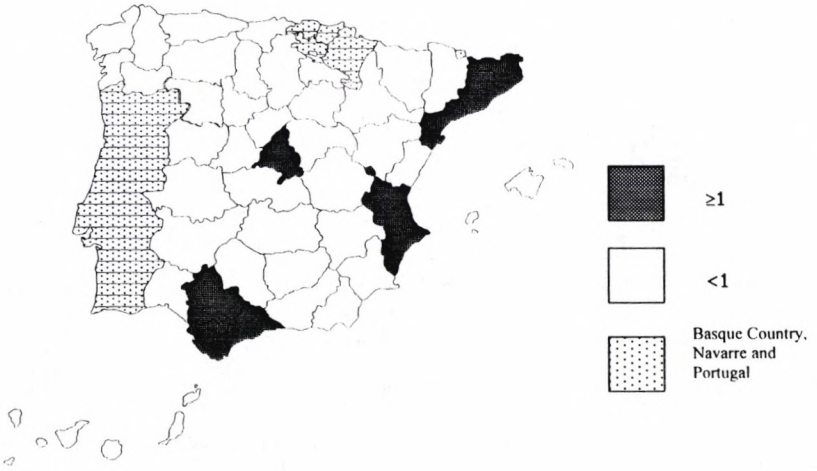
an index larger than one indicates that the province is specialised in industry, i.e., the relative weight of industrial activity is larger than that of the population. In contrast, an index of less than one would indicates that the province is not specialised in industry. In maps 1 and 2 we present the geographical distribution of the provinces with industrial specialisation indices larger than one in 1856 and 1893, respectively.

Map 1

Industrial specialisation indices in 1856



Map 2
Industrial specialisation indices in 1893



From the results obtained we can derive some conclusions. If we compare the indicator values at the two points in time, we observe how the number of provinces that present industrial specialisation diminishes considerably between 1856 and 1893. In 1856, 14 observations were larger than one, compared with only 9 in 1893. Secondly, there is a marked increase in the value of the indicator for the province of Barcelona between 1856 and 1893. This province already showed intense industrial specialisation in 1856 (3.79), but in 1893 the index had risen to 6.01.

If we analyse the provinces with above average industrial intensity in 1893, we can make some further comments. On the one hand, we see that all industrial provinces, except Madrid and Seville, belong to the maritime periphery. On the other, we note that 3 out of 4 Catalan provinces have indices larger than one. In the fourth, Lleida, industrial intensity increased considerably between our two dates. In addition, in 1893, the provinces with an industrial intensity larger than one appear grouped in supraprovincial regions or industrial specialisation poles.

Summarising, this period is characterised by a growth in the distance between industrial and agrarian Spain. The industrial map drawn reflects the intuitions of historiography. Castile became an industrial desert. In contrast, Catalonia was Spain's factory.

5. The determinants of Spain's industrial map

This section presents an empirical study of the determinants of the industrial map drawn by the industrial specialisation indices by provinces analysed in the previous section. The analysis is centred on two points in time. The first, 1856, corresponds to a period in which, although the initial advantage of certain regions was already established, the process of economic integration that might cause a change in industrial location, had not yet begun.[24] The second, 1893, was selected because it allows us to analyse the determinants of location after the first impact of the integration of the market. If we observe figure 1 and the Gini indices of geographical concentration in 1907 shown in table 2, we can conclude that neither the relative size of Catalan industry nor the geographical concentration of Spanish industry underwent significant changes with respect to the map drawn in 1893.

Table 2

Indices of geographical concentration by sectors (1907)

Food	0.44
Textiles	0.92
Metallurgy	0.78
Chemistry	0.69
Paper	0.69
China, glass &ceramics	0.58
Wood and cork	0.67
Tanning and leather	0.70
Others	0.78
GLOBAL	0.61

Source- See Appendix

The explanatory variables chosen proxy for industrial characteristics which, according to the trade theories summarised in section 3, might influence industrial location. We constructed the same variables for both periods.[25] The first two, POBPROV and ALFAB, attempt to capture the comparative advantage based on factor endowments which, according to the Heckscher-Ohlin model, explains the pattern of specialisation of different territories. The first of these two variables reflects the share of each province in the total Spanish population. If we consider capital to be completely mobile between Spanish provinces, population size would indicate each province's deviations with respect to non-qualified labour endowment. If we consider the industrial sector to be less intensive in non-qualified labour than the alternative sector (i.e. the agrarian sector), we would expect a negative relationship between this variable and the level of industrial specialisation.

