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Daniel A. Tirado
Universitat de València

Alfonso Díez-Minguela
Universitat de València

Julio Martínez-Galarraga
Universitat de València

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Daniel A. Tirado*
Universitat de València

Alfonso Díez-Minguela**
Universitat de València

Julio Martínez-Galarraga***
Universitat de València

Abstract

This paper explores regional (NUTS3) income inequality in Spain, 1860-2010. Using a novel dataset spanning 150 years, we analyse the evolution of inequality in regional per-capita GDP. To do this, we follow the growth literature and use spatial exploratory tools. Our aim is to understand not only the long-term evolution as regards convergence or dispersion, but also aspects related to income distribution, i.e. modality, mobility and spatial clustering. We therefore use tools such as kernel density estimates, boxplots, transition probability matrices, Shorrocks indices, Kendall's τ , Moran's I and LISA maps. The main finding is that there were two clearly distinguishable periods in the economic development process. First, there was an upswing in regional inequality accompanied by a certain mobility between 1860 and 1930. This was followed by a period of regional convergence lasting until the 1980's, in which mobility in income class or rank was rather low. As a result, spatial clustering became more significant and income distribution was transformed. Decreasing regional inequality was thus accompanied by a geographical concentration of the richest and poorest regions. While wealthy Spain was located in the north-east, poor Spain was in the south, particularly the south-west. Mobility has also been virtually non-existent in recent decades. All in all, the study shows the importance of history in the shaping of Spain's regional income distribution.

JEL classification: C21, O18, R0, N64, F14

Keywords: Regional inequality; Spain; Regional growth; Economic history

*Daniel A. Tirado-Fabregat, Universitat de València, E-mail.: daniel.tirado@uv.es

** Alfonso Díez-Minguela, Universitat de València, E-mail.: alfonso.diez@uv.es

*** Julio Martínez-Galarraga, Universitat de València, E-mail.: julio.martinez-galarraga@uv.es

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“So the last shall be first, and the first last: for many be called, but few chosen”

St. Matthew (20:16)

1. Introduction

Regional income inequality is one of the central issues on the agenda of policymakers at national and supranational level. Despite efforts to solve the problem, regional disparities in income remain large, even between well-integrated markets. For example, the European Union has introduced several territorial cohesion programs aimed at reducing regional inequalities. However, the publication of the Eurostat Regional Yearbook in 2010 confirmed that considerable disparities still existed. While Inner London (UK) appeared as the wealthiest region (NUTS2) in terms of per-capita GDP, Severozapaden (Bulgaria) was at the other extreme. Indeed Inner London per-capita GDP was 3.24 times greater than the EU-27 average and 12 times that of Severozapaden.

Regional disparities do not just correspond to extreme cases. The 2010 Eurostat Regional Yearbook also indicates that 68 European regions (NUTS2) had income levels less than 75% of the EU-27 average. In addition, it shows that the geography of regional inequality in Europe follows a well-defined spatial pattern, in which wealthy regions are clustered around a continental axis that stretches from the north to the centre of Europe, passing through the southern UK, Denmark, the Netherlands, Belgium, Île-de-France, Germany and northern Italy. This axis, known as the blue banana, has been remarkably persistent since at least the final decades of the 20th century (Combes & Overman, 2004)¹.

Under these circumstances the magnitude of the disparities, the territorial issues involved and the apparent lack of effectiveness of the policies applied have fuelled the proliferation of studies on the evolution and determinants of regional income inequality². In the last decade historical regional GDP estimates have been constructed for a number of European countries (Rosés & Wolf, forthcoming), thereby enabling researchers to make further progress in the study of long-term trends in regional inequality in many countries for the 20th century and, in some cases, from the mid-19th century onwards.

¹ Regional (NUTS2) disparities in per-capita GDP are notable within the EU as well. In the UK, Inner London per-capita GDP (3.24, with EU-27=1.00) was 4.8 times higher than that of West Wales and the Valleys (0.65). In Spain, per-capita GDP in the Basque Country (1.31) was 1.9 times greater than in Extremadura (0.69). Despite the policies implemented to reduce regional income inequality, particularly after the return to democracy in the late 1970s, there are still significant disparities in Spain.

² See Magrini (2004) and Breinlich et al. (2014) for recent reviews of the empirical literature.

Williamson (1965) paved the way as regards the analysis of regional income inequality. This seminal work looked at the long-term evolution of regional inequality in the United States and posed a hypothesis: that during the economic development process, regional inequality exhibited an inverted U-shaped pattern with increasing inequality in the early stages, mainly the 19th century, and convergence thereafter. Kim (1998) empirically supported this hypothesis and confirmed the inverted U-shaped pattern of regional inequality in the United States. He noted that specialization and divergence in economic structures would explain increases in inequality during the second half of the 19th century. In the 20th century, further progress in economic growth and national market integration was accompanied by a reduction in regional disparities, which could be explained by the homogenization of economic structures and convergence in productivity across states (also Mitchener & McLean, 1999; Caselli & Coleman, 2001; Kim & Margo, 2004).

In Western Europe, estimates of historical GDP at regional level have recently become available. For some countries the evolution of regional income inequality over the long term shows an inverted U-shaped pattern too. Crafts (2005), using new regional per-capita GDP estimates for Britain, found evidence to support this hypothesis. Regional inequality increased after 1871 and reached its highest point in the early 20th century, declining thereafter. From the 1970s onwards, it has been on the rise again. However, Geary & Stark (2015a, 2015b) have questioned these results. They claim that regional disparities were declining before the First World War. In the case of France, Combes et al. (2011) explored the long-term evolution of spatial inequalities across *départements* and observed an inverted U-shaped pattern. For them, economic agglomeration was a major force for change from 1860 to 1930, a period that saw an increase in inequality. Regional inequality then followed a downward trend mainly because of falling differences in human capital stock across *départements*. For Portugal, Badia-Miró et al. (2012) provide empirical evidence in support of an inverted U-shaped curve, noting that regional inequality reached its peak much later, during the 1970s.

Other studies, however, do not fully support an inverted U-shaped pattern as suggested by Williamson (1965). Felice (2011) finds that regional disparities in Italy reached a peak in the aftermath of the Second World War. Since then the dynamics of regional inequality have followed a pattern of convergence between the northern and central regions, but not

between these and the *Meridionale* regions, thus generating a striking North-South divide. For Sweden, Enflo et al. (2014) see a strong pattern of regional convergence up to the 1980s and an increase in inequality afterwards. Finally, for Belgium, Buyst (2010, 2011) points to a reversal of fortunes between northern (poor to rich) and southern (rich to poor) provinces in the course of the 20th century.

With regard to Spain, the evolution of regional inequality has been well documented since 1955 due to the publication of a harmonized biannual time-series on regional income (BBV, 1999). These data have been widely used in the regional studies literature, which have mostly followed Barro & Sala-i-Martin (1991) methodology. The main findings have pointed to the existence of regional (NUTS2/NUTS3) convergence (both β and σ) from 1955 to the 1970s. But this process came to a halt in the 1980s and there is no clear-cut evidence of convergence thereafter (Mas et al., 1994; De la Fuente, 2002; Cuadrado-Roura, 2010). Data for previous years are scarcer³, and hence the study of regional inequality in the long term has been particularly challenging. However, new estimates for the period 1860–1930 (Rosés et al., 2010) have made it possible to examine the long-term patterns of regional (NUTS2) per-capita GDP more closely (Martínez-Galarraga et al., 2015). The empirical evidence points to an inverted U-shaped pattern between economic development and regional inequality in Spain. It has been estimated that regional disparities reached a peak around 1920, thus establishing that the starting point of the subsequent convergence process is to be found in the first third of the 20th century.

