

REGIONAL INEQUALITY AND CONVERGENCE IN SOUTHERN EUROPE. EVIDENCE FROM HEIGHT IN ITALY AND SPAIN, 1850-2000*

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This paper analyses the growth in height and its regional variability in Spain and Italy between the generational cohorts of 1850 and 1980. Using male height data drawn from the military enlistment records of the period between 1870 and 2000, this paper explores inequality and regional convergence in both countries. This long period was characterised by economic growth and the increase of human welfare. Regional inequality and convergence are analysed using sigma and beta convergence, a methodology based on panel data to obtain the speed of convergence. The results show that in 1850 height measurements started at low levels, but the two countries recorded a significant increase in the average height over the long term, which became more intense in Italy from the beginning of the twentieth century and in Spain from 1950. Therefore, there was divergence in the first half of the century and strong convergence at the end of the century. Regional inequality was more significant in the Italian case. Processes of regional convergence can be observed in both countries during the second half of the twentieth century, although inequality was lower in Spain than in Italy at the end of the period.

Key words: height, biological welfare, Spain, Italy, economic development, regional inequality, convergence.

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For several decades, the analysis of economic inequality and disparities between countries and regions has drawn the interest of specialists in the development and economic integration of territories in a specific space [Barro and Sala-i-Martin (1991, 1992); Quah (1993); Magrini (2004)]. In addition to other large geographical and economic areas, researchers in the field have produced an abundance of literature on the European Union [Puga (1999); Mancha (2001); Cuadrado-Roura, Parellada (2002); Borsi and Metiu (2015)]. In general, the convergence between countries or regions has been analysed by comparing the average value of the distributions of specific variables, such as GDP or disposable income expressed in per capita terms, or real wages.

However, the increasing dissatisfaction with the use of per capita GDP to measure development and the standard of living of nations has awakened interest in other less conventional indicators of welfare, such as the Human Development Index and height. These indicators are commonly used by economists and economic historians, whose results focus on the social and biological dimension of welfare and discuss the differences found with the economic growth figures [Steckel (1995); Chanda Craig and Treme (2008); Prados de la Escusura (2011); Vecchi (2011, 2017); Escudero and Simón (2012); Murias *et al.* (2012); Marchante and Ortega (2006); Felice (2012); Felice and Vasta (2015)].

Initially used in the field of epidemiological auxology, height is an excellent proxy for the standard of living of a society as it reflects the environmental conditions experienced during childhood and adolescence which influence growth and therefore the final adult height. In addition to genetic inheritance, height is related to diet and the quality of food, environment-related diseases and physical effort or the intensity of work carried out since childhood. Therefore, the changes in height over the very long term reflect the impact of environmental transformations caused by economic growth which has advanced at a staggering pace since the beginning of the Industrial Revolution [Steckel (1995); Martínez-Carrión (2012); Hatton (2014); A'Hearn (2016)].

Economic historians have analysed these aspects with data panels of heights by principally country, region and population subsets. In recent years, specialists have analysed the regional inequalities in biological welfare and the convergence and/or divergence processes within the same country [Quiroga (2001); Bassino (2006); Salvatore (2004); Guntapalli and Baten (2006); Arcaleni (2006); Komlos (2007); López-Alonso (2007); Meisel and Vega (2007); Schoch, Staub and Pfister (2012); Cámara and García-Román (2015)]; between countries of major geographical areas, such as the case of Europe [Hatton and Bray (2010); Martínez-Carrión (2012); A'Hearn (2016)]; and even from a global perspective [Baten and Blum (2012), Blum (2013)]. Together, these anthropometric studies, based on height, weight and body mass data, reveal the existence of major regional disparities in the past and show that inequality still exists and is even significant within the European Union [Cavelaars *et al.* (2000); García and Quintana-Domeque (2007)]. One of the European countries with greatest regional inequality in terms of height which has received much attention from economic historians is Italy [Arcaleni (2006); Felice (2007); A'Hearn and Vecchi (2011); Lanari and Bussini (2014)]. The Spanish case has also been researched and strong regional contrasts have been observed until 1960 with a reduction of inequalities thereafter [Quiroga (2001, 2010); Martínez-Carrión (2005); Cámara and García-Román (2015)].

This study explores the topic comparing the evolution of regional heights between Italy and Spain. The two Latin countries of Southern Europe share common features with respect to the evolution of their contemporary history. They have a similar culture and geography due to their Mediterranean location, their institutions are also very much alike and they have both suffered the effects of fascism. In addition, their economic evolution has also been similar: a) their national markets took shape during the second half of the nineteenth century; b) the size of their economies has been relatively similar, although somewhat larger in Italy; c) their levels of per capita income were similar in the last third of the nineteenth century and beginning of the twentieth century and, although they diverged after the Second World War, they converged again at the beginning of the twenty-first century; d) the industrialisation process took place early in the northern regions and, in general, the southern regions displayed a relative secular backwardness; e) the regional issue has been relevant since the end of the nineteenth century, as revealed by the high levels of regional inequality between 1900 and 1930 –among the highest regional disparities in Europe (Iuzzolino, Pellegrini and Vesti (2013: 573)–, which prevails today as shown by OECD data (2016). These parallelisms between institutions and regional inequality mean that this comparison based on heights –an excellent proxy for the standard of living– is effective for addressing aspects of the territorial dimension of human welfare and inequality.

After this introduction, the first section of this article compares the evolution of economic welfare measured by per capita income over the long term. The second section reviews the literature on the relationships between the height and the economic development, and it compares the biological welfare trends of the two countries using male heights drawn from military recruitment records. The third section shows the regional heights and highlights the persistent inequality in both countries until the 1960s. The fourth section analyses the regional convergence between 1955 and 2000. Regional inequality and convergence are studied using sigma convergence and beta convergence, a methodology based on panel data in order to obtain the speed of convergence. We find that regional inequality is observed in both countries, but was more significant in Italy in the mid twentieth century. Both countries exhibit regional convergence processes during the second half of the twentieth century, but at the end of the period, the inequality was lower in Spain than in Italy. The converging trend has been much more significant in the Spanish case. Finally, we present an appendix that informs about the data sources of height in Spain and Italy.

Without overlooking the role played by genetic differences, the results of this article reveal that height is an excellent indicator of regional inequality and the territorial disparities of human welfare. The evidence is consistent with the abundant anthropometric literature that upholds that height is a reasonable proxy for economic development and extremely useful for the study of societies in the past and in developing countries for which there is no regional economic data available. Body size, and, in particular, height could explain the impact of wealth and public health as well as inequality and poverty. The findings may be important in order to reveal aspects of the impact of public policies, such as political decentralisation which, in the case of Spain, became effective from the beginning of the 1980s and affected the decentralisation of the healthcare system and social policies. This study, therefore, considers the need to take anthropometric indicators into account in the analysis of the territorial inequality in standards of living and public health.