ALFAB captures the relative endowment of an accumulative factor, human capital. If we assume that industry uses this factor more intensively than agriculture, the theory predicts a positive relationship between the region's relative endowment in this factor and industrial specialisation. Empirically, we sought to capture this effect through the share of the literate population in each province's total population.

The variables EXPEN, ICENTM and SCEC consider elements linked to the new trade and the new economic geography theories. The first of these variables proxies the relative size of the provincial market. The second is a province's centrality index analysed with respect to the Spanish market. Both variables relate positively the province's industrial intensity with its own market or the domestic market, in the latter case considering the geo-economic position occupied by the province in the Spanish economy. As both variables capture common elements, they are not entered jointly in the estimated equation. The last of these three variables, SCEC, attempts to capture the advantages derived from provincial specialisation in sectors characterised by a relatively larger plant size. These sectors will benefit more from the scale economies linked to large scale production. For this reason, we expect a positive relationship between this variable and the region's industrial specialisation. However, by construction, the variable also absorbs the existence of technological differences in the production of the same type of good between the different Spanish provinces and, hence, may also capture Ricardian elements present in the genesis of advantages.[26]

The estimated equation has the following form:

$$LCONLOC_{it} = C_t + \beta_1 LPOBPROV_{it} + \beta_2 LALFAB_{it} + \beta_3 LSCEC_{it} + \beta_4 LTAMERC_{it} + u_{it}$$

where LCONLOC is the industrial specialisation index defined in the previous section. The estimated market size variable (LTAMERC) is alternatively LEXPEN or LICENTM. All the variables are considered in logarithms, as is usual in this kind of exercise.

In addition, in the estimation process, we have sought to consider the position occupied by the different provinces in the space. That is, we analysed whether the spatial distribution of the variables is merely random or responds to a pattern of

autocorrelation or spatial dependence. The presence of spatial autocorrelation has important consequences for some of the inferences obtained using a classical econometric methodology, and may indeed invalidate them. The OLS estimators will be unbiased but inefficient and the inference based on the individual parameter's significance tests will be biased and will affect the use of different specification tests such as the heteroscedasticity test (Anselin and Griffith, 1988 and Mur, 1999).

In order to analyse the presence of spatial autocorrelation in the variables, first, we calculated the Moran I and Geary C statistics.[27] Under the null hypothesis, these statistics reveal a random distribution of the variables in the space. To make these calculations, we define a contact's matrix (W) showing the interactions or spatial dependence between the different provinces. For each element in the space, this matrix indicates the subset of elements characterised by the possible existence of mutual dependence relationships. For the analysis performed in this paper, we used a contact's matrix based on the inverse of the squared distance between each province's capital.

The results obtained are shown in table 3. If we were to reject the null hypothesis of a random distribution in space of the variables considered, we would have evidence of spatial autocorrelation, i.e. the value taken by these variables in one province is affected by the value they take in the geographically closest provinces.

The values obtained performing these tests indicate that in 1856 the variables LALFAB and LSCEC show spatial dependence. We reject the null hypothesis with a 10% significance level in the case of the LPOBPROV variable, only in the c-Geary test. On the other hand, in 1893, we find evidence in favour of the spatial dependence hypothesis for all variables except population. These results, especially for 1893, indicate the existence of spatial interdependence between the provinces considered. So, it is necessary to consider this non-random distribution of the series analysed in estimating

the equations proposed for the study of the patterns of activity location in Spanish provinces during the second half of the nineteenth century.