In short, all this body of research has stimulated the characterization of the evolution of regional income inequality. The empirical analysis of long-term trends in regional inequality has usually been undertaken by applying the concepts of β -convergence and σ -convergence typical of the growth literature (Barro & Sala-i-Martin, 1991 and 1992). However, this literature has failed to capture a number of essential aspects of the internal dynamics of regional inequality (Quah, 1993, 1996, 1997; Durlauf & Quah, 1999). For example, convergence analyses completely overlook issues such as the modality of the distribution, intra-distribution mobility (i.e. the possibility that regions change their relative position over time) and clustering-related aspects. If inequality is closely associated with low mobility, the need for active regional policies to maintain territorial cohesion becomes relevant. As for spatial clustering (i.e. whether high-income regions are increasingly

³ See Álvarez Llano (1986) and Alcaide (2003).

concentrated or dispersed across the space), its importance has been stressed by the new economic geography (NEG), which points to the role played by spatial externalities and their increasing relevance as the process of economic integration advances (Fujita et al., 1999). Therefore identifying the presence of such spatial dependence is essential, not only to get a more complete understanding of the dynamics of regional distribution, but also as an orientation for economic policy.⁴

A more comprehensive understanding of regional income distribution and its policy implications requires that it be considered as a complex concept, involving not only dispersion and convergence but also modality, mobility and spatial clustering. Indeed, substantial efforts have been made in the last two decades to design novel tools to capture these dimensions. Some of these have proved to be extremely useful. For example, non-parametric methods such as kernel density estimates enable us to look at the shape of each distribution and study its modality and the presence of so-called “*twin peaks*” (Quah, 1993, 1997). This descriptive evidence can be supplemented with the use of boxplots, which are of particular interest for detecting outliers in the sample. Correspondingly, it is important to examine whether poorer regions had the chance to improve their relative position over time or whether richer regions lost ground. Markov probability transition matrices make it possible to measure mobility (i.e. Shorrocks index), whereas Kendall’s τ -statistic captures the degree of rank stability (Quah, 1996; Rey, 2004b). Finally, Moran’s I spatial autocorrelation statistic and LISA maps are tools that are widely-used to explore spatial clustering (Anselin et al., 2004; Rey & Montouri, 1999).

All these indicators have been used in recent analyses of regional income disparities in the United States, Western Europe and Japan (e.g. Rey & Montouri, 1999; Rey 2004a; Kang, 2004; Ezcurra et al., 2006; Yamamoto, 2008)⁵. However, these studies have usually restricted themselves to analysing recent decades. In this respect our paper makes two main contributions. First, it offers a long-term view (150 years) of different dimensions of regional income inequality in Spain. The novel estimates of per-capita GDP are decadal, beginning in 1860 and ending in 2010. To our knowledge, this is the first study with such a broad scope in Europe. Second, our unit of analysis is the province (NUTS3) rather than

⁴ In addition, spatial autocorrelation can invalidate the inferential basis of econometric methods, since it violates the assumption of observational independence (Rey & Janikas, 2005). Hence regional analyses should not ignore the spatial component.

⁵ For Spain, see Gardeazábal (1996), Lamo (2000) and Tortosa-Ausina et al. (2005).

the region (NUTS2)⁶. This again is a contribution to the existing literature, and we rely on data from recent research (Rosés et al., 2010; Martínez-Galarraga et al., 2015; Díez-Minguela et al., 2015)⁷. The study thus combines inequality, modality, mobility and spatial autocorrelation statistics to shed further light on the evolution of regional inequality in Spain since the mid-19th century⁸.

Our findings suggest that there are two main scenarios. The first, between 1860 and 1930, roughly corresponds to the early stages of modern economic growth. In this period the process of market integration was underway and modern technologies were becoming more widespread. The second period covers from the 1930s until the present, and therefore includes the later stages of industrialization and the tertiarization of the economy. The most recent decades are characterized by Spain's membership of the European Union (EU) and the development of information and communication technologies (ICTs).

With the advent of industrialization, some Spanish provinces specialized in manufacturing activities more than others and regional income inequality thus increased between 1860 and 1920. Hence inequality came about due to the presence of a small group of rich provinces and a large majority of poor ones. However, this was compatible with moderate but sizeable mobility in income distribution. In addition, from a geographical perspective, relative income levels had a limited relationship with the location of territories within Spain. Nonetheless, in the period 1860-1930 a new picture started to emerge and, once established, this scenario became stronger from the 1930s onwards. In particular, in this second period the shape of the distribution functions of per-capita GDP exhibited a greater degree of bimodality. Likewise, although regional inequality has gradually decreased since the 1930s, the inequality seen at the beginning of the 21st century is not related to the presence of extreme cases. Moreover, from the 1930s to the present, income mobility appears to be rather low. Finally it must be stressed that regional per-capita incomes are increasingly related to the relative location of territories across the space.

⁶ A total of 49 Spanish provinces are included, given that the Canary Islands are taken as one.

⁷ These studies use regional (NUTS3) GDP estimates at factor costs and current prices. Using this information supplemented with population data provided by the Population Censuses, we have constructed per-capita GDP estimates. Rosés et al. (2010) and Martínez-Galarraga et al. (2015) use regional (NUTS2) estimates for their analyses.

⁸ Differences in the size of provinces could be potentially relevant in long-term studies (Milanovic 2005; Tortosa-Ausina et al., 2005). In 2010 Madrid was the largest province, with 6.5 million inhabitants, i.e. around 13.8% of Spain's population. In fact Madrid's population was 68 times that of Soria (95,611 inhabitants). To take this into account we show single and population-weighted measures of inequality and modality (i.e. kernel densities).

In terms of policy-making, there are two main features that characterize regional economic inequality in Spain over time. Firstly, there is a quasi-non-existent mobility in class or rank since 1940, i.e. wealthy provinces in 1940 tended still to retain their relative positions in 2010, whereas the poor provinces remained poor. As a result, the historical trajectories cannot be labelled along the lines of *American Dream* or *Nightmare on Elm Street*. Indeed quite the opposite, since a marked stability in income distribution is observed. Secondly, there is a high degree of spatial correlation observed in relative income. This was already present in the past, but it has become consolidated throughout the second half of the 20th century. Consequently a map with ‘two Spains’ emerges, where wealthy provinces are located in the north-east while the poorest ones cluster in the south. Bearing this in mind, spatial polarization becomes a major concern.

The paper is structured as follows. In the next section, we present a set of indicators to explore the evolution of regional (NUTS3) per-capita GDP inequality in Spain, 1860-2010. Sections 3 and 4 examine alternative aspects of regional income distribution, such as modality and mobility. Spatial clustering and geographical patterns are presented in Section 5. Finally, in Section 6 we summarize our main findings and discuss policy implications.

2. Long-term trends in regional income distribution in Spain: inequality

Previous attempts have been made to depict the long-term evolution of regional income inequality in Spain. Rosés et al. (2010) explored per-capita GDP inequality for Spanish regions or *comunidades autónomas* (NUTS2) between the mid-19th century and the 1930s. Using a battery of indicators - Gini coefficient, Theil index and variance of logarithms and their bootstrapped errors - they found that inequality increased between 1860 and 1900. Although it decreased slightly in the following decade, per-capita GDP inequality across Spanish regions reached a maximum in 1920, then declined. Their work confirms that the relationship between economic development and regional inequality formed an inverted U-shaped curve for the period 1860-1930. In fact there appears to be weak β -convergence of around 0.7% per year.

Martínez-Galarraga et al. (2015) studied the long-term evolution of regional inequality for Spanish regions (NUTS2) for the period 1860-2000. Their results again confirm the presence of an inverted U-shaped curve. Additionally, they point to a downward trend for

most of the 20th century, briefly interrupted in the aftermath of the Civil War (1936-39). However, this downward trend came to a halt in the 1980s and since the final decades of the 20th century could be in the process of reversing (see Figure 1a).

Following Martínez-Galarraga et al. (2015), we now use decadal regional GDP estimates for Spanish provinces (NUTS3) for the period 1860-2010⁹. To capture inequality we first calculate a population-weighted coefficient of variation, known as the Williamson index or WCV, which can be computed as follows:

$$\text{WCV} = \sqrt{\sum_{i=1}^n \left(\frac{y_i}{y_m} - 1\right)^2 \cdot \frac{p_i}{p_m}} \quad (1)$$

where y and p stand for per-capita GDP and population, while i and m refer to provincial and national values respectively (Williamson, 1965: p.11). We then include other inequality indicators such as the Gini and Theil indices.

Figure 1b shows regional income inequality in Spain at province level (NUTS3) between 1860 and 2010 and confirms the presence of an inverted U-shaped curve. We observe an upward trend in regional income inequality from 1860 to 1920¹⁰. From then on, convergence across Spanish provinces predominates. This downward trend was particularly strong from 1960 to 1980, but in recent decades regional income inequality appears to have become more stable. Whether the downward trend signifies deceleration or reversal (N-shaped curve) remains to be seen.

Interestingly, a comparison of Figures 1a and 1b provides some noteworthy information. The trends in the long-term evolution of regional income inequality are very similar for both NUTS2 and NUTS3. While the importance of dealing with different spatial scales has been highlighted in the economic geography literature, in the case of Spain, at least, the pictures that emerge at provincial and regional levels are very similar¹¹. These major trends also appear when we consider alternative inequality indicators like the Gini and Theil indices (Figure 1c). The main difference can be found in the evolution depicted over recent

⁹ The dataset used in Rosés et al. (2010), which includes the years 1860, 1900, 1910, 1920 and 1930, is completed with the provincial estimates of GDP provided in Díez-Minguela et al. (2015) for 1870, 1880 and 1890. For the period 1940-2000 we use the data in Martínez-Galarraga et al. (2015). Data for 2010 come from Funcas (2011).

