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From Locational Fundamentals to Increasing Returns: The Spatial Concentration of Population in Spain, 1787-2000

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Abstract: Does population follow the same inverted-U pattern of concentration/dispersion that has been found in the case of economic activity in the long run? In this paper we present the evidence for eight European countries during the nineteenth and twentieth centuries and find that, contrary to the inverted-U hypothesis, population has shown a steady, long-run trend towards concentration. After that, we estimate population density and population growth equations for the case of one of these countries, Spain from 1787 to 2000. Our results suggest that locational fundamentals (such as natural endowments) explain the distribution of population before industrialization and that industrialization reinforced the pre-existing regional population disparities, especially as the share of increasing-returns sectors in the Spanish economy became significant (that is, mainly during the twentieth century).

Keywords: economic geography, population history, locational fundamentals, increasing returns

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1. Introduction: population concentration, locational fundamentals and the new economic geography

The distribution of a country's population has far-reaching economic implications. In a context of population mobility, density reveals individual preferences with regard to the various regions of which the country is made up. These preferences are the result of aggregating the indirect contribution to utility due to higher wages driven by the higher productivity of higher density areas and the direct contribution of better living standards (Beeson et al., 2001, 672; Ciccone and Hall, 1996; Rappaport and Sachs, 2003, 9). This paper is fundamentally inspired by our concern to analyse why the population is not evenly dispersed throughout the territory of a country, but rather tends to become concentrated in certain spots.

The analysis of urbanisation and the dynamics of major cities is not, however, our main objective. We have sought to focus our study on the processes of population concentration-dispersion at a somewhat higher level of aggregation, which implies shifting our focus from the analysis of a strictly city-based framework to the examination of wider administrative units including not only major cities but also medium sized and small towns, as well as rural populations. This option means that population density in the units selected for analysis is not affected by the counter-urbanisation processes that have emerged with increasing strength in recent decades with the rise of peripheral towns around the great metropolises and the movement of city populations out to suburban environments[1]. These processes therefore need to be seen as movements within a given territory, which do not change regional population location patterns, though they may change the configuration of metropolitan areas. Also, the choice of a larger sized unit allows us to cover the whole territory of a country rather than just the city or metropolitan area, which avoids the problem of selectivity bias[2].

[1] This choice is consistent with Ciccone and Hall's (1996) approach to the study of spatial differences in productivity in the United States.

[2] Other studies also reveal a preference for the analysis of population in larger administrative units than the city or metropolitan area. See Beeson et al. (2001, 673-674), Davis and Weinstein (2002, 1272) and Rappaport and Sachs (2003).

We have opted for a long-run time frame for the analysis because the new economic geography attaches considerable importance to history as a determining factor in this kind of economic/population concentration-dispersion process, as well as stressing accumulative processes. We are interested in discovering the extent to which industrialisation processes in Europe generated a similar population concentration-dispersion pattern to that found for economic activities (Fujita, Krugman and Venables, 1999; Henderson, Shalizi and Venables, 2001; Fujita and Tisse, 2002; Duranton and Puga, 2004; Rosenthal and Strange, 2004) and the size of cities. In other words, did population concentration follow an inverted-U pattern during industrialisation?

Our results show that populations within Europe have tended to become increasingly concentrated over the past two centuries without any sign yet of a trend toward dispersion similar to the processes found in the case of economic and industrial activities or in the size of cities. We believe, however, that there is an explanation for the apparent contradiction between our approach and certain findings which suggest that the growth of small and medium sized towns outstrips that of major cities after a given point, resulting in the dispersion referred to. This dispersion has materialised mainly in the already familiar phenomenon of counter-urbanisation, which implies the geographical spread of metropolitan areas[3].

A second area of concern has to do with the impact of industrialisation on the location of population on specific areas and on the pre-existing patterns of population concentration. Did industrialisation tend to create its own pattern of demographic disparities? Or did it rather reinforce the pattern of population concentration generated during the early modern period? It is clear that industrialisation profoundly changed national economies and societies, but our results echo those by De Vries (1984, 160-196), who argues that European industrialisation did not create its own urban system but operated on the basis of the urban system that consolidated in the 17th century. Our results show that population concentration is today much higher than in the pre-industrial period, but present day populations tend to locate in the areas that already had the highest relative densities before industrialisation.

This leads to a third area of concern, which is the one that provides the logical structure for our econometric tests. Although industrialisation did not create its own

[3] In general, studies of this type reveal that the dispersion of industry is more important than that of population (Henderson, Shalizi and Venables, 2001, p. 96).

pattern of demographic disparities across the space, it seems clear that it introduced new, specific mechanisms leading to population concentration. Briefly stated, geography can be expected to play a very important role in a pre-industrial economy (whose energetic base is organic), but increasing returns seem to be the driving force of population concentration in an industrializing economy. Are these assumptions empirically sound? Our results show that they broadly are –our explanatory matrix moves gradually from locational fundamentals to increasing returns as industrialisation unfolds.