Table 3
Spatial autocorrelation tests

	1856	
Variables	Moran I	Geary c
LCONLOC	1.55	-1.51
LPOBPROV	1.49	-1.65[c]
LALFAB	6.84[a]	-6.67[a]
LSCEC	1.92[c]	-2.04[b]
LEXPEN	0.50	-0.26
	1893	
Variables	Moran I	Geary c
LCONLOC	3.51[a]	-3.22[a]
LPOBPROV	1.19	-1.38
LALFAB	6.85[a]	-6.75[a]
LSCEC	2.28[b]	-1.98[b]
LICENTM	2.11[b]	-2.14[b]

Note: Null hypothesis rejected at significance level α=0.01([a]), α=0.05([b]) and α=0.10 ([c])

Spatial autocorrelation might adopt two forms in the regression models. Anselin calls the first case the autoregressive spatial model. In this kind of model, there is structural dependence because the dependence appears when the value of the endogenous variable in an area depends on the values taken by this variable in the neighbouring areas. The second form of autocorrelation is the so-called model with autoregressive spatial error disturbances, in which the spatial dependence is included in the error term.

For each of the years considered in our analysis, we estimated the basic functional form proposed by OLS and contrasted the presence of spatial autocorrelation, either at the level of the endogenous variable or at the residual level.[28] To determine this, we calculated the Moran I tests and the tests based on the Lagrange multipliers

principle, LM-LAG (Anselin, 1988b) and LM-ERR (Burridge, 1980). The Moran I contrast is a general test that does not give us additional information about the spatial process form, while the LM-LAG and LM-ERR contrasts allow us, in the case of spatial dependence, to discriminate between the two forms that this dependence can adopt.

These two contrasts based on the Lagrange multipliers' principle require a normal distribution in the errors of the models estimated by OLS. We examined this normality hypothesis through the Kiefer and Salmon test and we accepted the normality of the residuals in the OLS estimations for the two years considered. On the other hand, in the estimated models we calculated the Breusch and Pagan test and could not reject the null hypothesis of the sample's homoscedasticity in either case.

The results obtained are shown in table 4[29]. In the 1856 estimation we observe that it is not necessary to estimate the model that includes spatial effects because we do not reject the null hypothesis of absence of spatial autocorrelation with the Moran I and the Lagrange multipliers' tests. On the other hand, when estimating the model for 1893, we reject the null hypothesis of absence of spatial dependence. The results obtained suggest that the spatial dependence is included in the error term and so we re-estimated the model with autoregressive spatial disturbances using the Lagrange multipliers' method. As we can see in the table, the results obtained for the year 1893 using the two estimation methods are similar, and the conclusions we can derive from the analysis of estimated parameters' values and signs are the same. However, the non-inclusion of spatial dependence in the model estimation could have affected the inference realised and the validity of the specification tests performed. In addition, the Aikake AIC statistic and the maximum value of the likelihood function indicate that for 1893 it is better to use the model with spatial dependence.

Table 4
Estimation results

	1856 (OLS)	1893 (OLS)	1893 (ML-SER)
Constant	-0.26 (0.69)	-1.22[a] (0.41)	-1.09[a] (0.38)
LPOBPROV	-0.83[a] (0.28)	-0.35[a] (0.11)	-0.31[a] (0.11)
LALFAB	0.09 (0.18)	0.23[b] (0.09)	0.23[b] (0.10)
LSCEC	0.44[b] (0.17)	0.66[a] (0.10)	0.67[a] (0.09)
LEXPEN	0.78[a] (0.20)		
LICENTM		0.40[a] (0.08)	0.36[a] (0.17)
λ			0.38[b] (0.16)
R^2-adj.	0.56	0.92	(*)
AIC	45.81	-8.51	-10.87
LIK	-17.91	9.25	10.43
Kiefer-Salmon	0.63	1.32	
Breusch-Pagan	6.84	3.01	2.77
I-MORAN	0.26	2.15[b]	
LM-ERR	0.52	8.26[a]	
LM-LAG	0.73	1.88	0.08

Notes: Estimated standard errors are in parenthesis.

Null hypothesis rejected at significance level α=0.01 ([a]), α=0.05 ([b]) and α=0.10 ([c]).

OLS: Ordinary least squares

LM-SER: Maximum likelihood estimation with spatial error autocorrelation

λ: Spatial autocorrelation coefficient.

(*) The presence of spatial autocorrelation means the adjusted determination coefficient, R^2 adj., is inadequate for determining the goodness of fit, and so, as is usual in the literature, we calculated Aikake's information criterion (AIC) and the maximum value of the likelihood function (LIK) for each of the estimated models.