¹⁰ The peak reached in 1920 might be related to the uneven regional impact of the First World War.

¹¹ Yamamoto (2008) deals with the issue of multiple spatial scales, using different territorial definitions in the analysis of the regional trajectories of spatial income inequality in the United States.

decades. The slight increase in provincial income inequality is only apparent in the Williamson coefficient of variation, while the tendency of the Gini and Theil indices, which are not population-weighted, is moderately downward.

As already noted, Figures 1a, 1b and 1c provide evidence in support of Williamson (1965). Regional income inequality rose in the early stages of economic development and then declined. In this the Williamson (1965) hypothesis is largely compatible with the predictions of the new economic geography (Krugman, 1991; Puga, 1999; Alonso-Villar, 2007), according to which falling transport costs and increasing returns to scale would be central to the industrial agglomeration process, clustering and regional income inequality. All in all, Figures 1a, 1b and 1c just capture the major trends. In the next sections we complete our descriptive analysis with other relevant dimensions of regional inequality: modality, mobility and spatial clustering.

Figure 1a. Regional (NUTS2) income inequality (WCV), Spain 1860-2010 (1860=1)



Figure 1b. Regional (NUTS3) income inequality (WCV), Spain 1860-2010 (1860=1)

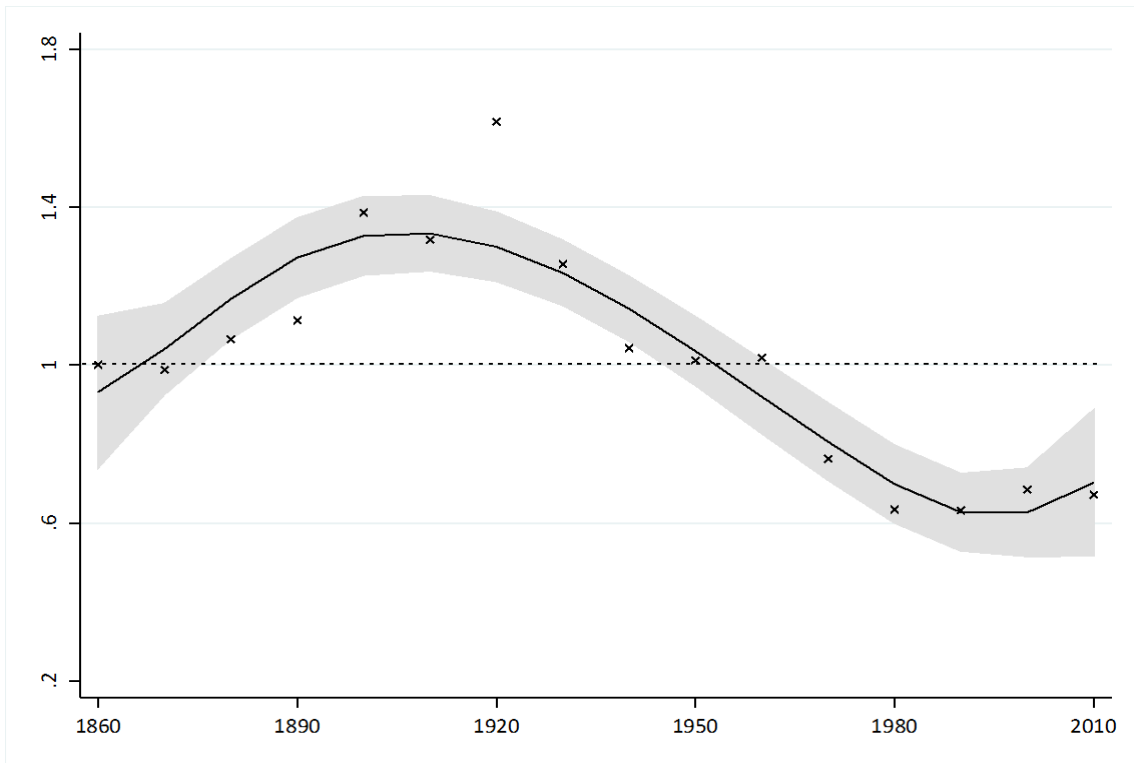
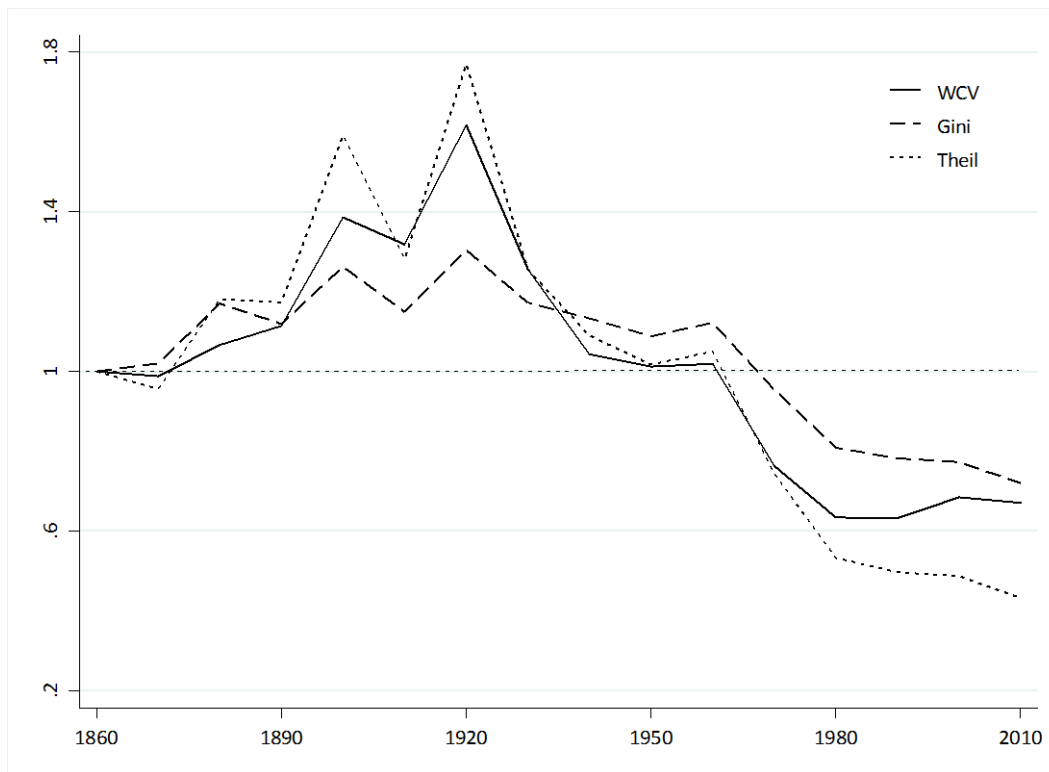


Figure 1c. Regional (NUTS3) income inequality (WCV; Gini; Theil T), Spain 1860-2010 (1860=1)



Source: main text.

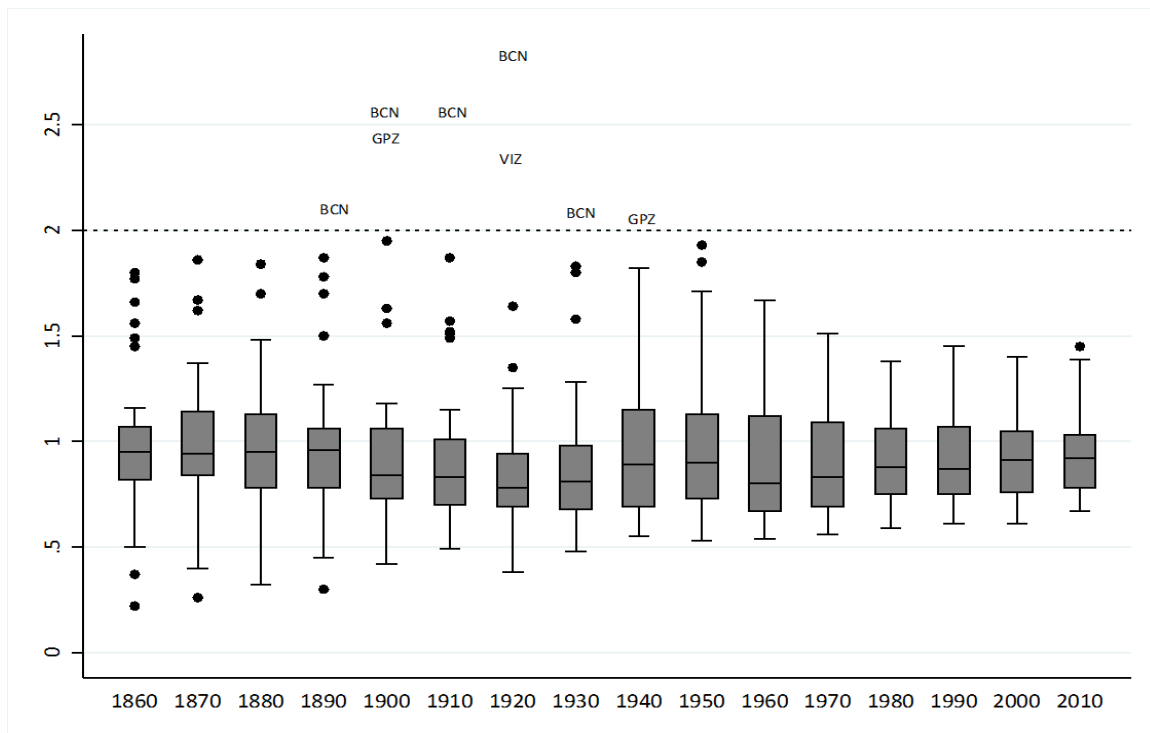
3. Long-term trends in regional income distribution in Spain: modality