In the pre-industrial epoch, natural factors were of enormous importance in shaping opportunities for the spatial location of populations. Thus, farm productivity was conditioned by weather and topographical factors, as well as the accessibility of markets, which may be considered good examples of the “natural” variables (first nature advantages) determining population location. We believe the apparent paradox inherent in the scant capacity of industrialising phenomena to change the patterns of population location can also be explained through some of the arguments and ideas offered by the new economic geography, in particular the emphasis placed by this research programme on the importance of cumulative processes (Krugman, 1992). The “natural” determining factors that existed before industrialisation of course continue to be important, but let us note that the historical dynamic itself has favoured cumulative processes that have also been enormously influential in conditioning the distribution of the population. As numerous studies have shown, industry not only grew up in those places where comparative advantages favoured development, but also increasing returns both at the level of the firm and of the sector, as well as proximity to markets, favoured concentration from the outset once transport costs had fallen sufficiently.

Logically, this was of tremendous importance in terms of population distribution, because the activation of major migratory flows favoured an intense process of redistribution from rural to urban areas, and from the economically less dynamic regions to those enjoying modern economic growth. This would explain why industry in many European countries emerged mainly in those areas with the highest population densities, thus tending to reinforce the situation, while the demographically weaker areas could not provide the incentives necessary to locate new industrial activities and tended to lose demographic share in absolute or relative terms. The improvement of communications networks and falling transportation costs further favoured concentration by enhancing the relative advantage of the main urban centres over smaller towns, and of the densely over more sparsely populated regions (Thisse, 1993). Only those regions with particularly favourable resources for the location of certain types of industry could generate their own growth dynamics based on such comparative advantages. In fact, this latter possibility may help explain the relevant shift in economic and population regional shares that took place in Britain during the early stage of industrialization, in which resources such as coal played a major part in a context of still high transport costs (Pollard 1997: 221-254). However, our results suggest that it is not easy to find other examples of such shifts in Europe.

In short, as Krugman (1993) argues, first nature advantages generally tended to create second nature advantages through cumulative processes, and these are decisive in explaining the concentration of populations that has taken place both during and after the industrialisation process. In this way, virtuous circles of demographic growth or vicious circles of stagnation were created in the regions of every European country, and these tended to feedback into themselves with the outcome that initial location advantages became key determining factors in population location, and these processes retain considerable power to explain the situation down to the present day. The old Myrdalian concept of "circular causation" would thus play a key role in explaining how the increasing divergence of initial conditions between regions tends to reinforce population concentration (Myrdal, 1957). Hence, in the long run history itself, or path dependence, becomes increasingly important in explaining population distribution, insofar as increasing returns have favoured the concentration of economic activities (Krugman, 1991 b).

To sum up, it seems reasonable to suppose that the concentration of the European population could be explained through a combination of locational fundamentals and increasing returns. This is in line with Davis and Weinstein (2002, 1271), when they state that we would do well "to consider a hybrid theory in which locational fundamentals play a key role in establishing the basic pattern of relative regional densities and in which increasing returns play a strong role in determining the degree of concentration". However, these authors do not provide a formal, econometric way of nesting both hypotheses and test their explanatory power through time. That is what we try to do for the case of Spain over a period of two hundred and thirteen years at a time that spans from the late 18th century, a time when industrialisation had not started yet in Spain, to the present day, when Kuznetsian structural changes associated to 'modern economic growth' have been completed and new, post-industrial dynamics begin to emerge. This period comprises the beginnings of the country's industrialisation in the mid-19th century, a period of gradual development lasting almost one hundred years, intense acceleration and completion of the process in the 1960s and 1970s.

Following this introduction, the rest of this paper continues with an analysis of population concentration patterns on a European scale. Such analysis is based on a province/county-level database we have constructed for a sample of eight European countries. After that, we provide the econometric tests for our model, which refer to the particular case of Spain. We end with some brief conclusions.

2. Modern economic growth and demographic concentration: the European experience

The European economies have provided fundamental empirical support for the Kuznetsian account of the structural changes accompanying "modern" economic growth. This is also true for Williamson's (1965) hypothesis regarding the existence of an inverted U-shaped pattern in regional disparities in the course of the development process. What happened in the case of population distribution? We have constructed a database for broadly comparable administrative units (see Appendix for details) in eight European countries. The two main results can be found in Tables 1 and 2 and summarized as follows: (*a*) there has been a continuous increase in the spatial concentration of the population throughout the 19th and 20th centuries (i.e. absence of an inverted-U pattern); and (*b*) the persistence in each country of the relative positions of the various regions in terms of demographic densities. The resulting picture is that of an industrialisation process that enormously amplified regional already existing demographic disparities.

France provides the clearest example. The north-east is today the most densely populated region in the country, but this was already the case in 1800. Density in the departments of Pas-de-Calais, Bas-Rhin, Rhône, Nord and Seine Maritime, as well as the departments of the Paris area, is significantly higher than the average for the country as a whole in the present. In the departments of the Seine population density is 15 times the national average, while in Rhône and Nord it is five and four times, respectively, and so on. The densities in these departments were, however, already high in 1800. Thus, the departments of the Seine were easily three times, and Rhône and Nord twice the national average. At the other extreme, every one of the twenty least densely populated departments today were already sparsely populated in 1800. Lozère and the Alpine departments, for example, have population densities less than 20% the national average today, but even in 1800 they were not much closer (40-50% of the average). Indeed, these three were the least densely populated departments, together with Corsica, and they have remained so for the last two centuries.