We will now analyse the economic significance of the 1856 estimation, when the geographical concentration of production was low and the Spanish market was not

integrated. First, we note the high goodness of fit of the regression, taking into account that it is a cross section analysis. Among the variables suggested by the different theories, LALFAB is not significant and thus is unable to explain the relative industrial intensity of the Spanish provinces. LPOBPROV is highly significant and presents the expected sign (negative). In addition, the variables related to the new trade theory have the expected signs and acceptable significance levels. The provinces where industrial production is specialised in sectors characterised by a relatively large plant size tend to show an industrial intensity larger than the provinces specialised in sectors characterised by small scale production. As for the variable that captures market size, first, we note that, in 1856, LEXPEN (province's market size) has a greater explanatory power than LICENTM (province's centrality index). Furthermore, LEXPEN has the expected sign and an acceptable significance level.

The results obtained in the 1893 estimations suggest a number of interesting conclusions. We should remember that by 1893 Spanish market integration was complete and the geographical concentration of industrial production had increased considerably. As we can observe in table 4, the variables suggested by the theoretical models now give us a very good explanation of the relative industrial specialisation of Spanish provinces in 1893. In general terms, the approximation is better at this point of time than in 1856, prior to the integration of the Spanish market. All variables are highly significant and, moreover, present the signs predicted by the theory.

The comparison of the results obtained at each point of time reflects the existence of major changes in the determinants of industrial location in Spain. First, the value of the coefficients changes significantly. In the endowment variables, we observe how the labour force endowment coefficient falls between 1856 and 1893. The result is consistent with the changes experienced during this period. A more integrated economy

favours labour mobility between the different provinces and, hence, the endowment disadvantage of relatively abundant labour force is, now, a less potent determinant of the relative specialisation. The coefficient of the human capital variable increases and now, its significance is acceptable. In principle, we would expect that the variables that are capturing Heckscher-Ohlin effects would lose importance as market integration progresses. However, in this particular case, the increase in the explanatory power of the variable that captures the differences in the literacy level could be caused by the growing importance of technological skills in the factories during the second half of the XIX century.

The variables related to the new trade and new economic geography theories are highly significant and have the expected signs. Nevertheless, the comparison with the results obtained in 1856 highlights a number of points. First, we observe that the magnitude of the coefficient that relates scale economies with the endogenous variable increases between 1856 and 1893. This fact appears consistent with the theoretical predictions of an increase in the industrial concentration stimulated by the interaction between scale economies and economic integration. Second, we note that, in 1893, LICENTM is the more significant of the two variables that seek to capture the importance of market size. Furthermore, this variable now shows a high significance; market size is a relevant factor in the understanding of province's productive specialisation, but now, after the integration process, what is more relevant is not a province's size but its geo-economic place in the national market. Market size had grown for all provinces, but the access of each province to this market was different, and these differences affect their productive specialisation.

The comparison of the results thus suggests that domestic market integration accentuated the geographical concentration of industrial production. The reason is that

while integration attenuated the endowment differences between Spanish provinces, it also stimulated the genesis of advantages related to the existence of cumulative effects, both in market size and production scale. Moreover, the existence of spatial dependence in the residuals of the model estimated for 1893 appears to indicate that these cumulative effects go beyond the province's geographical limit. They thus favour the existence of a greater industrial intensity in the provinces close to those with an industrial intensity larger than that predicted by the basic model. This explains the evidence shown in map 2.

6. Conclusions

This article has offered a first empirical appraisal of the evolution and determinants of Spanish industrial geography during the second half of the nineteenth century.

On the one hand, the exhaustive analysis of the data published in the *Estadística Administrativa de la Contribución Industrial* for the years 1856, 1893 and 1907 has allowed us to characterise the evolution of Spanish industry geographical concentration in the second half of the nineteenth century. From the comparison of the first two points in time, we confirm that Spanish industry underwent a major drive towards geographical concentration in the second half of the nineteenth century, as had already been suggested by historiography. This impulse affected the majority of productive sectors; it led to the emergence of large differences in the industrial intensity of the Spanish provinces but did not cause a generalised increase in industrial specialisation at the provincial level. So, on average, the larger geographical concentration of the industrial sectors coexisted with the diversification in the productive structure of the representative province. The results obtained for 1907 allow us to locate the great

impulse in geographical concentration before the First World War. This impulse gradually disappears at the end of the nineteenth century and, hence, the increase in concentration seems to find its maximum level in the 1890s.