To further examine per-capita GDP inequality across Spanish provinces (NUTS3), we first use a distribution dynamics approach (Quah, 1993, 1997). Given the nature of our dataset, we normalize per-capita GDP for each decade, with the national average being equal to one. We present boxplots and kernel densities in Figures 2 and 3. Figure 2 illustrates income inequality in boxplots for each decade. A boxplot is a graphic representation in which values from the 25th to the 75th percentile of the distribution are grouped in a box. The 50th percentile is represented by a dividing line within the box. Two vertical lines appear at the upper and lower limits of the box. These lines give information about the adjacent values of the distribution, i.e. they are order statistics corresponding to actual observations of the variable that cover the rank of observation that cannot be considered atypical¹². Outliers are thus *outside* the box (marked by a black spot, while the more extreme cases are represented by a 3-digit code to identify the province). Boxplots are therefore a useful tool for assessing the degree of dispersion within a distribution and the outliers.

As Figure 2 indicates, differences in per-capita GDP across Spanish provinces have varied substantially over time. While dispersion was a distinguishing characteristic in the early stages, the number of outliers has decreased since 1920. For example, per-capita GDP for Barcelona (BCN) was over twice the national average from 1890 to 1930, whereas in 2000 and 2010 it was only 1.20 and 1.18 times the national average. Outliers are symptomatic of unequal economic growth, which was a distinguishing feature in the early stages of industrialization. This was the case in Spain, where some provinces (i.e. Barcelona, Guipuzcoa, Madrid and Vizcaya) had very high levels of per-capita GDP in the early 20th century. The increase in average inequality would therefore be linked to the take-off of a few regions that moved ahead of the central mass of the distribution. After this initial take-off the number of outliers declined, clearly pointing to lower dispersion in the per-capita GDP distribution over time. Also, not only do the outliers virtually disappear, but the boxes become more compressed. This would indicate that the average levels of inequality have been decreasing over time.

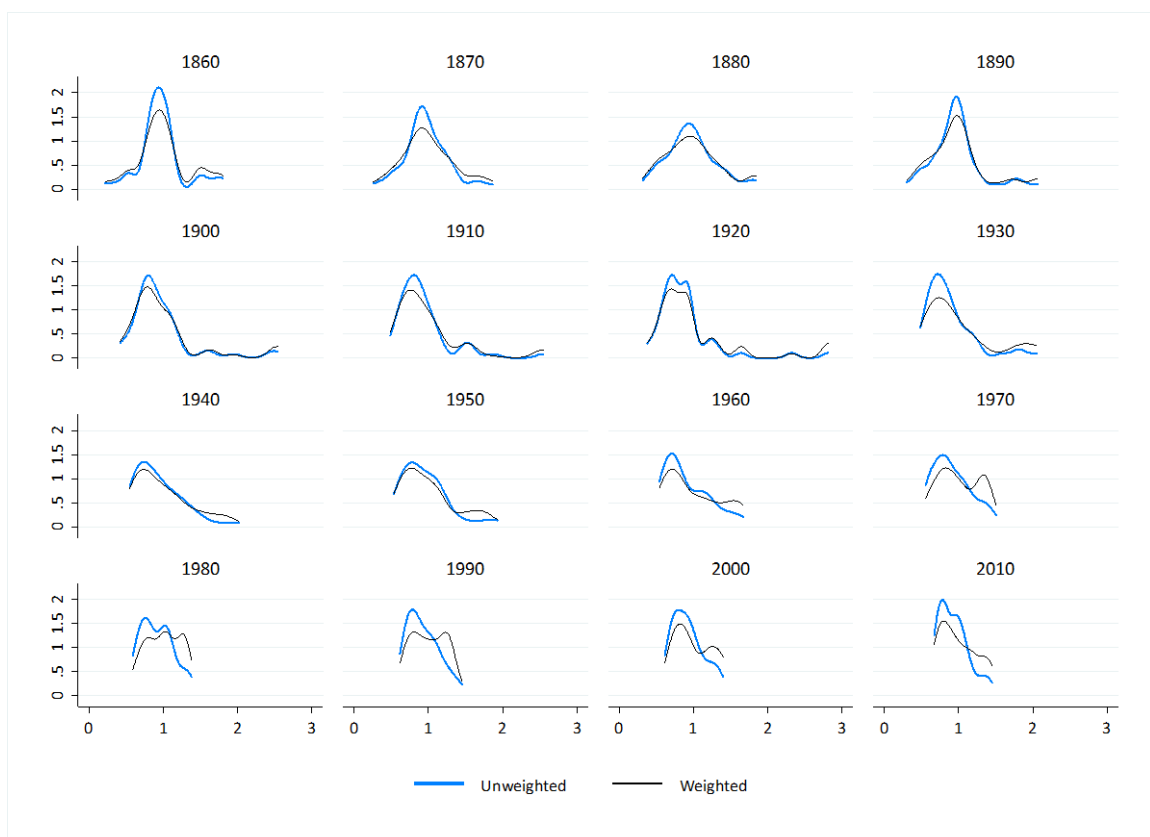
¹² From the inter-quartile rank, $R(\xi_{.25})$, the upper adjacent value is defined as the actual value of the variable represented which is not larger than $\xi_{.75} + 1.5R(\xi_{.25})$; the lower adjacent value would be the actual value of the variable represented which is not lower than $\xi_{.25} - 1.5R(\xi_{.25})$.

Figure 2. Boxplots, per-capita GDP by province and year (Spain = 1)



Source: main text.

Figure 3. Kernel densities, per-capita GDP by province and year (Spain=1)



Source: main text.

To enhance our discussion, we show kernel densities in Figure 3. This allows us to graphically explore the modality of the distribution for each decade. Figure 3 illustrates the kernel densities for each decade treating each province as an equal unit of observation. It also includes the population-weighted kernel densities in order to take into account the different sizes of the provinces in terms of population¹³. As might be expected, changes in kernel distribution estimates are consistent with the evolution of overall inequality. However, these general trends are compatible with very different distributional shapes.

We first look at the evolution depicted by the unweighted kernels. It is interesting to observe that during the initial period of relatively low inequality (1860) a large number of provinces were grouped around the Spanish average, as shown by the greater height of the distribution. The distribution also shows a tendency towards there being a cluster of regions in the tails of the distribution, especially in the upper tail. While the lower tail gradually disappeared, with the take-off of some provinces the upper tail became stretched. In other words, as shown in the boxplots, regional distribution was characterized by a few regions forging ahead of the rest of the economy. Up to 1930 the upper tail moves forward, showing the favourable position reached by a number of provinces, mainly those that became industrialized during the stage characterized by the integration of the Spanish market. These provinces reached values for income per capita around 2 times higher than the Spanish average.

After the Civil War (1936-39), the shape of the distribution shows a decrease in the upper tail that tallies with the story that emerges from the boxplots. Also, the distribution shows an evolution towards bimodality or polarization up to 1980, i.e. during the period of convergence. In recent decades, together with the halt in the reduction of regional inequality, bimodality has become less pronounced although it might be re-appearing with the turn of the century, in parallel with the new upswing in regional inequality. In this regard it is worth drawing attention to the observed re-emergence of an outlier in the boxplot for 2010. Overall, the unweighted kernel densities depicted in Figure 3 thus support our central story.