(Tables 1 and 2 about here)

With slight differences, a similar picture may be observed in the cases of Sweden, Switzerland, Italy and Belgium. On the Iberian periphery, Spain and Portugal reflect the two key features of the European pattern (continuous increase in demographic concentration and persistence of the relative positions before industrialisation), but the timing and pace of the process were, logically, affected by the peculiarities of industrialisation in these two countries. In both Spain and Portugal, modern economic growth in the 19th century was slow and took place in a context of divergence from the leading European states. Convergence would come in the 20th century, particularly in the period from 1950 to 1975, when both countries were able to exploit the relative advantages of backwardness, achieving spectacular growth rates, which would later slow to a more moderate pace. In this light, it is no surprise to find that the spatial concentration of the population in Spain and Portugal did not follow the French pattern of a more or less uniform increase over time, but rather grew slowly until 1950 only to shoot up over the following three decades until 1980, since when it has returned once again to a path of slow growth.

The main exceptions to the general picture are to be found in the case of the United Kingdom. In the first place, our analysis is confined to the 19th and 20th centuries, preventing any consideration of the spatial distribution of the United Kingdom in the 18th century. Various studies suggest, however, that the country's demographic centre of gravity from the south-east shifted toward the north-west of England in precisely that century, as a consequence of the influence of coal deposits on the map of early industrialisation in a technological context of high transport costs[4]. These studies thus suggest that industrialisation may have created its own demographic disparities in the United Kingdom, in contrast to events in France or Spain. With this exception, however, the case of the United Kingdom evolved to fit the common European pattern in the course of the 19th century. However, our results point to a slight but persistent decline in demographic concentration in the 20th century, above all in the second half. This would be the only case of the inverted U during industrialisation. In any event, it is possible that the small size of English counties may have an influence on the results obtained as a consequence of the increasing distance between the place of work and the place of residence (this phenomenon is much less viable at the scale of Spanish provinces or French departments).

However, because the Spanish case fits the usual European experience in which demographic concentration increases continuously throughout the period of industrialisation (which reinforces the disparities handed down from the pre-industrial epoch), it may be an interesting case for the test of different hypotheses about the factors underlying such dynamics. That is the task of the next section.

3. Econometric tests: locational fundamentals, increasing returns and the concentration of Spanish population

In the first place, then, we shall seek to verify empirically the importance of the natural or situational advantages acting as determining factors of demographic density in the Spanish provinces at five different moments, 1787, 1860, 1900, 1950 and 2000. The first date allows us to analyse a pre-industrial situation, the second approximately coincides with the onset of Spanish industrialisation, the next two reflect moments in the development process before the final triumph of the new economic system, and the last refers to a mature modern economy.

The province has been chosen as the territorial unit in the model we propose for two reasons. Firstly, the size of the provinces, though very variable, is appropriate for our objective. They are neither too big, which might permit medium distance population

[4] Braudel (1979), pp. 486-7; Cameron (1989), p. 223. Pollard (1997), pp. 221-54 provides a detailed analysis of the reasons why initially marginal areas may become leaders of industrialisation.

movements within their bounds, nor too small, which might result in a spill-over of counter-urbanisation processes beyond them[5]. Moreover, they formed the only official administrative unit, together with municipal councils, in Spain during the period between 1833 and 1977, with the advantage that all the necessary data are available.

The endogenous variable in each case is the population density of each province in the year in question (LDENx), while the exogenous variables of altitude (ALT), annual rainfall (RAIN), coastal location (DCOAST) and Madrid's status as the capital city (MAD) are kept fixed in each of the five models.

Altitude has been approximated as the height of provincial capitals above sea level, and the variable provides an indication of advantages in terms of both farm productivity and lower transport and communication costs. Obviously, negative values are expected.

Rainfall, measured as average precipitation between 1960 and 1990 is a good indicator of agricultural potential in such dry conditions as the predominantly Mediterranean climate of the Iberian Peninsula. Given the importance of unirrigated crops, and particularly cereals, in Spanish agriculture, low rainfall would determine sharply fluctuating and low farm yields in the absence of irrigation. Hence, positive values are to be expected for this variable.

The dummy variable "coastal location" takes a value of one where the province in question has a coastline and zero if not[6]. This variable is intended to measure the contribution of proximity to the coast to productivity and quality of life. Until recent years, the first of these effects is held to be the most important, consisting above all in advantages for the maritime provinces derived from lower transport costs in gaining access to markets (Rappaport and Sachs, 2003; Fujita and Mori, 1996). In this light, a favourable relationship is also to be expected between coastal location and density.

Finally, the dummy variable MAD, which takes a value of one for the province of Madrid and zero for the rest, takes account of Madrid's uninterrupted region as the capital of Spain since 1551, which has been a crucial advantage for the city's growth. A number of studies have stressed the capacity of political institutions to favour

[5] The arithmetical mean area of the Spanish provinces is 10,359 km^2. The standard deviation is 4,702. Beeson et al. (2001: 673-674) advance similar arguments for their choice of the county to study the evolution of the US population.
[6] We also calculated the models with this variable measured as the length of coast of each province in kilometres. However, the results obtained for the measures of fit and selection criteria were worse in all cases, and because of this we have treated the DCOAST variable as a dummy variable.

concentration. A typical example are national capitals, which benefit from political favouritism to achieve a high level of local public services and a strong transportation network, while investment in, for example, interregional transport remains meagre, penalising the competitiveness of other cities. Capitals also enjoy other benefits, such as the concentration of government institutions. This effect is accentuated in highly centralized and undemocratic countries, as was the case in Spain until 1977 (Henderson, Shalizi and Venables, 2001, 94; Davis and Henderson, 2003) [7].