1. GROWTH AND REGIONAL INEQUALITY IN THE LONG TERM

Historiography has regarded the economies of Italy and Spain as being backward and on the periphery of Europe's industrial revolution. From the mid nineteenth century, a process of modern economic growth began in both countries which reached its highest levels during the twentieth century [Prados de la Escosura (2003); Toniolo (2013)]. Although Italy reached a relatively higher level of economic development than Spain during the lead-up to the First World War, –its industrial expansion occurred during the *giolittiana* era between 1896 and 1913–, which it maintained during the whole of the twentieth century (Figure 1), a comparative study can be made of the two countries in terms of welfare. In the short term cycles there are differences in both countries, but they exhibit a similar trajectory in terms of the rhythm of economic growth in the long term. The gap between the two countries with respect to economic welfare which appeared during the 1940s and 1950s –observed in the per capita GDP series¹– reduced in the final decades of the twentieth century; the differences have narrowed in recent years and convergence has taken place since the beginning of the twenty-first century². As well as suffering from the effects of fascism or political authoritarianism, both countries also exhibit an acute dualism which is evident in the strong regional disparities in per capita income.

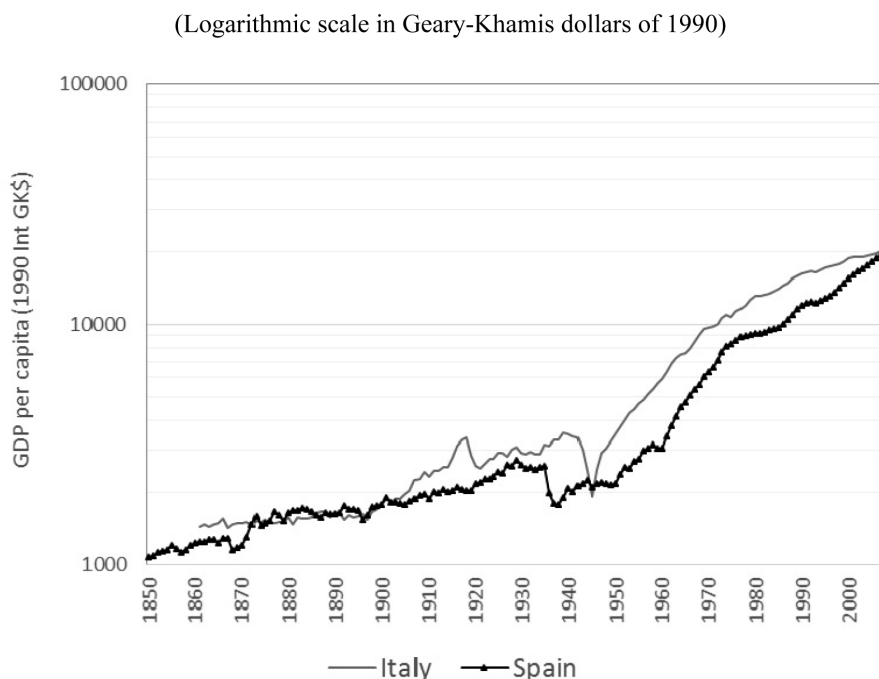
The regional inequality has drawn the attention of economic historians in both countries. However, the studies on the regional issue in Italy have been more abundant than those in the case of Spain. It is not without reason that there has been an intense debate since the 1960s on Italian dualism and '*la questione meridionale*', which highlights the industrial backwardness of the Mezzogiorno [Cafagna (1989); Cohen and Federico (2001); Felice (2010, 2011, 2012, 2015a); A'Hearn and Venables (2013), Daniele and Malanima (2014)] and, most of all, the strong differences between the north and the south since Italian Unification [Felice (2013)]³. It has been generally commented that the socio-institutional gap between the north and the south of the Italian peninsula before the Unification became wider during the Unification process and has remained that way since then, although there was a certain degree of socio-institutional convergence in the final decades of the twentieth century. In the case of Spain, the regional economic inequality was also significant from the beginning of the industrialisation process, and was conditioned by the geography, the distribution of resources and the localisation of human capital or economies of agglomeration [Betrán (2011); Dobado (2006); Pons and Tirado (2008)]. Recent studies reveal that inequality increased from the end of the nineteenth century until the 1930s,

(1) Subsequent estimates to those of Maddison (2010) of per capita GDP in Italy can be found in Baffigi (2013). We have used the Maddison series for comparative purposes.

(2) The convergence between the two countries at the end of the twentieth century was due to the strong boost experienced by the Spanish economy between 1995 and 2008, while the Italian economy slipped into an irreversible downturn which some recent interpretations attribute to the absence of convergence between the north and the south. The failure of the southern regions to catch up with those of the centre and the north could have contributed to the lack of dynamism in the Italian economy during the 1990s after an excellent trajectory during the whole of the twentieth century (Felice and Vecchi 2015).

(3) In recent years there has been an abundance of literature addressing the regional disparities and convergence in Italy, see Iuzzolino, Pellegrini and Vesti (2013), and Felice (2015a and 2015b).