An interesting feature emerges when we weight Spanish provinces by population. While the evolution during the second half of the 19th century and the first half of the 20th is quite similar for both densities, from then onwards there is a notable change. The population-

¹³ For the sake of simplicity, we chose the Gaussian kernel with a width that minimized the mean integrated squared error (Silverman, 1992).

weighted kernels show that the more unimodal distribution typical of the early stages of economic development gradually became bimodal in the second half of the 20th century. Hence the gradual disappearance of atypical values observed in the boxplots would translate into the emergence of a bimodal structure in provincial income per capita distribution throughout the period 1940-2010. In other words, in the Spanish case the reduction of inequality is accompanied by the appearance of a persistent bimodal structure.

Kernel diagrams provide information on what the whole distribution looks like over different periods of time, but they tell us nothing about mobility within the distribution. The next section will analyse other aspects of the distribution, particularly mobility within Spain, i.e. the degree to which provinces have climbed up or down since 1860. The aim is to find out to what extent there were changes in the regional rankings, or whether on the contrary the peaks and troughs of polarization were compatible with stability in the positions of regions across the national distribution.

4. Long-term trends in regional income distribution in Spain: mobility

There are several exploratory tools for studying regional income mobility over time. Following Quah (1993, 1996), we look at transition probability matrices that provide the estimated probability p_{ij} of transition from income class i to income class j during a given period of time S (Hammond & Thompson, 2002). In this case we rank the 49 NUTS3 provinces according to their per-capita GDP and group them into five equal classes or quintiles (very poor, poor, average, rich and very rich)¹⁴. Our dataset contains provincial per-capita income in current pesetas, hence the cut-offs vary over time¹⁵. Therefore, if y_t is a vector containing the income distribution in year t , then:

$$y_{t+s} = P_{t,t+s} \cdot y_t \quad (2)$$

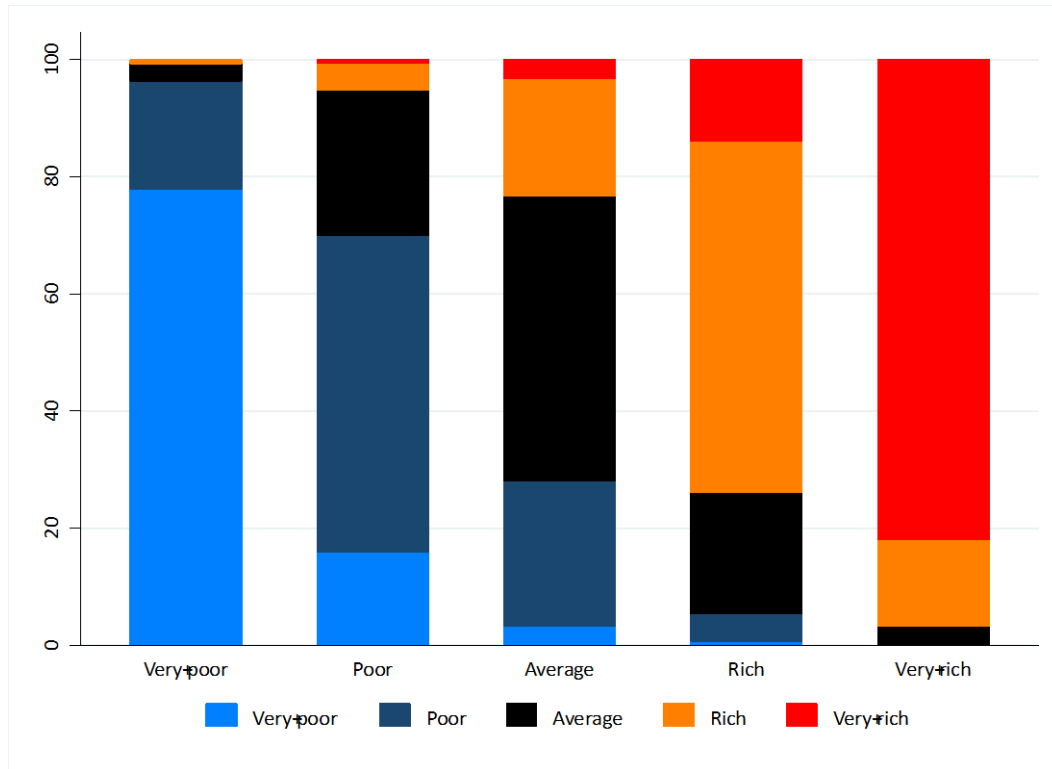
Transition probability matrices allow us to study regional income mobility in greater detail. Figure 4 shows the average probability p_{ij} for our period of study, 1860-2010. As expected,

¹⁴ Regional (NUTS3) per-capita GDPs are ranked from highest to lowest for each year. Provinces are then classified into five equal income classes or quintiles (very poor, poor, average, rich and very rich). Each quintile contains 10 provinces, except for the bottom or “very poor” one, which has 9. Our sample comprises 49 provinces. We do not take into account differences in province size, as proposed by Tortosa-Ausina et al. (2005). The transition probability matrices are therefore not population-weighted.

¹⁵ Hammond & Thompson (2002) use the mean-adjusted log of relative per-capita income to create cut-offs, and thus income classes. These cut-offs are maintained over time.

mobility is lower at the extremes, both the top and bottom quintiles. To be more precise, the average probability of being “very rich” and staying there is above 80%. Table A.1 in the Appendix presents the transition probability matrices for the periods 1860-2010, 1860-1930 and 1940-2010, while Figures A.1 and A.2, also in the Appendix, show the transition probabilities for the two periods not included in Figure 4. The diagonal p_{ii} provides the average probability of staying in the initial income class. When we divide the sample into two major periods, regional income mobility seems higher in the earlier one. All estimated probabilities p_{ij} for 1940-2010 are greater than for 1860-1930.

Figure 4. Regional (NUTS3) income (class) mobility, Spain 1860-2010



Source: See Table A.1 in the Appendix.

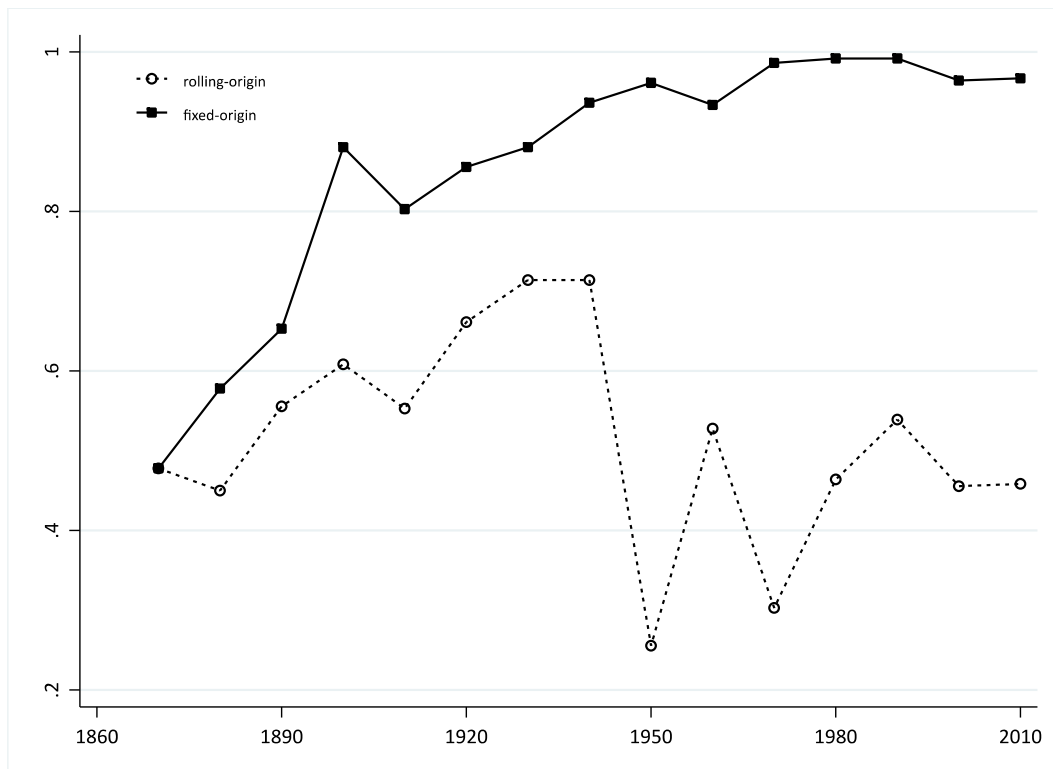
To provide further insight we use the transition matrices to calculate the Shorrocks index (Shorrocks, 1978), namely SHI_{t+s} , which can be computed as follows:

$$SHI_{t+s} = \frac{\#Classes - \text{Trace}(P_{t,t+s})}{\#Classes - 1} \quad (3)$$

where $\#Classes$ stands for the number of income classes. Since we have five equal income classes or quintiles, then $\#Classes = 5$. Trace captures the sum of the elements in the

diagonal of the transition matrix. Given that $\#Classes = 5$, then SHI_{t+s} ranges between 0 and 1.25. The higher the Shorrocks index, the more mobility there is across income classes. Following Yamamoto (2008) we employ two methodologies. First, we use the regional income distribution in the earliest year or 1860 as “fixed-origin”. Then we use quintiles based on the distribution at the beginning of each period, hence “rolling-origin”. For 1910-1920 and 1980-1990, for example, we use the 1910 and 1980 distribution for the “rolling-origin” Shorrocks index. Figure 5 shows both.