Our expectation is that these variables would be significant, highlighting the importance of the locational fundamentals approach to explain the location of the Spanish population over the last two centuries.

Before calculating the proposed models, we first investigated whether the spatial distribution is random or reflects a spatial dependence model. In order to analyze the possible presence of spatial autocorrelation in the variables, we have calculated Moran's I test and Geary's c test (Table 3), the null hypothesis for which is that there is no spatial autocorrelation. The results of these statistical tests depend on the choice of the spatial weights matrix or the contact's matrix. Because of this, we have used two possible spatial weights matrices measuring spatial dependence between provinces in our analysis:

- (WK): square matrix consisting of 48 rows and 48 columns, one for each province, where each element is the inverse of the distance between provincial capitals, standardised by rows (i.e. the sum of the rows is one).

- (W): this has the same dimensions as (WK), but comprises values of 1 or 0 depending on whether provinces are adjacent or not.

Let us call:

LDENx: Natural logarithm of population density for each province in year x.

LALT: Natural logarithm of the altitude of the provincial capital.

LRAIN: Natural logarithm of average annual rainfall.

(Table 3 about here)

[7] In highly interventionist undemocratic models, the power of bureaucrats and politicians to award licences of all kind (e.g. export-import licences or production rights) also favours national capitals. This would be the case in Spain between 1939 and 1959, when the Franco dictatorship imposed an economic policy of autarky.

Based on these data we may reject the null hypothesis of space random distribution for all variables at a level of significant of 5%, except for population density in 1950 and 2000 if the weights matrix defined as WK is used. Hence, there is clear evidence for positive spatial autocorrelation in almost all of the variables, so the values taken by the variables in one province are affected by the values taken in nearby provinces.

This spatial interdependence of the variables considered needs to be taken into account in estimating the models proposed to study the importance of the situational advantages acting as determining factors of demographic density in the Spanish provinces at four different moments. Now we shall use only the matrix we have called WK as the weights matrix, because it accounts for the distance between the province capitals and not only the bordering between them.

This spatial autocorrelation or spatial dependence may take two forms, respectively called substantive spatial dependence and spatial dependence in the error term. The first form appears when the model exhibits structural dependence, in those cases where the values taken by endogenous variable in a given province depend on the values for the same variable in adjacent provinces. The second type of spatial autocorrelation appears when dependence is exhibited in the model's residual values. The consequences of ignoring such spatial dependence, when it is fact present, depend on the type of dependence present in the model (Anselin, 1988a). If spatial autocorrelation is substantive, the OLS estimates will be biased and all inferences based on the standard regression model will be incorrect. In a sense, this is similar to the consequences of omitting a significant explanatory variable. However, the consequences of ignoring spatial dependence in the error term are the same as for heteroskedasticity: the OLS estimators remain unbiased but it is no longer efficient. Hence, any conclusions obtained on the basis of t- or F-type tests will be incorrect.

In this light, we have checked for the presence of spatial dependence using three tests: The first test is an extension of Moran's I test to measure spatial dependence in regression residual. It does not provide any guidance in terms of which the sustantive or the dependence in error term is the most likely alternative. The second one is a Lagrange Multiplier test diagnostic for a spatial lag, suggested by Anselin (1988b), LM-LAG. The final test is also a Lagrange Multiplier statistic, suggested by Burridge

(1980), LM-ERR, for a spatial error case. The last two tests are robust against specification errors in the dynamic structure of the equation (Anselin et al. 1996).

Since both of these two last robust tests require normality in the residual values, we have examined the normality hypothesis for each model using the Jarque-Bera test. We have also checked the null hypothesis of homoskedasticity in the various models calculated using the Breusch-Pagan test (for a review, see Chasco, 2003).

Table 4 presents the results for each of the five years analysed and the general econometric model is:

$$LDENx = \beta_0 + \beta_1 DCOAST + \beta_2 MAD + \beta_3 LALT + \beta_4 LRAIN + u$$

(Table 4 about here)

In the models where a problem of sub-specification attributable to the omission of dynamic elements in the equation was detected using Moran's I, and the LM-ERR and LM-LAG tests, we reestimated the models with spatial autocorrelation coefficients, and the model was selected on the basis of the significance of these coefficients, as well as the Akaike's information criterion (AIC), Akaike (1981), the Schwarz´s Bayesian information criterion (SBIC), Schwarz (1978) and the value of the likelihood function (LIK).