Figure 1: PER CAPITA GDP IN ITALY AND SPAIN, 1850-2008

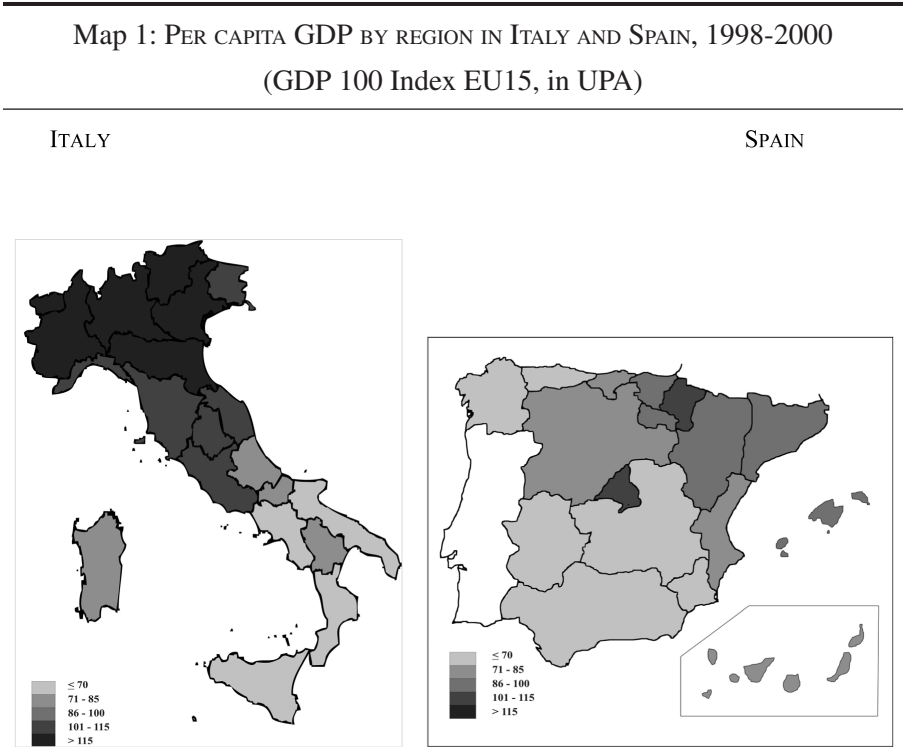


Source: Maddison (2010).

although others indicate that the divergence continued until the 1950s [Martínez-Galarraga *et al.* (2015); Díez-Minguela *et al.* (2016)]. In any case, convergence was a phenomenon of the second half of the twentieth century. Regional inequality began to fall in 1960, when the regional economies began to converge, a process that came to a halt in the mid 1980s [Pérez (2000); De la Fuente (2002a and 2002b); Garrido-Yserte (2002)]. Although the data regarding the social distribution of income reveal an increase in the inequality between Spaniards between 1973 and 2001, the inter-regional differences reduced due to the redistributive action of the State [Carreras, Tafunell (2004); Goerlich, Mas (2002)].

The strong regional differences observed in Italy a century ago in terms of wealth, income and industrialisation, have persisted until recent times (Map 1). Despite Italy's economic progress during the twentieth century and its position as a principal member of the European Union and one of the ten leading economies in the world, the wealth between the Italian regions reveals a significant lack of convergence measured in terms of per capita GDP. During the nineteenth century, there were three large regional blocks in Italy which became two in the twentieth century, namely the rich, industrialised north and a more backward and impoverished south. However, Spain, being a lesser developed country, could have progressed more than Italy be-

fore the end of the twentieth century in terms of regional convergence [Goerlich, Mas (2001)]. We can see that in the period 1998-2000, the wealth of Lombardy or Trentino, rich regions in northern Italy doubled that of Calabria, which was then the poorest region in the Italian Mezzogiorno [Felice (2013)]. This, and other southern regions of Italy, had a similar level of income per inhabitant as the poorest regions of Spain, also located in the south, and Galicia (Map 1).



Source: Eurostat (2003).

In the Italian case, we can observe that there is clear divergence between the northern and southern regions that is much more intense than the Spanish case, despite the fact that on an aggregate level, the average per capita GDP is clearly higher in Italy than in Spain. The difference between the richest and poorest regions in Italy is 75 points, while in Spain it is 57. Relative poverty is prevalent in the south of both countries and also in the western part of the Iberian Peninsula, while in Italy most of the wealth is concentrated in the north. In Spain, the average levels of the highest wealth are similar to those found in the central regions of the Italian peninsula, very much lower than the northern regions, the richest in Italy and also among the most prosperous in Europe.

2. HEIGHT AND ECONOMIC DEVELOPMENT

2.1. *Background*

It is well known that height and the level of per capita income are two complementary measurements of the level of well-being which do not necessarily have to evolve in parallel [Komlos (1998)]. The main reason for this is that height is influenced by other variables such as food prices, the level of urbanisation and health conditions. In spite of this, a high correlation between the two variables has been observed during the second half of the twentieth century [Steckel (1995)]. In the two countries analysed, there is abundant evidence of the existence of such a relationship.

For the Italian case, Arcaleni (2006) revealed a secular trend with a growth in biological welfare among the cohorts of the post-Unification period and a strong increase after the Second World War which corresponded to the increase in per capita income. The relationship with the increase in calorie intake and the decrease in malnutrition and poverty from the cohorts of the end of the nineteenth century was brought to light by Federico (2003) and Vecchi and Coppola (2006). Peracchi (2008) reviewed the empirical evidence regarding the relationship between economic development and height and indicated an increase in the dispersion of heights between 1930 and 1960, emphasising the persistence of regional inequality. Peracchi and Arcaleni (2011) went a step further and found that income largely defines average height more than other variables related to health conditions. The statistical reconstruction carried out by A'Hearn and Vecchi (2011) reveals an increase in the average height of one centimetre per decade between 1861 and 1980 and a high level of biological welfare reached in the northern regions (Piedmont, Lombardy and Liguria) where industrialisation was more widespread in line with other human welfare indicators [Brandolini and Vecchi (2013)]. Finally, Lanari and Bussini (2014) use cohort data from Italian recruits born in 1951 and 1980 to explore regional convergence.

For Spain, several studies have analysed the relationship between height and economic development, also based on panel data of male heights drawn from military sources. Gómez-Mendoza and Pérez-Moreda (1985, 1995) examined the relationship between height, the level of education and child mortality at the beginning of the twentieth century using the average height of military recruits by province between 1915 and 1929. With data from an extensive sample of the heights of conscripts from 1857 to 1960 (Levant series), which have been linked to a national series from 1955 onwards [Quiroga (2003)], Martínez-Carrión and Puche (2010) find an increase in height of almost one centimetre per decade among the cohorts of 1850-1980. The findings point to a significant increase in adult height in post-1950s generations, who benefited from the country's economic liberalization, and especially those that emerged after the transition to democracy in the 1970s [Costa-Font and Gil (2008)]. There is a close relationship between income and height, even during the decades before the Civil War, although divergence can be observed between the two indicators during the middle decades of the nineteenth century, in a similar way to the puzzle at the start of the European and American industrialisation processes [Martínez-Carrión and Pérez-Castejón (2000); Komlos (1998)].

An econometric study for the period from the 1850s onwards highlights the close relationship between income and height, and identifies the role played by hygiene and public health measures, education and wealth as determining factors mainly in the twen-

tieth century [María-Dolores and Martínez-Carrión (2011)]. Data reveals that height responds positively to an increase in per capita GDP, to the greater participation in the consumption of health services, and to the degree of openness. With data drawn from an enlarged sample of the European Community Household Panel (ECHP) of 2000 and two alternative sources [the National Health Survey (ENSE) for Spain conducted in 2006 and the European Health Survey for Spain (EESA) of 2009], Quintana-Domeque, Bozzoli and Bosch (2012) showed that height increased by similar amounts for men and women: 1.7 cm and 1.6 cm per decade respectively, in the period 1950-1980 (cohorts). The authors researched the correlations between height, the level of education and the self-reported state of health. The findings confirm that in the case of both men and women the taller subjects tended to reach a higher level of education and reported a better state of health than the other participants [Costa-Font and Gil (2008)].