Secondly, we offered an analysis of the determinants of industrial specialisation of Spanish provinces in the two first points in time, 1856 and 1893. The analysis confirms the validity of most of the historical approaches to the process. Behind the economic geography of Spanish industry in 1856, we find endowment, market size and production scale factors. As a result, and because of the deep historical roots of the regional differences in these factors, our analysis suggests the importance of the past in explaining relative regional advantages.

Furthermore, the comparison of the results obtained in the two points in time has allowed us to make some additional comments. Between the two dates selected, we observe the existence of qualitative changes in the significance and explanatory power of the suggested variables. First, some of the endowment variables have a larger explanatory power in the first of the dates considered. As regards market size, geo-economic location of the province analysed, or scale of production, the reverse is true: their explanatory power is larger in the estimation corresponding to 1893.

The changes experienced by the Spanish economy between these two dates account for these facts. Technological innovations in the transport system and institutional transformations of the monetary and banking sectors unleashed the integration process in the Spanish economy. As a consequence, resource mobility was favoured and endowment differences in factors with a high spatial mobility, such as non qualified labour, reduced their capacity to explain the economic geography. In contrast, integration accentuated the explanatory power of the variables linked to the new trade and new economic geography. The large interprovincial differences in the industrial

intensity in 1893 are explained by the scale economies or by the market potential of the different provinces. At the same time, the residuals in the model follow a spatial dependence pattern that reinforces the importance of the cumulative effects in the understanding of the industrial specialisation of the period.

Our study suggests a further hypothesis. The Spanish experience during the economic integration process in the second half of the century is the story of increasing inequality in the spatial distribution of industrial production. The comparison of the results obtained in 1856 and 1893 allow us to give a possible explanation. Economic theory predicts that when factor mobility is high and elements that favour industrial agglomeration such as scale economies and external economies are present, the integration process will accentuate the genesis of the forces favouring concentration of production in a limited number of productive centres and, hence, will produce an increase in the geographical concentration of production. The results indicate that this seems to have been the case of Spanish industry during the second half of the nineteenth century. Therefore, it would not be hazardous to say that Spanish market integration triggered industrial activity concentration in some Spanish regions.

Notes

[1] Nadal 1985.

[2] Nadal 1987.

[3] The exclusion of Navarre and the Basque Country is due to their exclusion from the fiscal statistics of the period. As is well known, these regions had their own fiscal regime.

[4] Nadal 1987.

[5] In particular, the studies of Carreras 1990 or Prados de la Escosura 1995 offer indices of Spanish industrial production. In Carreras 1990 and Maluquer 1994 we have indices of the Catalan industrial production for the period analysed here.

[6] The series plotted in the graph is constructed as follows. From Nadal 1987, we use the share of Catalan industry of the Spanish total (without the Basque Country and Navarre) in 1856. Using these data and the evolution in the Spanish and Catalan industrial production indices of Carreras 1990 and Maluquer 1994, respectively, we can represent the evolution in the weight of Catalan industry with respect to the Spanish total. Evidently, this approximation, given the absence of the Basque Country and Navarre in the data, deserves just a relative consideration as an indicator of the evolution of Catalonia's relative weight. As for the alternatives to the series used, we verified that using the Spanish industrial product series of Prados 1995 and/or the Catalan series of Carreras 1990, do not significantly change the indicator's evolution over time. Using as a reference the data offered by Nadal 1987 on the participation of Catalan industry's in the Spanish total in 1900, has no bearing on the evolution of the indicator that we present here.

[7] Apart from special sector cases like the Asturian steel industry or the Castilian-Leonese flour mills, the regional analysis emphasise the lack of aggregate industrial impulse in the majority of Spanish regions during this period.

[8] Sánchez Albornoz 1987.

[9] A number of studies present examples linking the financing of the first cotton manufactures to colonial trade, especially, though not exclusively, wine exports. See Fontana 1974.