All of the variables in the model are significant at a level of 5% except the dummy variable for coastal location in 2000. These results underscore the importance of geographical factors (not to mention institutional factors in the case of the capital city, Madrid) in explaining the distribution of the Spanish population in the last two centuries. All of the independent variables take the expected sign and, as a whole, they explain how the highest population densities in Spain were historically to be found in the maritime provinces, non mountainous areas and in those areas with the highest annual rainfall. Specifically, these geographical factors allowed for greater farm yields in such regions due to better weather and topographical conditions. For economic activities in general, meanwhile, proximity to the coast and location in low altitude areas implied lower transport costs and, therefore, higher productivity. Before us, Dobado (2004) had already stressed the importance of this type of geographical variables in order to explain the distribution of Spanish population in 1787, advancing the hypothesis of subsequent relevance due to the persistence until now of the relative positions of the various provinces in terms of demographic densities.

The explanatory power of our models is very high, particularly in comparison to similar studies carried out in the United States for the same time horizon (Beeson et al., 2001; 682). However, an important qualification must be made. Our results for 1900, 1950 or 2000 seem to tell us that population concentration was driven by geographical fundamentals not only during the pre-industrial period, but also during the whole process of industrialisation. Although geography remains important for several industrial and service sectors, it is sound to suspect that our models for the 20^{th} century are reflecting not only natural advantages, but also path-dependency. Thus, the existence of these natural advantages in the past may have generated other advantages of the kinds suggested by the new economic geography. These in themselves could be decisive in explaining the distribution and concentration of the population. As a matter of fact, a simple graphic representation of the annual growth rate of provincial population densities between 1860 (a moment when industrialization had just started in Spain) and 2000 (R1860-2000) and the logarithm of relative density in each province in 1860 (LDR1860) reflects a clear positive relationship between the two variables (Figure 1).

(Figure 1 about here)

In order to discover the extent to which the initial population density may have conditioned subsequent growth, we propose a fresh model in which the dependent variable, RCx-z, is the percentage annual rate of change in population density between two chosen dates. These are 1860-2000, 1787-1860, 1860-1900, 1900-1950 and 1950-2000. We have kept the same independent variables as in the previous models, but add initial population density for each province, LDENx. So the general econometric model is:

$$RCx - z = \beta_0 + \beta_1 LDENx + \beta_2 DCOAST + \beta_3 MAD + \beta_4 LALT + \beta_5 LRAIN + u$$

(Tables 5 and 6 about here)

Table 5 shows the Moran's I and Geary's c tests for spatial autocorrelation. Based on these data we not reject the null hypothesis of spatial random distribution for all variables at a level of significant of 5%, except for RC1787-1860 and RC1950-2000.

But, as for the explanatory variables we have rejected the null hypothesis of no spatial autocorrelation we have used the same tests for spatial autocorrelation and model selection criteria as in the previous study and we have selected the following models presented in Table 6.

The results validate the increasing returns approach as key to understanding the rising concentration of the Spanish population during and after the industrialisation process. Thus, between 1860 and 2000, first column, the initial density of the population is significant to explain the growth of provincial populations at 5%. This is also true of Madrid's condition as capital and altitude. The fact that rainfall is not significant could be due to the declining importance of agriculture in the Spanish economy and the fall in the farm sector's demand for labour[8]. However, it is more interesting to draw conclusions from shorter periods. The models estimated in columns 2, 3, 4 and 5 correspond to the four sub-periods into which we have divided the years from 1787 to 2000. The results show that the relationship between initial population density and subsequent population growth is highly dependent on the historical context. More specifically, this relationship was initially negative and it became positive and significant only during the 20th century. This fits with some basic facts about Spanish economic history.

For the late pre-industrial period, from 1787 to 1860, there was an inverse relationship between initial population densities and population growth. This reflects an economic context in which not only increasing returns were mainly absent (a hardly striking conclusion for a pre-industrial situation) but also one in which population concentration could act as an obstacle for further population growth. Between 1787 and 1860, Spain registered a pattern of extensive growth based on the addition of land to the agrarian production function but little growth in productivity (Llopis, 2002). The qualitative evidence in favour of Malthusian ceilings being dangerously approached in several regions in the central part of the 19th century as elasticity of land supply began to decrease (Llopis, 2004, 58) fits with our result that population growth tended to be higher in those provinces with low initial population densities and bigger reserves of underexploited land.

[8] The decline in the general importance of natural variables to explain population growth is similar to the results obtained by Beeson et al. (2000) for the United States. In this case, the population of US counties in 1840 was the variable with the greatest explanatory power to elucidate the situation in 1990.

The years between 1860 and 1900 witnessed the first stage of industrialisation in Spain and the building of the country's basic modern transport network (particularly the railway network, that greatly reduced transport costs and fostered market integration). In terms of our previous discussion, this means that we could for the first time expect to find some increasing-returns logic in population concentration. However, our results do not support such an idea. Instead we find a non-significant relationship between initial densities and subsequent growth. In case we are willing to accept 85 per cent as our threshold level of significance, then the relationship would still be inverse, that is, the same situation than in the late pre-industrial period 1787-1860. Again, the reasons for such a result can be found in the features of the Spanish economy at that particular moment. True, industrialisation had begun, but the industrial structure was still dominated by consumption goods sectors (Maluquer de Motes, 2002, 270-271) in which increasing returns did not play a great part. Furthermore, agriculture remained the main sector in terms of employment (around two thirds of the Spanish active population was employed in this sector both in 1860 and 1900) and still held a very considerable share (around 30 per cent in 1900, following a period-peak of 42 per cent in 1878) in national GDP (Carreras and Tafunell, 2004, 453; Prados de la Escosura, 2003, 581-582). In such an slowly-industrialising economy, it is not surprising to find high rates of population growth in regions endowed with a potential for agrarian growth (low-altitude regions with low starting population densities, as our coefficients show).