Quiroga and Coll (2000) considered the differences in height as a proxy variable for inequality in income levels and revealed an increase at the beginning of the twentieth century which is consistent with the inverted U of the evolution of regional income inequality [Rosés, Martínez and Tirado (2010); Tirado, Díaz and Martínez, (2015); Díaz, Martínez and Tirado (2016)]. Social inequality increased between the end of the nineteenth century and the First World War. It reduced before the Spanish Civil War and increased again during the first phase of the Franco Regime. There was a slight upward trend in the first half of the twentieth century. Spatial inequalities of nutritional status, as reflected by anthropometric polarity during the 19th century may be largely associated with environmental changes related to the modernization and industrialization processes [Martínez, Cámara and Pérez (2016)]. Regional disparities reaching their peak between 1930 and 1960 and subsequently diminishing [Quiroga (2001); Martínez-Carrión (2005); Cámara and García-Román (2015); Cañabate and Martínez (2017)].

In both countries, anthropometric studies reveal that per capita income, food consumption and health were determining factors for the increase in height. The nutritional, demographic and epidemiological transitions conditioned the changing dynamics of height and the secular trend. The research suggests that the increase in height recorded for the Italian and Spanish cohorts from the end of the nineteenth century was dramatic compared to that of other European countries. The populations of both of these nations grew at a higher rate than those of Northern Europe [Hatton and Bray (2010); Martínez-Carrión (2012)]. The economic miracle following the Second World War, which occurred in Italy before Spain, stimulated the progress of human welfare. If we consider that height reflects the standard of living of a society and we can establish that there was economic convergence between the two countries at the threshold of the twenty-first century, the question that we must ask is whether there was also a convergence in height.

2.2. *The secular trend of male height*

The estimated evolution of the height of the cohorts of both countries from 1854 to 1980 can be seen in Figure 2. On the sources of military recruitment in both countries, see Appendix. In Italy, the average male height grew from 162.39 cm to 174.58 cm, with an increase of 12.19 centimetres. In Spain, it grew by 12.78 cm, from 162.29 cm to 175.08 cm. The heights in both countries started at very similar levels in 1854 but the greatest increase observed is that of the average height of the Spaniards (Table 1). At the end of the twentieth century, the height of Spaniards had converged with that

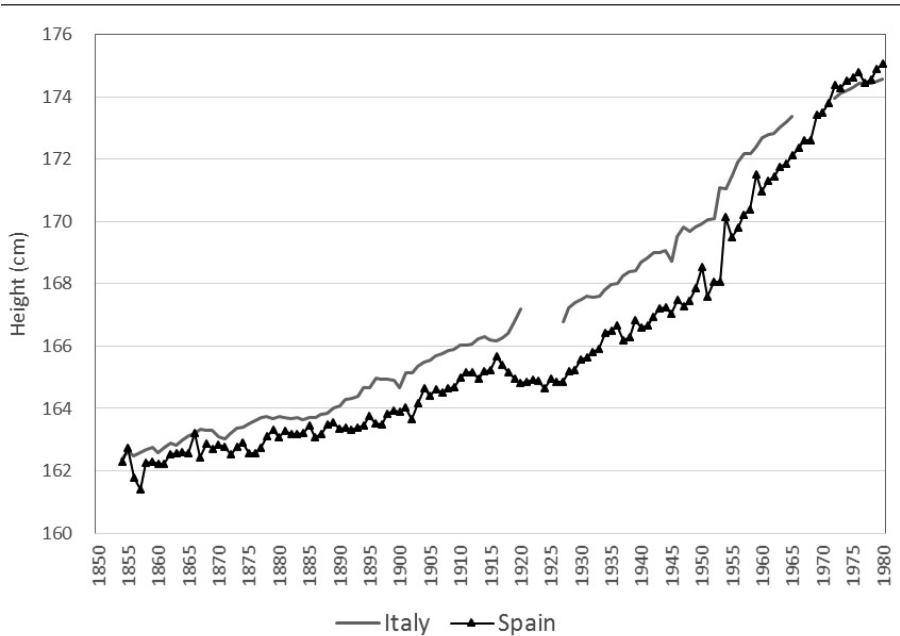
of the Italians. After the decline in height due to deprivations suffered in childhood and during the teenage growth spurt throughout the 1930s and 1940s, which affected the cohorts born between 1915 and 1930, the increase in the male average height in Spain was dramatic in the subsequent decades, particularly from the mid 1950s. The spread of human well-being generated by economic growth and an institutional climate that was more favourable for child growth narrowed the gap with the average adult height of the Italians in the last third of the twentieth century (Figure 2).

Table 1: INCREASE IN HEIGHT OF MALE COHORTS BETWEEN 1854 AND 1980

	1854	1980	Increase cm
Spain	162.29	175.08	12.78
Italy	162.39	174.58	12.19

Source: Own elaboration. Italy, ISTAT. Spain, see Martínez-Carrión and Puche (2010), and INE, Military Recruitment Statistics.

Figure 2: EVOLUTION OF MALE HEIGHT IN ITALY AND SPAIN.
COHORTS BETWEEN 1854 AND 1980



Source: Italy: based on ISTAT, height standardised at the age of 20. Spain: Levant Series (1854-1948 cohorts), INE, Military Recruitment Statistics (1949-1980 cohorts); see Appendix.