[10] This thesis was developed by Maluquer 1985.

[11] This does not mean that we should undervalue the domestic commercialisation of Catalan manufacturing during the late eighteenth century. See Delgado 1995 and Muset 1997.

[12] The relationship between industrial location and the existence of a previous manufacturing tradition has been emphasised by many sectoral studies. See, as a representative example, the compilation by Nadal and Catalan 1994.

[13] For the chronology, rhythms and effects of railway construction in the Spanish economy, see the classical references such as Nadal 1975 or Tortella 1981. The impact of the railway network on the Spanish economy has been a controversial subject, and few authors have discussed its importance as a dynamic agent in the domestic market integration. The main disagreements concern the degree, not the direction, of the effect. There is an evaluation of the impact in Gómez Mendoza 1982. Comín, Martín Aceña, Muñoz and Vidal 1998 offer an exhaustive and recent summary of this process and its impact.

[14] Although the substitution of sail by steam impulsion in ships was a late development in Spain, some authors have noted the reduction in cost that this change brought with it in coastal trading. Frax 1981 offers data about the evolution of Spanish coastal trading during this period.

[15] Tortella 1970. Castañeda and Tafunell 1993, p.375-377, emphasise the effects of this new service and argue: 'this financial innovation could have represented an appreciable reduction in the transaction costs involved in geographical mobility of money, which could explain its immediate acceptance'.

[16] Gómez Mendoza 1982, for the railway, and Frax 1981 for coastal trading confirm this intuition. In Garrabou and Sanz 1985, we find an analysis of the domestic agrarian market during this period. GEHR 1985 analyses in detail the formation of common domestic wheat and barley prices as a consequence of market integration.

[17] As an example, see Germán 1990, p. 195-196, where the author explains the depressing effects of integration on Aragonese industry.

[18] Benaul 1994, offers an overview of the interaction of all these factors in the hegemony that the Sabadell-Terrassa wool district finally achieved over the large range of wool nuclei in nineteenth century Spain.

[19] The idea that economies of scale at the level of the individual plant translated into increasing returns at the aggregate level via pecuniary external economies was present already in the 'Big Push' theory of Rosenstein-Rodan 1943 and Fleming 1955.

[20] 'New economic geography' is the name given to a specific class of increasing returns models by Paul Krugman. We will use it with this meaning in the remainder of the paper although economic geography refers to a more general field. An excellent survey of the new economic geography can be found in Ottaviano and Puga 1998.

[21] In fact, as we explain in the appendix, as an approximation to the province's contribution to industrial production, the article uses the share of each province and sector in the tax payments corresponding to the *Contribución Industrial y de Comercio, tarifa tercera* (Industrial and Commercial Contribution, third tariff).

[22] See table 5 in the Appendix.

[23] This relative industrial specialisation index was used, at the regional level, by Nadal 1987. The results of its calculation for the different provinces are presented in Table 6 in the Appendix.

[24] Note that the Castilian wheat markets and the Mediterranean periphery were connected by railway in 1863.

[25] In the Appendix we present the sources and the method used in the construction of each series.

[26] As we explain in the Appendix, the variable considers the average tax payment per taxpayer in each province. Provincial differences in this variable may be due to two factors: the existence of a different sectorial specialisation and the use, in the same sector, of different technologies in the production of the

same good. In this regard we should emphasise that the Spanish fiscal system often imposed different taxes on producers who used a technology that increased the volume of production.

[27] For a formal analysis of the techniques of Spatial Econometrics, see Anselin 1988a and Anselin and Florax 1995.

[28] These statistics and the rest of results obtained in this section have been calculated using the program Space Stat, Anselin 1992.

[29] When analysing the observations of the different Spanish provinces, we notice that Barcelona presents a pattern very different from the rest of provinces. As particular observations might be especially influential in the results obtained, we studied with the Cook Distance statistic (Belsley, Kuh and Welsch, 1980) if any province could cause this problem in the inference realised. The evidence found indicates that no observation, including Barcelona, influences especially the results and hence, no individual observation modifies the conclusions derived from Table 4.