It is only for the 20th century that we find support for the increasing-returns story. Between 1900 and 1950, the share of agriculture in employment fell from 66 to 48 per cent (Carreras and Tafunell, 2004, 453), the share of consumption goods in industrial production fell below 50 per cent for the first time in Spanish history (Carreras and Tafunell, 2004, 244) and therefore increasing returns became more significant, and internal migrations provided a major boost (Silvestre, 2001 and 2005), as a result of which initial density (1900) becomes significant to explain the variation in the following fifty years.

Between 1950 and 2000, a period that witnessed the culmination of Spanish industrialisation, initial density remains highly significant. During the 1950s and the 1960s, internal migrations were very intense and led to a massive reallocation of population from backward, agrarian regions to advanced, industrial ones. By 1981, more than 60 per cent of Spanish population lived in towns above 10,000 inhabitants, as compared to 14 per cent in 1860 or 28 per cent in 1930. Considering cities above 50,000 inhabitants, Spain's urbanization rate had climbed from 31 per cent in 1950 to 51 per cent in 1981. Moreover, the share of agriculture in employment declined from figures close to 50 per cent in 1950 to less than 10 per cent during the 1980s (Carreras and Tafunell, 2004, 451-453). A post-industrial society was beginning to emerge by then, the industrial sector having declined in terms of both employment and production shares in the last three decades of the 20th century (Prados de la Escosura, 2003, 584-590). The demographic implications of these post-industrial dynamics remain to be seen. For instance, the rise of tourism as one of Spain's main industries implied that some basic geographical fundamentals became significant again, as our model shows. With this qualification in mind, it seems clear anyway that the twentieth century can be characterized from a long-run perspective as the period in which Kuznetsian changes were completed and agglomeration forces eventually shaped the geographical concentration of Spanish population.

4. Conclusions

One of the central concerns of the new economic geography literature is the discussion surrounding the factors that determine the concentration of economic activities. In this paper, we have explored the demographic side of this story and have switched the usual scope from cities to a regional level.

In the first place, we have found that populations in Europe have tended to become concentrated from the outset of the industrialisation process until the present day, in contrast to trends in economic activity. The dispersion found in studies of the urban phenomenon in recent decades is compatible with our view, because this process is above all a consequence of changes in the environment of the major metropolises. From this standpoint, industrialisation would seem rather to have played the role of driver of this intense concentration process than to have radically changed population distribution patterns. Thus, the pre-industrial age emerges as the key to understanding the present-day situation, because it was then that the system of cities and population distribution was fixed, while industrialisation greatly strengthened this existing order. This consistently echoes the findings by De Vries (1984) and Hohenberg (2004) on European urbanization.

We have also examined closely the case of Spain and found that it fits well in an explanatory framework that combines locational fundamentals and increasing returns. In line with Davis and Weinstein (2002, 1285-1286), we have found that while locational fundamentals are key to explaining general patterns of regional population distribution and the persistence of such phenomena, it would not be possible to understand the increasing concentration of the population since industrialisation or the degree of spatial differentiation of this population without the theory of increasing returns. We have proceeded as follows. In the first place, we have verified that locational fundamentals are indeed immensely important in explaining the provincial distribution of the Spanish population between 1787 and 2000. We then sought to verify the extent to which the proposed models might not hide the importance of economies of scale through cumulative processes that would tend to explain the distribution of the Spanish population. To this end, we have tried to establish whether initial density, which we have taken as an approximation to the advantages of relatively large size, might be an important factor to explain variations in population density over time. Our results confirm that initial density was indeed important in explaining relative population growth in the various provinces from 1900 onwards, when modern industry had begun to represent a significant share of the Spanish economy.

Therefore, our results support Krugman's (1991a, 487) argument that population divergences feedback on themselves with the final result that population concentration will depend to a great extent on initial conditions, even where differences between regions are originally small. In Spain, the most densely populated provinces in 2000 were not only the same ones than in 1860, but the relative gap had widened considerably, and the initial conditions had had a major impact on the final result. Industrialisation thus sharply reinforced the concentration of the population in those places that already had relatively high densities, not only because of initial location advantages continued to favour these regions, but also because the location of industry was conditioned by factors such as proximity to markets and increasing returns (Rosés, 2003; Tirado, Paluzie and Pons, 2002). Consequently, high initial population densities generated additional advantageous conditions (second nature advantages) that favoured industrialisation, resulting in a cumulative process, which tended to further widen demographic disparities. This Spanish story (or, at least, substantial parts of it) may be useful for the study of regional population dynamics in Europe as a whole, but more detailed case studies from other countries are badly needed before such a grand interpretation can even be posed.