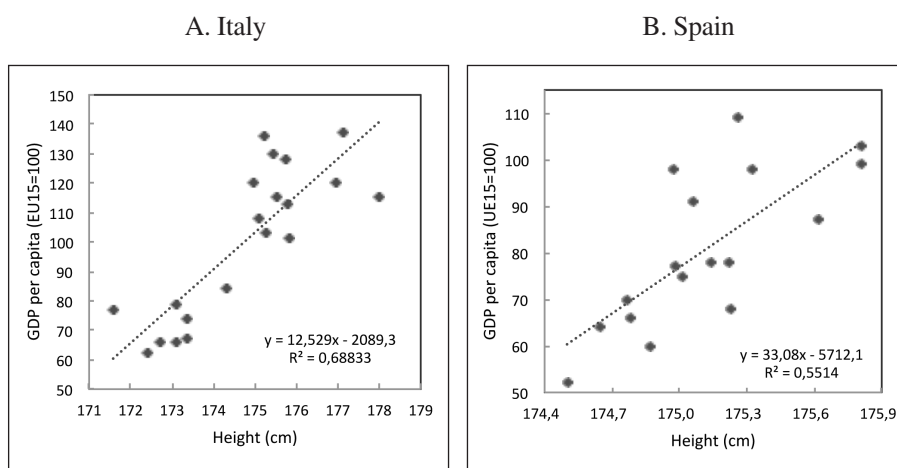
Although both countries exhibit similar average heights at the beginning and at the end of the period analysed, the secular evolution shows a process of divergence in detriment to the Spanish height. This process began in the final decades of the nineteenth century, when a gap began to appear between the average heights of the two countries with the Italian heights being slightly taller. Starting from an average height of 162.3 cm, recorded for both series in 1854, the average height of Spaniards was 163.9 cm and that of Italians was 164.7 cm in 1900. The relative advantage of the Italian biological standard of living can be observed in the income per inhabitant [Federico (2003)], beginning after the Italian Unification, consolidating during the *giolittiana* period and persisting at similar levels until the recruitment processes of the beginning of the First World War in 1914. The greatest divergence of the height series can be observed among the cohorts of the inter-war period, reaching a difference of two centimetres. This difference remained stable until the mid 1950s. From then, the differences began to diminish, coinciding with the period of the Spanish economic miracle in the 1960s.

From the mid twentieth century, the increase in height was greater in Spain than in Italy. The Italian annual growth rate between the cohorts of 1934 and 1980 was 0.88%, while in the Spanish case it was 1.22%. The height of the Italians increased by 0.15 cm/year between 1934 and 1980 and that of the Spaniards grew by 0.21 cm/year. The Italians born between 1934 and 1980 grew in height by 6.91 cm while the Spaniards grew by 9.53 cm. Without a doubt, the “economic miracles” in both countries after the Second World War influenced this strong increase in biological welfare.

The increase in height recorded in both countries between 1940 and 1970 was unprecedented in their histories. The economic growth cycle which began in 1950 fostered the strong increase in height in Italy and Spain although the phenomenon was widespread throughout the industrialised world [Hatton and Bray (2010); Floud, Fogel, Harris and Hong (2011); Hatton (2013)]. The relative backwardness of the economy and welfare in Spain in as late as 1950, after the fall in height in the previous decades, meant that the physiological growth was even greater. Furthermore, the progress made from the 1960s and 1970s in terms of access to health and education had a positive effect on the average height of Spaniards which grew until the end of the twentieth century more intensely than in Italy.

Finally, before analysing the disparities between the regional heights in both countries in the following section, we will observe the relationship between height by date of recruitment and per capita GDP for each of the countries using regional data at the end of the period studied (Figure 3). We should note that the relationship in Italy between height in 2000 and average per capital GDP in the period 1998-2000 was clearly positive, with the correlation between the two variables increasing to 0.82. Spain also shows a positive relationship between the average per capita GDP for the same period and the height data of the 1999 recruitment process. The correlation between the two series is high, although slightly lower than in Italy (0.74).

Figure 3: HEIGHT VS. PER CAPITA GDP IN ITALY AND SPAIN (1998-2000)



[Correlation coefficient (r) Italy: 0,829656561; Correlation coefficient (r) Spain: 0,742565521]

Source: Per capita GDP Data, in Eurostat. Height data by draft year: ISTAT (Italy); Ministry of Defence. Unit of Statistics (Spain).

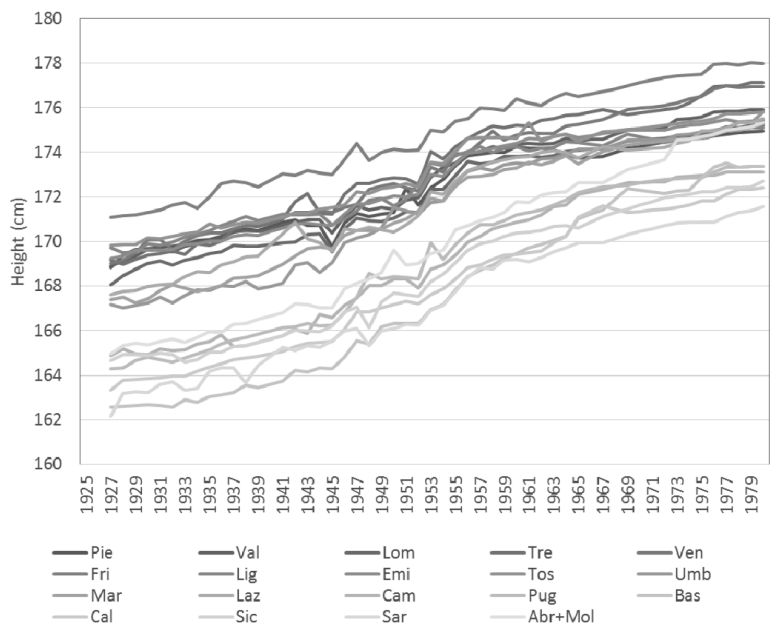
3. HEIGHT AND REGIONAL INEQUALITY

Over the last decade, there has been increased interest in the use of panel data of height for studying the different autonomous regions of Spain and the Italian regions. In the Spanish case, in addition to the military recruitment sources, data drawn from the National Health Survey and the Household Panel of the European Commission (Eurostat) have been used, including data referring to the evolution of the height and weight of the Spanish population which also includes that of women [García and Quintana-Domeque (2007); Quintana-Domeque, Bozzoli and Bosch (2012); Cámara (2015); Cámara and García-Román (2015)]. The regional analysis made in this section is based on data from the statistics of military recruitment. For Italy from the cohorts of 1927 (enlistment of 1947) and for Spain from the cohorts of 1934 (enlistment of 1955). In the latter country, the abolition of the compulsory Military Service in 2001 implied the disappearance of the annual enlistment operations and, with it, the statistics itself. In Italy, compulsory draft was abolished in 2005, but data from the 1980 birth cohort were the last published by the Ministry of Defence (see Appendix).