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Appendix

Construction of the Gini indices of geographical and sectorial concentration:

These indices have been constructed proxying the contribution of each sector and province to the industrial product by the data on the tax payments of the different sectors and provinces to the *Contribución Industrial y de Comercio* (Industrial and Commercial Contribution) in 1856, 1893 and 1907.

Although the source offers the distribution of the tax payments for the provinces and sectors, the aggregation of the productive sectors in nine large groups needs a special comment. First, we opted to follow the aggregation given by Nadal, 1987. We thus had a first reference for the aggregations and made our results perfectly comparable to Nadal's results.

The complexity in the aggregation process increases as the indicator refers to more contemporary periods, because the tax includes an increasing number of entries. In this respect, as Nadal, 1987, pp. 51-58, points out, the aggregation in 1856 and 1893 does not present any problem. However, the criteria used in 1907 must be shown explicitly. Therefore, we detail the entries that form each sector epigraph.

1907

Food	226-230, 242-245, 283-289, 304-310, 364-366, 369-370, 391-416
Textiles	1-82
Metallurgy	83-114, 121-137
Chemistry	138-158, 160-177, 179-190, 222-225, 297-300, 316-323, 327-328, 417
Paper	246-272, 342-344, 347
China, Glass and Ceramics	203-221
Wood and Cork	115-120bis, 359, 290 y bis, 291
Leather and shoes	191-202, 355
Others	All the non reported, even the non numbered, except 418.

Table 5

Gini indices of specialisation for each province

	1856	1893
Albacete	0.89	0.87
Alicante	0.77	0.68
Almería	0.88	0.61
Ávila	0.87	0.81
Badajoz	0.89	0.78
Barcelona	0.79	0.71
Burgos	0.70	0.64
Cáceres	0.86	0.84
Cádiz	0.68	0.82
Castellón	0.68	0.82
Ciudad Real	0.87	0.91
Córdoba	0.91	0.59
Coruña	0.73	0.71
Cuenca	0.84	0.72
Girona	0.46	0.60
Granada	0.76	0.78
Guadalajara	0.78	0.74
Huelva	0.88	0.78
Huesca	0.74	0.79
Jaén	0.95	0.77
León	0.84	0,76
Lleida	0.84	0.84
Logroño	0.79	0.70
Lugo	0.69	0.89
Madrid	0.60	0.56
Málaga	0.61	0.73
Murcia	0.75	0.59
Orense	0.87	0.83
Oviedo	0.85	0.66
Palencia	0.83	0.72
Pontevedra	0.85	0.66
Salamanca	0.76	0.73
Santander	0.79	0.70
Segovia	0.84	0.64
Sevilla	0.80	0.62
Soria	0.67	0.70
Tarragona	0.80	0.71
Teruel	0.77	0.78
Toledo	0.77	0.78
Valencia	0.71	0.49
Valladolid	0.71	0.57
Zamora	0.90	0.80
Zaragoza	0.72	0.65
Baleares	0.71	0.55
Canarias	0.88	0.94
Global	0.69	0.58