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Appendix: sources and details

The database used for calculations in Tables 1 and 2 has been constructed for the following spatial units and the following precise dates: British (English, Welsh, Scottish) old counties for 1801, 1851, 1901 and 1961; British new counties for 1961, 1981 and 1991; French departments for 1801, 1861, 1901, 1946, 1982 and 1999; Swedish counties for 1750, 1800, 1860, 1900, 1950, 1980 and 1990; Swiss cantons for 1850, 1900, 1950, 1980 and 2000; Belgian provinces for 1816, 1856, 1900, 1947, 1981 and 2003; Italian provinces for 1871, 1901, 1951 and 1991; Portuguese regions for 1878, 1900, 1950, 1981 and 1991; and Spanish provinces for 1787, 1860, 1900, 1950, 1981 and 2000. The sources are Mitchell (2003), Collantes and Pinilla (2003), www.insee.fr, www.statistik.admin.ch, www.starbel.fgov.be, www.citypopulation.de, and Spain's 1787 census. Additional sources for tables 4 and 6 were Instituto Nacional de Metereología de España for average precipitation between 1960 and 1990 and Instituto Nacional de Estadística for the height of provincial capitals above sea level. The two Spanish provinces in the Canary Islands, located very far away from Europe, were excluded from calculations.

Table 1. Gini coefficients: provincial-regional population densities in a selection of European countries

	1750	1800	1850	1900	1950	1980	2000
United Kingdom		0.423	0.508	0.631	0.635		
					0.552	0.527	0.515
France		0.192	0.243	0.316	0.393	0.454	0.463
Sweden	0.396	0.418	0.451	0.434	0.479	0.519	0.531
Switzerland			0.311	0.359	0.392	0.418	0.410
Belgium		0.216	0.303	0.325	0.350	0.360	0.359
Italy			0.226	0.233	0.290		
					0.328		0.398
Portugal			0.331	0.339	0.395	0.545	0.562
Spain		0.255	0.266	0.289	0.358	0.508	0.522

Sources: see Appendix.

Table 2. Spearman ranking correlation coefficients provincial-regional population densities

	Reference year	Correlation coefficients with the reference year				
		1850	1900	1950	1980	2000
United Kingdom	1800	0.940	0.881	0.883		
France	1850		0.915	0.853	0.762	0.727
Sweden	1850		0.924	0.881	0.877	0.870
Switzerland	1850		0.973	0.953	0.926	0.903
Belgium	1800	0.733	0.617	0.517	0.583	0.633
Italy	1850		0.962	0.853		0.778
Portugal	1850		0.991	0.958	0.914	0.911
Spain	1850		0.967	0.922	0.920	0.916

Sources: see Appendix.

Table 3. Moran's I test and Geary's c test applied to the variables in the model.

Variables	Moran's I		Geary's c	
	W	WK	W	WK
LDENS1787	3.9841 (0.0000)	3.8546 (0.0001)	-4.0750 (0.0000)	-4.0480 (0.0000)
LDENS1860	4.1885 (0.0000)	3.7541 (0.0002)	-3.7781 (0.0001)	-3.5394 (0.0004)
LDENS1900	3.4178 (0.0006)	2.6601 (0.0078)	-2.9790 (0.0028)	-2.1214 (0.0339)
LDENS1950	2.5656 (0.0103)	1.2814 (0.2000)	-2.3346 (0.0195)	-0.6214 (0.5343)
LDENS2000	2.7039 (0.0068)	1.7055 (0.0881)	-2.1309 (0.0331)	-0.7389 (0.4599)
LALT	5.1412 (0.0000)	5.1422 (0.0000)	-4.4495 (0.0000)	-4.3174 (0.0000)
LRAIN	5.1541 (0.0000)	7.0388 (0.0000)	-6.2816 (0.0000)	-6.7543 (0.0000)

P-values given in brackets.

Table 4. Estimates of population density models for the Spanish provinces, 1787-2000

Endogen	LDEN1787	LDEN1860	LDEN1900	LDEN1950	LDEN2000
C			2.1319 (0.0036)	6.7350 (0.0053)	3.4759 (0.0069)
WLDEN		0.5729 (0.0003)		-1.2416 (0.0418)	
DCOAST	0.3789 (0.0127)	0.3677 (0.0054)	0.4159 (0.0050)	0.36.4 (0.0241)	0.3601 (0.1551)
MAD	0.9524 (0.0045)	1.2036 (0.0000)	1.4825 (0.0000)	1.8689 (0.0000)	3.3048 (0.0000)
LALT	-0.0841 (0.0291)	-0.1277 (0.0003)	-0.1586 (0.0002)	-0.2225 (0.0000)	-0.3841 (0.0000)
LRAIN	0.5247 (0.0002)	0.3112 (0.0002)	0.3278 (0.0024)	0.4648 (0.0000)	0.3636 (0.0499)
Jarque-Bera	4.1636 (0.1247)		1.1567 (0.5608)		0.00040 (0.9979)
Breusch-Pagan	0.5717 (0.7513)	1.2470 (0.8703)	0.9715 (0.9141)	1.4331 (0.8384)	1.3429 (0.8540)
N	48	48	48	48	48
R^2-corr.	0.7138	*0.7491	0.7658	*0.7870	0.7614
AIC	28.2659	24.8280	24.8567	45.4760	79.7366
SBIC	35.7507	34.1840	34.2127	56.7032	89.0926
LIK	-10.1330	-7.4140	-7.4283	-16.7380	-34.8683
MORAN'S I	1.9183 (0.0551)		1.7505 (0.0800)		0.9449 (0.3447)
LM-LAG	0.8992 (0.3429)	7.7924 (0.0052)	0.0021 (0.9638)	3.4705 (0.0624)	0.4289 (0.5125)
LM-ERR	0.0031 (0.9550)	0.3916 (0.5314)	0.1915 (0.6616)	0.4534 (0.5007)	0.1710 (0.6792)

Notes: P-values are given in brackets. WLDEN is the coefficient accompanying the spatial lag of the endogenous variable in each model.* Because of the presence of substantive spatial autocorrelation, the adjusted determination coefficient is not appropriate to measure goodness of fit, and in this case we provide the squared value of the correlation between the dependent variable and the value estimated.