Figure 5. Regional (NUTS3) income (class) mobility (Shorrocks indices), Spain 1860-2010

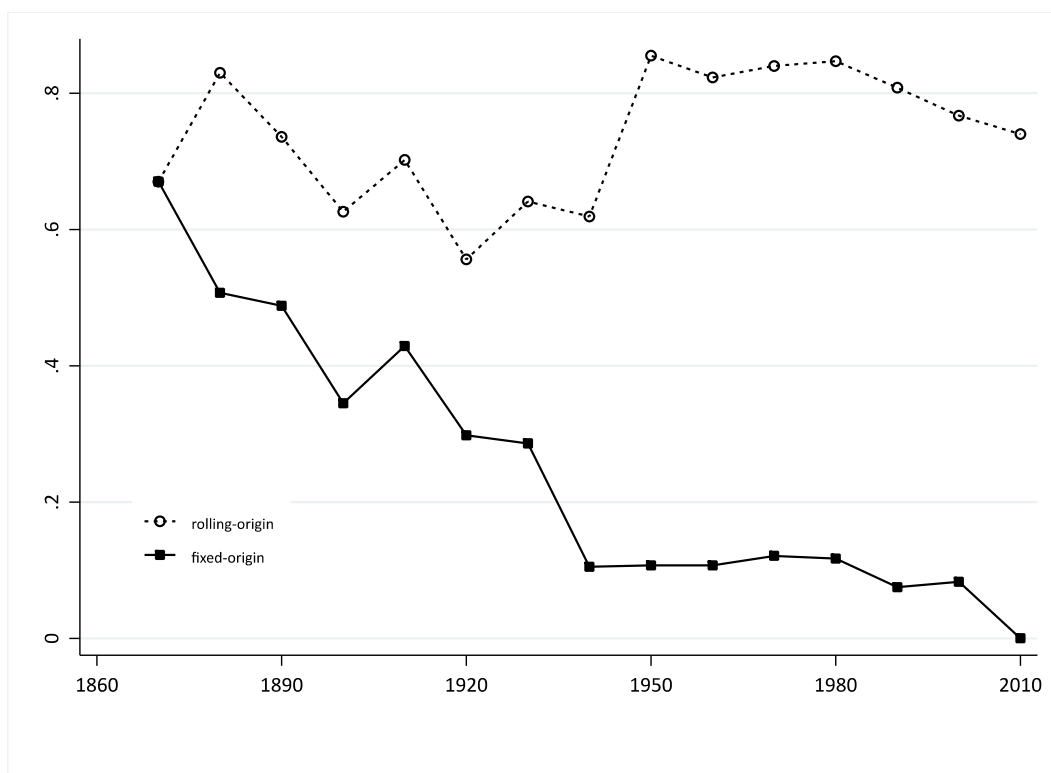


Source: main text

Note: “rolling-origin” corresponds to 10-year intervals.

As Figure 5 illustrates, there are two scenarios. From 1860 to the Spanish Civil War (1936-39), mobility, measured as a “rolling-origin” index, was higher than it would be later. Indeed mobility was increasing in the early stages, while it seems trendless for most of the second half of the 20th century. This suggests that regional income mobility was noteworthy in the early stages of economic development. The rise of the Basque Country coincided with the fall of Andalusia, in a period in which market integration was under way. With industrialization new opportunities appeared, which stimulated economic growth in some provinces. As a result regional inequality increased, and so did income class mobility. Later, a marked stability in regional income distribution can be observed.

Figure 6. Regional (NUTS3) income (ranking) mobility (Tau rank), Spain 1860-2010



Source: main text

Note: “rolling-origin” corresponds to 10-year intervals.

However, increased mobility across income classes need not imply changes in the rankings or relative positions of provinces. Similarly, low mobility, as measured by the Shorrocks index, could be associated with a high degree of positional change. To check our previous findings on income class mobility we compute Kendall’s τ rank correlation coefficient, which considers the degree of concordance in the rankings of all pairs of observations for two variables. In our case the variables of interest would be per-capita GDP in the first and last years of the period. If two provinces have the same relative rankings in both periods, that pair is said to be concordant. But if the relative rankings changed, then the pair is discordant. With N observations there are $(N^2 - N)/2$ possible pairwise comparisons. We therefore use Kendall’s τ rank correlation coefficient to capture ranking as opposed to class mobility. It can be computed as follows:

$$\tau = \frac{PW_c - PW_d}{(N^2 - N)/2} \quad (4)$$

where PW_c is the number of concordant pairs and PW_d the number of discordant pairs. If all pairs are concordant, then $\tau = 1$, whereas if all pairs are discordant, $\tau = -1$. Thus high values of τ would reflect low mobility in income ranking. Figure 6 shows the long-term evolution of Kendall's τ . Again we use the "rolling-origin" and "fixed-origin" approaches. Figure 6 confirms our previous findings. Rank mobility is lower and trendless in the second half of the 20th century. The trends of the Shorrocks indices and Kendall's τ are inversely related¹⁶. The correlation coefficient between class and rank mobility using the "rolling-origin" and "fixed-origin" approaches is -0.793 and -0.941 respectively. This result calls for further evaluation of the main forces of socioeconomic change to find out why mobility has been relatively low in recent decades, even after Spain joined the European Union.

5. Long-term trends in regional income distribution in Spain: spatial clustering

In previous sections we described regional income distribution in Spain 1860-2010 in terms of inequality, modality and mobility. However, another well-known phenomenon in regional studies is spatial-clustering. A simple illustration of the evolution of regional income distribution can be seen in Map 1, which shows Spanish provinces classified in quintiles as above. Between 1860 and 1930, a number of provinces in the south shifted from the top and second quintiles to the fourth, "poor" quintile. This downward spiral continued during the second half of the 20th century. By 1990 most of the southern provinces were at the bottom of the regional income distribution. Meanwhile the richest provinces were clustering in the north-east. In short, it can be observed that the core-periphery structure of present-day Spain was already established by the 1930s. The resulting pattern was characterized by a decreasing gradient of per-capita GDP from the north-east to the south-west of Spain.

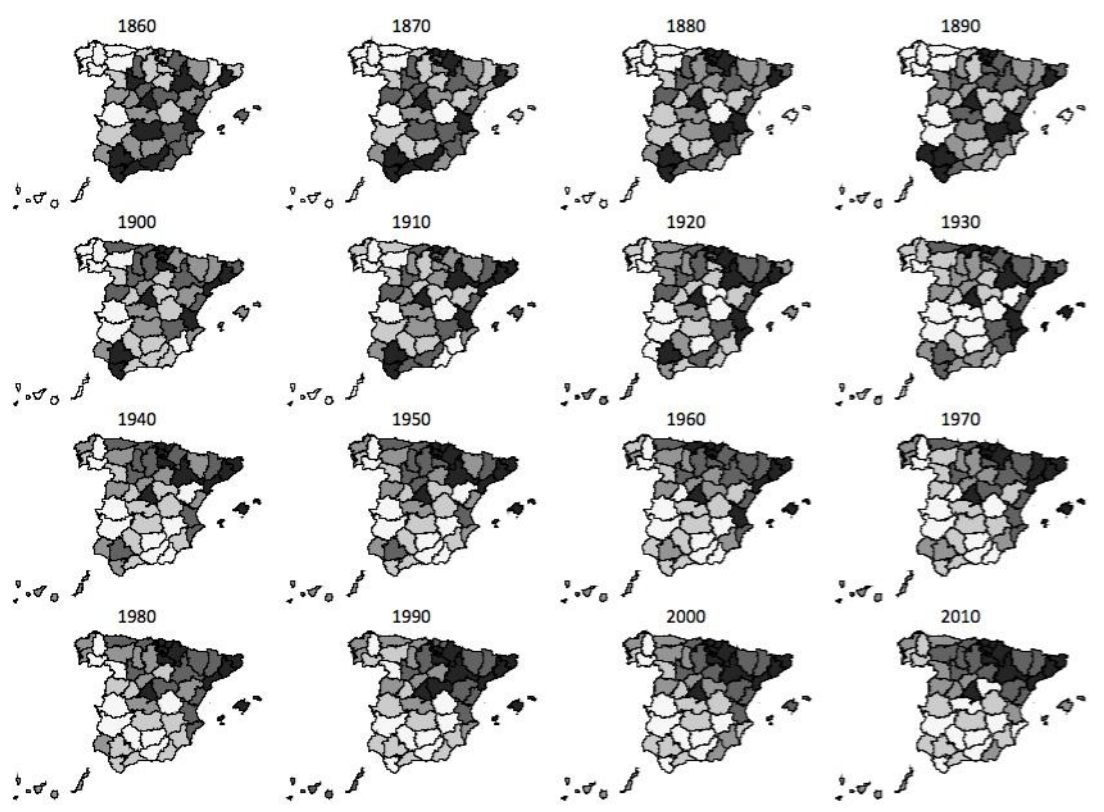
To test for the presence of spatial clustering we use Moran's I spatial autocorrelation statistic, which can be defined as follows:

$$I = \frac{\#Provinces}{\Sigma_i \Sigma_j \omega_{ij}} \frac{\Sigma_i \Sigma_j \omega_{ij} (Y_i - \bar{Y})(Y_j - \bar{Y})}{\Sigma_i (Y_i - \bar{Y})^2} \quad (5)$$