Inter-regional economic inequality is reflected in height (Figures 4 and 5). In Italy, the heights in the south were slightly lower than those in the central and northern regions. The north-south gap between Italian heights reached its greatest width among the cohorts of 1930-40, after diverging between 1871 and 1940 [A'Hearn and Vecchi (2011, 2017)]. The analogy with the north-south divide in economic welfare is absolute. This widened dramatically between 1871 and was greatest between 1930 and 1950 [Felice

(2015a, 2015b); Felice and Vecchi (2015)]. Between 1920 and 1930, the tallest heights were found in Friuli-Venezia-Giulia, Veneto, Tuscany, Piedmont and Liguria, while the shortest were in Basilicata, Sardinia, Abruzzo, Calabria and Sicily. Although not all of the regions in the north of Italy enjoyed economic prosperity Veneto and Friuli-Venezia-Giulia (the north-eastern part) were relatively poor regions until the 1960s, historically, the North has recorded taller heights. The gap between the industrial regions in the north –particularly the Turin, Milan, Genova triangle– and the more agricultural regions of the Italian Mezzogiorno (Figure 4) widened after the Post-Unification period and most of all during the *giolittiana* phase. We can observe an Italy divided into three macro areas which then became two areas after the First World War. The central regions, with intermediate values, were among the regions with the tallest heights, similar to those in the north of Italy, comparable to income per inhabitant. From the mid twentieth century, the central regions reached the same average levels of wealth as those in the north, while the southern regions remained relatively stagnated at the same poverty levels and a great distance from the central-northern macro area.

Figure 4: EVOLUTION OF REGIONAL HEIGHTS IN ITALY. COHORTS OF 1927-1980

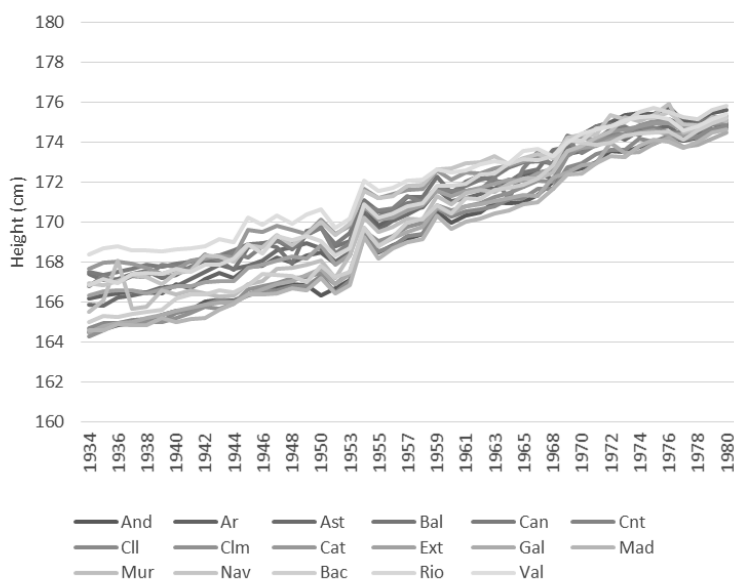


Source: Based on ISTAT, see Appendix.

The average heights of the Italian Mezzogiorno were close to those of the more backward regions of the Spanish South, the two Castiles and Galicia, with averages below 165 cm. The tallest heights in Spain corresponded to the regions with the highest

indices of industrialisation: the Basque Country, Catalonia, Cantabria, Madrid, the Region of Valencia, and also the island regions: the Balearics and the Canaries. At the end of the twentieth century, the correspondence with regional levels of wealth measured in per capita income, employment and education was high, following a regional pattern that was less pronounced than Italy in terms of human or social capital [Arcaleni (2006), Felice (2012)]. The island effects seem more advantageous in Spain than in Italy, due to the environmental protection provided by any island, consumption, trade exchange networks and a degree of economic development driven by the tourism industry.

Figure 5: EVOLUTION OF REGIONAL HEIGHTS IN SPAIN. COHORTS OF 1934-1980



Source: Based on Ministry of Defence. ERRE-Military Statistical Yearbooks, and Quiroga (2003). See Appendix.

The greatest increases corresponded to the most backward regions which, as we have seen, had the shortest heights. In Italy, the largest rises occurred in Basilicata, Abruzzo, Apulia, Calabria, Umbria, Sardinia, Sicily and Campania, where increases of more than 7 cm were recorded between 1934 and 1980. In Spain, the regions which had the lowest levels at the beginning of the period also exhibited the greatest increases, higher than those of the most economically backward Italian regions. Therefore, Castile-La Mancha, Andalusia, Castile and Leon, Murcia, Extremadura and Galicia experienced increases of more than 10 cm in this period.

Table 2 shows the height values for the different Italian regions in the years of birth for the cohorts of the first and last data of the sample. The relative position in the height ranking for the Italian regions is shown in brackets. During the period un-

Table 2: GROWTH IN HEIGHT IN THE ITALIAN REGIONS OF THE COHORTS 1934-1980

Region	1934 cm	1960 cm	1980 cm	Δ 1934-80 cm	Δ 1934-80 (cm/year)	Growth rate 1934-80
Basilicata	162.80 (19)	169.47 (17)	173.36 (13)	10.56	0.23	1.37
Abruzzo-Molise	164.97 (15)	171.77 (13)	174.05 (12)	9.08	0.20	1.17
Apulia	165.00 (14)	171.19 (14)	173.36 (13)	8.36	0.18	1.08
Calabria	164.18 (17)	169.43 (18)	172.40 (16)	8.22	0.18	1.06
Sardinia	163.40 (18)	169.22 (19)	171.58 (17)	8.18	0.18	1.06
Umbria	167.82 (11)	173.51 (11)	175.82 (3)	8.00	0.17	1.01
Sicily	164.71 (16)	170.38 (16)	172.70 (15)	7.99	0.17	1.03
Campania	165.40 (13)	170.85 (15)	173.12 (14)	7.72	0.17	0.99
Marche	167.78 (12)	173.29 (12)	175.29 (8)	7.51	0.16	0.95
Trentino	169.90 (6)	175.21 (2)	177.12 (2)	7.22	0.16	0.91
Aosta Valley	168.83 (9)	174.36 (6)	175.73 (5)	6.90	0.15	0.87
Lazio	168.70 (10)	173.77 (10)	175.52 (6)	6.82	0.15	0.86
Veneto	170.30 (4)	174.77 (3)	176.96 (3)	6.66	0.14	0.83
Friuli V. Giulia	171.50 (1)	176.40 (1)	178.00 (1)	6.50	0.14	0.81
Lombardy	169.26 (8)	173.81 (9)	175.21 (9)	5.95	0.13	0.75
Emilia-Romagna	169.89 (7)	174.40 (5)	175.45 (7)	5.56	0.12	0.70
Tuscany	170.41 (2)	174.64 (4)	175.81 (4)	5.40	0.12	0.68
Piedmont	170.05 (5)	172.47 (8)	174.97 (11)	4.92	0.11	0.62
Liguria	170.32 (3)	174.27 (7)	175.10 (10)	4.78	0.10	0.60
ITALY	167.67	172.90	174.58	6.91	0.15	0.88

Source: Authors' own elaboration based on ISTAT.