Figure 1. Initial densities vs. population growth in Spanish provinces, 1860-2000

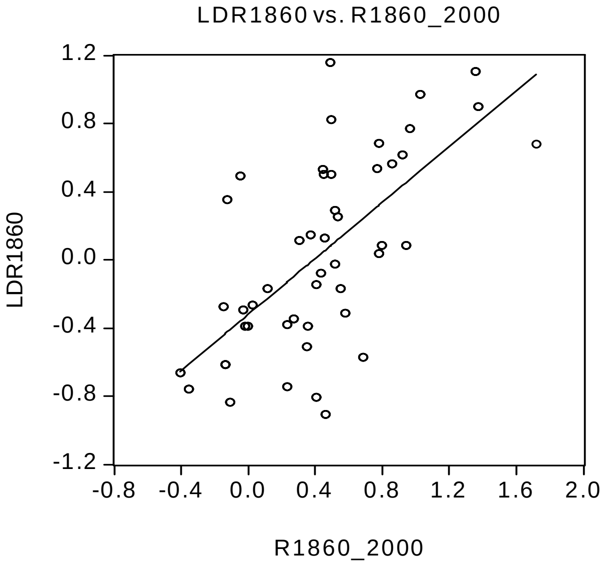

Table 5. Moran's I test and Geary's c test

Variables	Moran's I	Geary's c
RC1860-2000	1.3336 (0.1823)	0.1875 (0.8513)
RC1787-1860	4.7010 (0.0000)	-3.8353 (0.0000)
RC1860-1900	0.7118 (0.4766)	-0.0360 (0.9710)
RC1900-1950	0.2807 (0.7790)	0.4303 (0.6670)
RC1950-2000	3.1651 (0.0015)	-1.7991 (0.0720)

Table 6. Estimates of the variation in population density models in the Spanish provinces, 1787-2000

Endogen	RC1860-2000	RC1787-1860	RC1860-1900	RC1900-1950	RC1950-2000
C		1.7894 (0.0000)	1.4386 (0.0561)	0.3443 (0.1325)	0.4382 (0.0760)
WRC					0.5357 (0.0614)
LDEN1787		-0.1561 (0.0425)			
LDEN1860	0.2599 (0.0268)		-0.2410 (0.1126)		
LDEN1900				0.0095 (0.0000)	
LDEN1950					0.0041 (0.0178)
DCOAST	-0.1111 (0.3749)	0.0960 (0.2128)	0.1084 (0.4801)	-0.3669 (0.0090)	0.2159 (0.3081)
MAD	1.2962 (0.0000)	0.4200 (0.0139)	1.1795 (0.0013)	0.6141 (0.0767)	1.4884 (0.0147)
LALT	-0.1318 (0.0000)	-0.0546 (0.0145)	-0.1159 (0.0099)	-0.0001 (0.4563)	-0.0011 (0.0000)
LRAIN	0.02960 (0.6979)	-0.0858 (0.1941)	0.0418 (0.7138)	0.0000 (0.6211)	-0.0004 (0.0908)
λ	0.5845 (0.0337)	0.5598 (0.0533)		0.7477 (0.0000)	
Breusch-Pagan	2.1861 (0.8228)	1.7656 (0.8805)	6.0307 (0.0490)	2.3241 (0.8027)	12.6948 (0.0264)
N	48	48	48	48	48
R^2-corr.	*0.6666	*0.3187	0.2596	*0.4070	*0.6654
AIC	13.3762	-29.7423	24.9168	34.5382	79.6154
SBIC	22.7327	-18.8151	36.1440	45.7654	92.7135
LIK	-1.6884	20.8711	-6.4584	-11.2691	-32.8075
MORAN'S I			1.1571 (0.2472)		
LM-LAG	1.1754 (0.2782)	2.2525 (0.1333)	0.5955 (0.4403)	0.1215 (0.7273)	1.4995 (0.2207)
LM-ERR	1.6092 (0.2046)	1.1003 (0.2942)	0.4713 (0.4924)	3.5502 (0.0595)	0.9572 (0.3278

Notes: P-values are given in brackets. WRC is the coefficient accompanying the spatial lag of the endogenous variable in each model. λ is the spatial autocorrelation coefficient where cases of autocorrelation were detected in residual values.* Because of the presence of spatial autocorrelation, the adjusted determination coefficient is not appropriate to measure goodness of fit, and in this case we provide the squared value of the correlation between the dependent variable and the value estimated. In the two last columns the variables measuring density, rainfall and altitude have been taken at levels rather than in natural logarithms, because the selection criteria indicated that this functional form would be better for the two periods concerned.

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