¹⁶ By definition, high values for Kendall's τ are associated with low rank mobility, whereas high values for the Shorrocks indices reflect high income mobility.

where $\#Provinces$ is the number of provinces, Y_i is provincial per-capita GDP, \bar{Y} is the average of Y , and ω represents the matrix of spatial weights¹⁷. We use two different matrices to compute Moran's I: a contiguity matrix and an inverse distance (provincial capitals) squared spatial matrix.

Map 1. Regional (NUTS3) per-capita GDP, Spain 1860-2010



Source: main text.

Note: Spanish regions (NUTS3) have been grouped in quintiles for each given year. The darkest regions are in the top or “very rich” quintile, while the bottom or “very poor” quintile is shown in white.

According to Map 1, we should expect the presence of spatial autocorrelation. On the whole, Moran's I statistic confirms our expectations, being significant at a level of either 1% or 5% for all years (see Figure 8). The trajectories reveal that spatial autocorrelation decreased between 1860 and 1930. This is partly due to the concentration of industry in certain non-contiguous provinces, e.g. Barcelona and Vizcaya. It then rapidly increased, reaching a peak in 2000. Generally speaking, spatial clustering and decreasing regional inequality would indicate that high-productivity activities are spreading from the richest provinces to contiguous or nearby ones during the second half of the 20th century.

¹⁷ Subindex i denotes the province being studied, while j denotes the remaining provinces.

However, spatial clustering occurs when income (class/rank) mobility is low, which would suggest that relative positions have been consolidated.

Figure 8. Spatial clustering (Moran's I) of regional (NUTS3) per-capita GDP, Spain 1860-2010

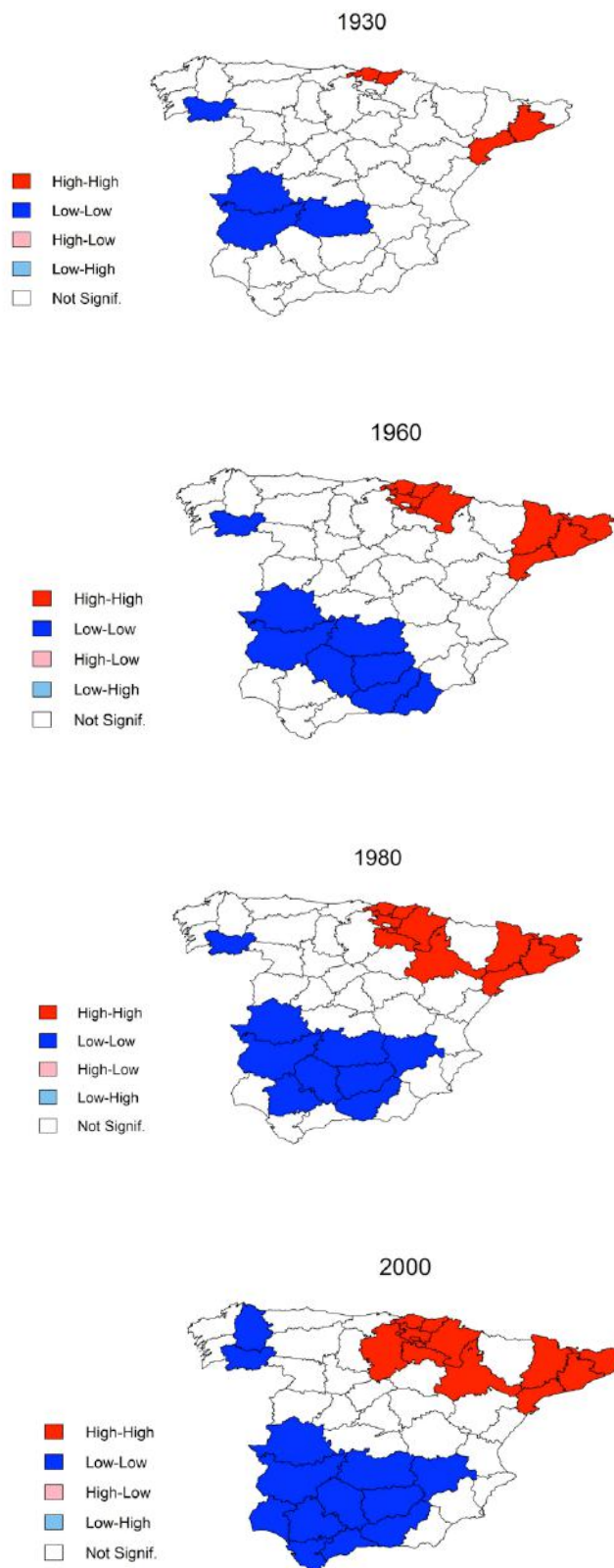


Source: main text.

Note: All values are statistically significant at 1% except for the years 1910, 1920 and 1930, for which values are significant at 5%.

To further analyse spatial clustering we present LISA (local indicators of spatial association) maps of regional income inequality. LISA maps are useful for identifying the geographical position of rich (poor) provinces and the degree of spatial autocorrelation. In these maps the blue-coloured provinces illustrate clusters with low per-capita GDP, while the red ones reflect those with high levels. Earlier we pointed out that spatial clustering increased rapidly from 1930 onwards. Map 2 shows that there are four major clusters with correlated levels of per-capita GDP by 1930, two of them (rich) in the north-east and two (poor) in Extremadura-Ciudad Real and Orense. Since then these clusters have expanded. By 2000 a cluster in the north-east can be plainly identified, while the southern provinces have become spatially clustered along with Orense and Lugo in the north-west. This suggests the creation of two major poles within Spain.

Map 2. Spatial clustering. LISA maps, 1930-2010



Source: main text.

6. Concluding remarks

This study explores different dimensions of the long-term evolution of regional inequality in Spain 1860-2010. To begin with we have shown that, using “provincias” (NUTS3) as a territorial scale, the main findings provided by previous studies based on “comunidades autónomas” (NUTS2) are not substantially altered (Rosés et al., 2010; Martínez-Galarraga et al., 2015). Regional income inequality exhibited an upswing between the mid-19th century and the early 20th century. Convergence then emerged, though this process came to a halt in the 1980s. In the late 20th century and early 21st it can be argued that the evolution of regional inequality in Spain might be turning into an N-shaped curve. To describe regional disparities we have expanded previous approaches and considered three additional dimensions: the shape of the distribution function, the degree of mobility, i.e. whether or not poor/rich provinces have retained their relative positions over time, and finally the existence of spatial patterns in income inequality.

Our findings allow us to split 1860-2010 into two major periods. Firstly, we have shown that regional inequality was relatively low in the early stages, as opposed to the first decades of the 20th century. Regional disparities in income were a result of the emergence of poles, e.g. Barcelona and Vizcaya. The upward part of the inverted U-shaped pattern coincided with the strengthening of a distribution characterized by a stretching of the upper tail. Regional inequality thus reflected a small group of wealthy provinces and a majority of (relatively homogeneous) poor ones. Spatial clustering, although statistically significant, was not very high, due mainly to the limited number of wealthy provinces. This would be consistent with the presence of poles with few non-contiguous dynamic provinces. A certain mobility in the regional income distribution can also be observed insofar as the ranking of provinces underwent changes between 1860 and 1930.

Secondly, regional inequality has gradually declined since the 1930s. However, the decrease in inequality coincided with the appearance of bimodality, i.e. it came about not only due to a lessening of the differences between rich and poor, but also due to a relative increase in the homogeneity of the rich and poor provinces. This reduction in inequality was accompanied by a lessening of mobility and a dramatic increase in spatial clustering. This means that, although differences between rich and poor provinces decreased, their relative positions to a large extent became permanent.