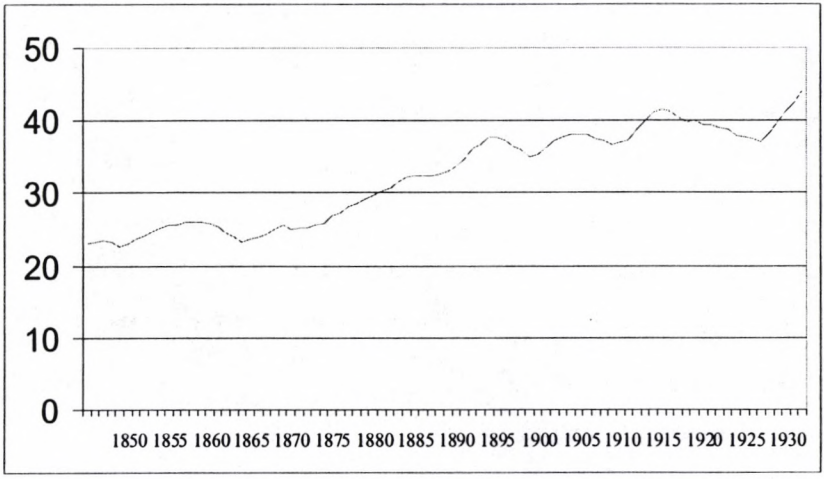
Table 6

Indices of specialisation or industrial intensity of each province

	1856	1893
Albacete	0.71	0.39
Alicante	0.75	0.99
Almería	0.49	0.38
Ávila	0.43	0.24
Badajoz	0.84	0.58
Barcelona	3.80	6.01
Burgos	0.94	0.45
Cáceres	0.74	0.39
Cádiz	0.95	1.37
Castellón	0.75	0.58
Ciudad Real	0.50	0.51
Córdoba	1.29	0.65
Coruña	0.73	0.38
Cuenca	0.86	0.38
Girona	1.19	1.17
Granada	0.65	0.55
Guadalajara	0.76	0.40
Huelva	1.15	0.83
Huesca	0.35	0.25
Jaén	1.44	0.48
León	0.92	0.28
Lleida	0.54	0.83
Logroño	1.10	0.87
Lugo	0.25	0.12
Madrid	1.28	1.34
Málaga	1.13	1.43
Murcia	0.65	0.56
Orense	0.26	0.08
Oviedo	0.50	0.64
Palencia	1.03	0.74
Pontevedra	0.49	0.28
Salamanca	0.81	0.63
Santander	0.74	0.92
Segovia	1.12	0.39
Sevilla	2.15	1.08
Soria	0.45	0.21
Tarragona	1.46	1.43
Teruel	0.59	0.38
Toledo	1.06	0.50
Valencia	0.79	1.18
Valladolid	1.34	0.86
Zamora	0.47	0.29
Zaragoza	0.75	0.66
Baleares	0.90	0.65
Canarias	0.13	0.23

Figure 1

Catalonia«s share in Spanish industrial output



Source: See note 6.

Variables used in the econometric analysis

1) Index of industrial specialisation of each province

$CONLOC_i = (C_i/\Sigma C_i) / (POB_i/\Sigma POB_i)$

where, C_i is the province's industrial product and POB_i is province *i* total population

As a proxy of the province's distribution of industrial product we have taken the province's share in the *Contribución Industrial y de Comercio, tarifa tercera.*

The variable has been calculated for 1856 and 1893. In the first case, the data on industrial production comes from the *Estadística Administrativa de la Contribución Industrial y de Comercio* (EACI) (1856) and the data on population from the *Censo de la Población Española* (CPE) (1860). In the second, the production data correspond to EACI 1893 and the population data to CPE 1887.

2) Non qualified labour endowment

$POBPROV_i = POB_i/\Sigma POB_i$

This variable has also been calculated for the two points in time using the data in the 1860 and 1887 CPE.

3) Human capital endowment

$ALFAB_i = (PA_i/POB_i)/(\Sigma PA_i/\Sigma POB_i)$

This variable is defined as the share of literate population with respect to each province's population divided by the national average. The information comes from Nuñez (1992). For 1856 we used data from 1860 and for 1893, data from 1887.

4) Province's market size

$LEXPEN_i = CONS_i / \Sigma CONS_i$

As a proxy of the province's consumption we used the province's Consumption tax payment. For 1856, this variable has been calculated with data on the Consumption tax of 1883.

5) Province's Centrality Index

$ICENTM_i = (\Sigma_j ((CONSj/\Sigma CONS_i)/D_{ij}) + CONS_i/\Sigma CONS_i) * MAR_i$

where *CONSj* is province's *j* consumption. D_{ij} is the railway distance between the capitals of both provinces and *MARi* is a dichotomic variable which takes value 1 if province *i*'s does not have a sea port and 2 if it does (See Keeble et al. 1986).

For 1893, this variable has been calculated using the data on the 1883 Consumption tax. The railway distance in km corresponds to the railway track exploited in December 1894.

6) Scale economies

$SCEC_i = (C_i / CONT_i) / (\Sigma C_i / \Sigma CONT_i)$

where C_i is the province's industrial production, proxied through the province's tax payment in the *Contribución industrial* and $CONT_i$ is the province's number of taxpaying establishments.

For both 1856 and 1893 this variable has been constructed using data from the EACI.

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