Table 3: GROWTH IN HEIGHT IN THE SPANISH REGIONS OF THE COHORTS 1934-1980

Region	1934 cm	1960 cm	1980 cm	Δ 1934-80 cm	Δ 1934-80 (cm/year)	Growth rate 1934-80
Castile-La Mancha	164.29 (17)	170.31 (15)	174.78 (13)	10.49	0.23	1.35
Andalusia	164.50 (15)	169.98 (16)	174.87 (12)	10.37	0.23	1.33
Castile and Leon	164.69 (13)	170.59 (12)	175.01 (9)	10.32	0.22	1.32
Murcia	164.97 (12)	170.42 (14)	175.23 (5)	10.26	0.22	1.31
Extremadura	164.46 (16)	170.46 (13)	174.50 (15)	10.04	0.22	1.29
Galicia	164.61 (14)	169.70 (17)	174.65 (14)	10.04	0.22	1.29
Rioja, La	165.52 (11)	170.93 (11)	175.06 (8)	9.54	0.21	1.22
Aragon	166.17 (9)	171.46 (8)	175.62 (2)	9.45	0.21	1.20
Navarre	166.87 (6)	171.82 (4)	175.81 (1)	8.94	0.19	1.14
Asturias	165.89 (10)	171.04 (10)	174.77 (16)	8.88	0.19	1.13
Valencian Com.	166.35 (8)	171.34 (9)	175.14 (7)	8.79	0.19	1.12
Madrid	166.95 (5)	172.73 (1)	175.26 (4)	8.31	0.18	1.06
Cantabria	166.79 (7)	171.57 (5)	174.98 (10)	8.19	0.18	1.04
Canary Islands	167.52 (3)	171.54 (6)	175.22 (6)	7.70	0.17	0.98
Catalonia	167.68 (2)	172.12 (3)	175.32 (3)	7.64	0.17	0.97
Balearic Islands	167.40 (4)	171.49 (7)	174.97 (11)	7.57	0.16	0.96
Basque Country	168.40 (1)	172.47 (2)	175.81 (1)	7.41	0.16	0.94
SPAIN	165.55	171.17	175.08	9.53	0.21	1.22

Source: Own elaboration based on Quiroga (2003), Ministry of Defence. Military Statistical Yearbooks.

der study, few variations can be observed. Only the large rise in the relative position of the region of Umbria is noteworthy from the eleventh to third position and to a lesser extent the regions of Marche, Trentino, Aosta Valley and Lazio. The greatest decrease can be observed in the regions of Piedmont and Liguria. There were relative changes in the height ranking but not all of the regions experienced changes. We have no evidence, *a priori*, that there was any convergence between the regions.

Table 3 shows the height values for the Spanish regions and reveals that the majority of them, except for the Basque Country and Navarre, experienced changes in their relative position throughout the period. Those with a worse position, such as Murcia and Castile and Leon saw greater increases in height and some of the better ranking regions, such as the Canary Islands and the Balearic Islands, registered considerable decreases. This indicates that there was a certain degree of convergence between the heights of the different Spanish regions.

4. ANALYSIS OF THE REGIONAL CONVERGENCE IN HEIGHT IN SPAIN AND ITALY

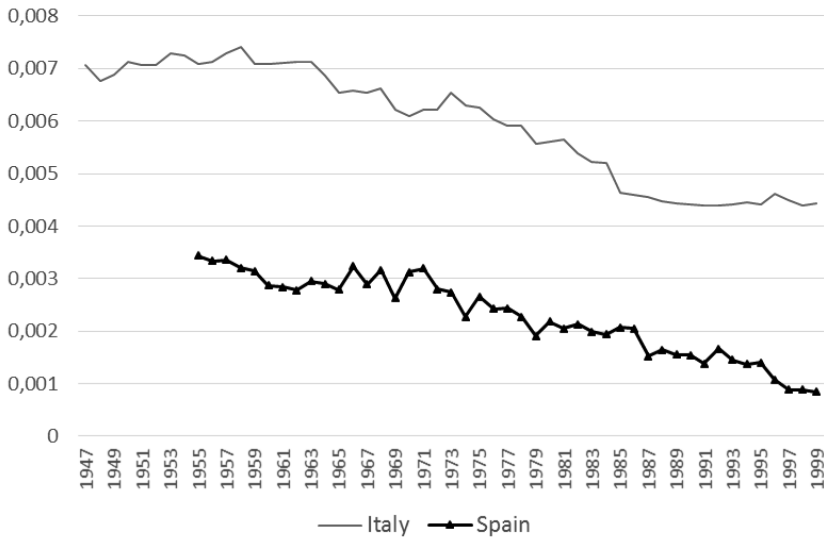
In this section we will analyse whether the difference in height between the regions diminished over time for both countries by using the traditional beta and sigma convergence analysis proposed by Barro and Sala-i-Martin (1991, 1992).

4.1. *Sigma convergence*

One way of observing whether there has been convergence between the different regions in the two countries would be to analyse the dynamics of height dispersion. In Figure 6, the evolution of convergence for the Italian case shows how the divergences gradually diminish until the beginning of the 1980s when they stagnate. The intensity of the convergence until the 1970s is consistent with the strong increase in heights registered in the southern areas. The average heights in the regions of southern Italy, which were initially characteristically lower than the national average, increased more than those of the north. However, this trend may have also been affected by mass migratory flows of people from the south to the north of Italy in the fifties and sixties [Lanari and Bussini (2014)]. The principal destination of migration was the northern cities which were experiencing great industrial development; the 'industrial triangle' [Genova, Milan, and Turin; see Gomellini and O'Grada (2013)]. The migrant-receiving regions par excellence (Lombardy, Liguria and Piedmont) were precisely those that had lower annual growth rates. The size of the migrant flows from the south to the north of Italy may have reduced the growth rate of the average height in the receiving regions, as the immigrants were, on average, shorter than the local residents. This contributed to the catching up of regional heights. The stagnation of the process in the 1980s and 1990s which did not change the huge gap between regional heights, does not mean that during this period the Italian population (cohorts of 1960-70) continued to record remarkable improvements in their biological welfare as a whole.

For Spain, the convergence- σ reveals differentiated phases: a slight decrease between 1955 and 1960, stagnation in the 1960s and a clear downward trend from the beginning of the 1970s. We should note that the decrease in divergence has been considerable and there has been no change in the trend as in the Italian case. In both countries the differences have reduced over time, considerably for Spain and to a lesser

Figure 6: SIGMA CONVERGENCE. REGIONAL DISPARITIES IN HEIGHT IN ITALY AND SPAIN BY DRAFT YEAR



Source: Own elaboration.

degree in the case of Italy where the differences between the regions are greater. Regional inequality is less intense in Spain than in Italy suggesting that the effects of political decentralisation may have contributed to this.