Thirdly, spatial correlation has undergone steady growth since 1920. Rich and poor regions have clustered in geographical areas. This could be due to the presence of spillovers that did not spread to poor provinces situated further away from the country's core provinces. Under these circumstances, the laggards did not fully benefit from the process of inequality reduction that has been identified by the literature.

Indeed, these observed patterns have relevant policy implications since they show that the result of Spain's development process has been an unequal regional income distribution, which seems to have been worsening over the last two decades. In addition, there appears to be very little prospect of improvement for low-income regions that are located further away from the dynamic nodes. Regional policies applied during the final decades of the 20th century might have had a short-term impact on relative income levels, but they have been unable to alter the long-term dynamics of regional income distribution.

Finally, the rise of an economic cluster in the north-east of the Iberian Peninsula may be a sign of the crucial and growing relevance of proximity to European markets for regional economic development, from a historical perspective. As NEG literature stresses, the presence of economic activities characterized by the emergence of economies of scale makes accessibility to the nodes act as a catalyst in boosting regional development. Quah (2011) investigated where the centre of gravity of the world economy was located and noticed a dramatic shift eastwards in recent decades as a result of the rapid economic growth of the Asian economies. We replicate this exercise for Spain 1860-2010 and find that the centre of gravity moved from the south-west to the north-east. Greater openness since the 1970s and Spain's membership of the EU has strengthened movement in that direction. In recent years the relative poverty of the southern and western Spanish provinces has increased and the spatial polarization of income at the beginning of the 21st century is more striking than ever. European economic integration can only reinforce this tendency. Therefore, in the case of Spain, progress in the political and economic integration of Europe calls for the design of territorial cohesion policies aimed at counteracting the structural elements of economic regional inequality highlighted above.

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APPENDIX

Table A.1 Transition probability matrices: (a) 1860-2010; (b) 1860-1930; (c) 1940-2010

1860-2010	Very poor	Poor	Average	Rich	Very rich	Total
Very poor	77.8	18.5	3.0	0.7	0.0	100.0
Poor	16.0	54.0	24.7	4.7	0.7	100.0
Average	3.3	24.7	48.7	20.0	3.3	100.0
Rich	0.7	4.7	20.7	60.0	14.0	100.0
Very rich	0.0	0.0	3.3	14.7	82.0	100.0

1860-1930	Very poor	Poor	Average	Rich	Very rich	Total
Very poor	76.2	15.9	6.4	1.6	0.0	100.0
Poor	17.1	47.1	24.3	10.0	1.4	100.0
Average	4.3	30.0	40.0	20.0	5.7	100.0
Rich	0.0	8.6	24.3	54.3	12.9	100.0
Very rich	0.0	0.0	5.7	14.3	80.0	100.0

1940-2010	Very poor	Poor	Average	Rich	Very rich	Total
Very poor	82.5	17.5	0.0	0.0	0.0	100.0
Poor	14.3	62.9	22.9	0.0	0.0	100.0
Average	1.4	21.4	60.0	17.1	0.0	100.0
Rich	0.0	0.0	15.7	70.0	14.3	100.0
Very rich	0.0	0.0	1.4	12.9	85.7	100.0

Figure A.1. Regional (NUTS3) income (class) mobility, Spain 1860-1930

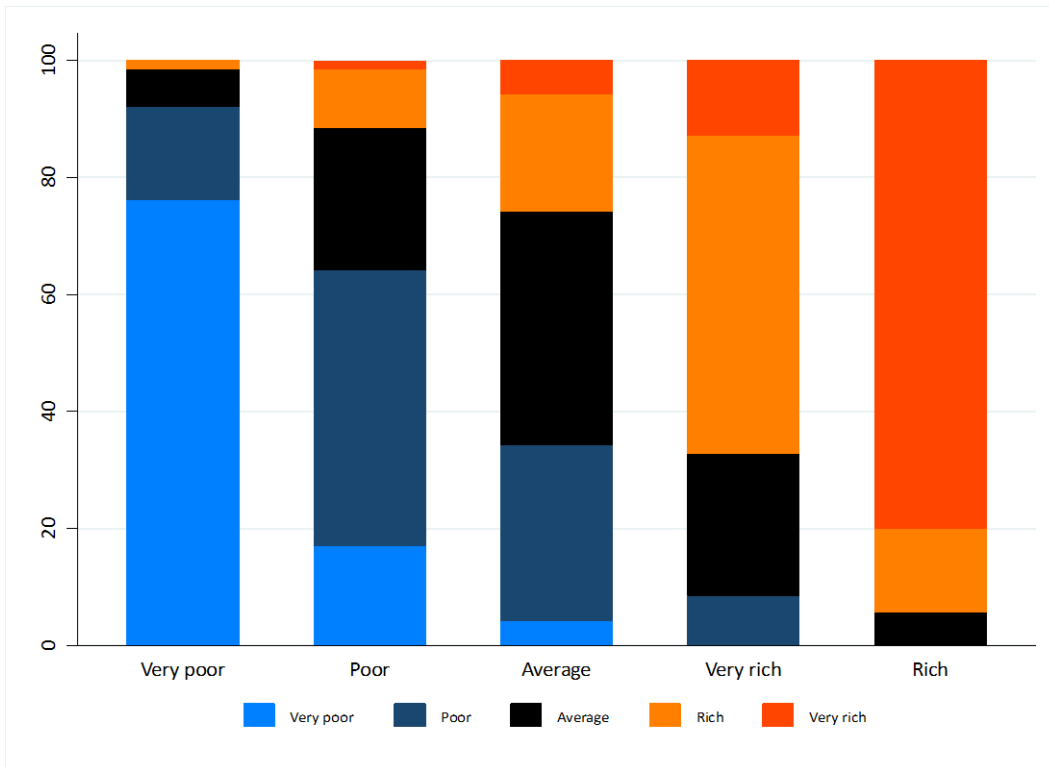
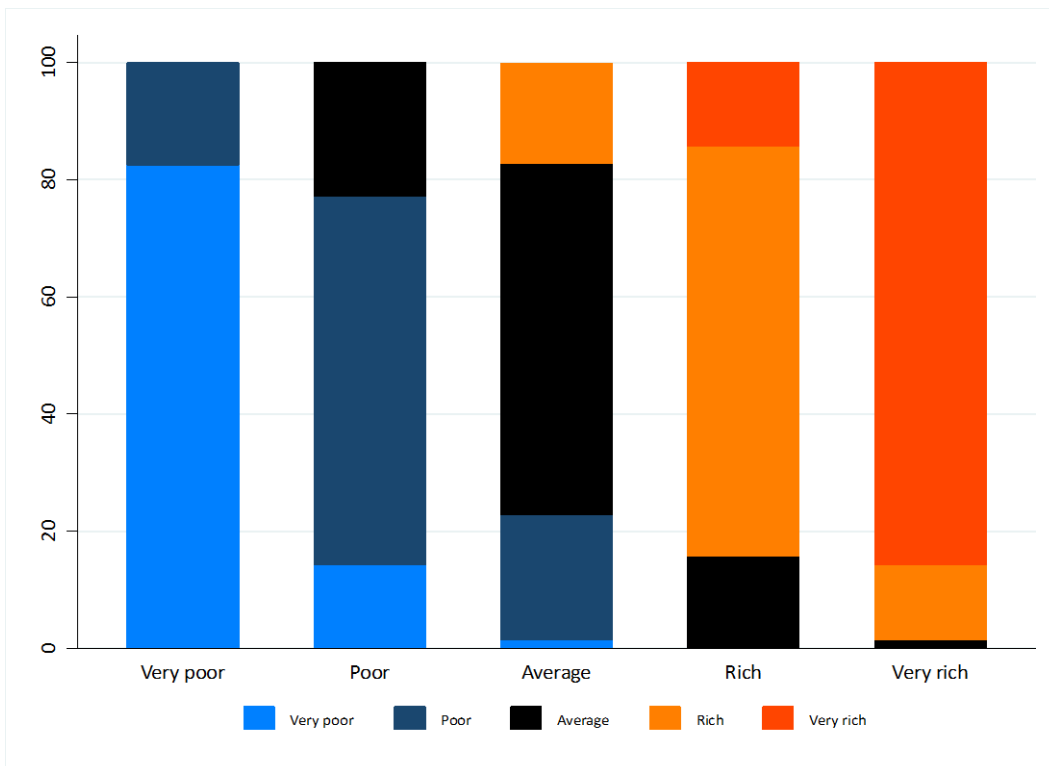


Figure A.2. Regional (NUTS3) income (class) mobility, Spain 1940-2010



Source: See Table A.1 in this Appendix.

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