4.2. Unconditional or absolute beta convergence

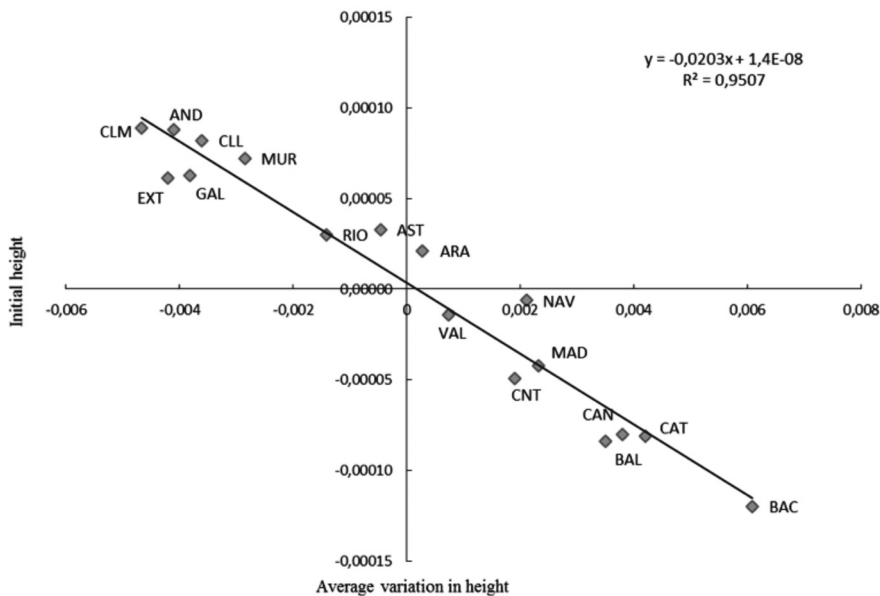
An initial analysis of the convergence between the different regions would study the unconditional or absolute convergence between them. This analysis will enable us to obtain the speed of convergence for the Spanish and Italian regions, assuming that each country has its own steady state. To do this, we have estimated the beta-convergence standard equation substituting the value of per capita income with the value of height which is the variable that we have used as a proxy for the level of welfare, using cross sectional data.

$$\Delta \log(\text{height})_t = \alpha - \beta \log(\text{height})_{t-T} + u_t$$

where we measure height in relative terms, that is, regional height normalized by the national average, $\Delta \log(\text{height})$, the growth rate of the same variable over the period, T is the length of the period, α is a constant and β the annual rate of convergence to a common steady state.

For the Spanish case, we can observe that during the final years of the period the differential with the national average diminished by 1.93% per year with convergence between the Spanish autonomous regions (Figure 7). If the Y-axis repre-

Figure 7: BETA CONVERGENCE IN HEIGHT OF THE SPANISH REGIONS (1955-1999)



AND, Andalusia; ARA, Aragon; AST, Asturias; BAC, Basque Country; BAL, Balearic Islands; CAN, Canary Islands; CAT, Catalonia; CNT, Cantabria; CLL, Castile and Leon; CLM, Castile–La Mancha; EXT, Extremadura; GAL, Galicia; MAD, Madrid; MUR, Murcia; NAV, Navarre; RIO, La Rioja; and VAL, Valencian Community.
Source: Own elaboration.

sents the average variation in height for the period 1955-99 and the X-axis represents the initial height we can see this type of convergence between the Spanish regions, with no atypical observations.

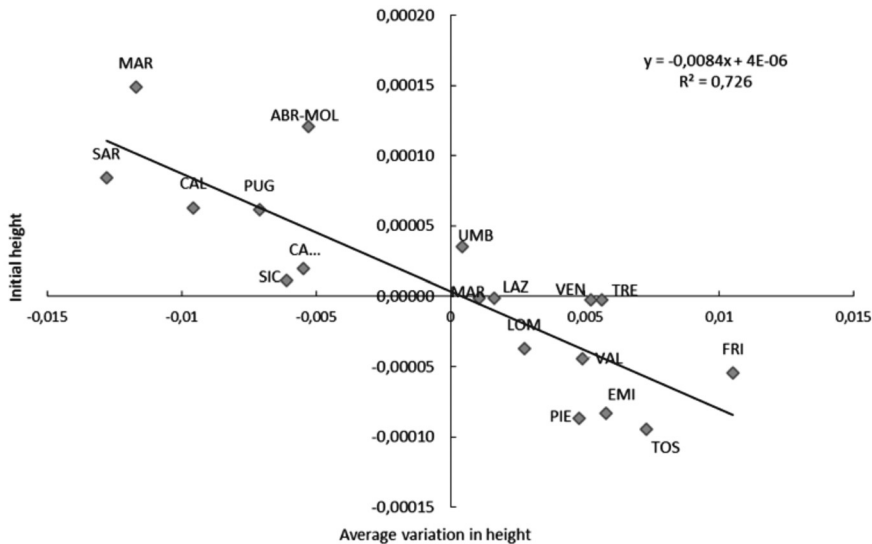
Figure 8 shows the same analysis for the Italian case, with the period of reference being 1948-2000. In the final years, the difference with the national average using the height variable as a proxy for the level of pc income diminishes by 0.83% per year and there is hardly any convergence between the Italian regions which is lower than that experienced by the Spanish economy (Figure 7).

4.3. Conditional beta convergence

The model was then estimated using panel data instead of cross-sectional data to obtain conditional beta convergence, assuming, more realistically, that each region has its own steady state. Through this estimate, we can observe, again, that the speed of convergence is much higher between the Spanish regions than the Italian regions. In this case the following equation is estimated:

$$\Delta \log(\text{height}^i)_t = \alpha^i - \beta \log(\text{height}^i)_{t-T} + u_t$$

Figure 8: BETA CONVERGENCE IN HEIGHT OF THE ITALIAN REGIONS (1948-2000)



PIE, Piedmont; VAL: Aosta Valley; LOM, Lombardy; TRE, Trentino; VEN, Veneto; FRI, Friuli V. Giulia; EMI, Emilia-Romagna; TOS, Tuscany; UMB, Umbria; MAR, Marche; LAZ, Lazio; CAM, Campania; PUG, Apulia; BAS, Basilicata; CAL, Calabria; SIC, Sicily; SAR, Sardinia; ABR+MOL, Abruzzo+Molise.

Source: Own elaboration.

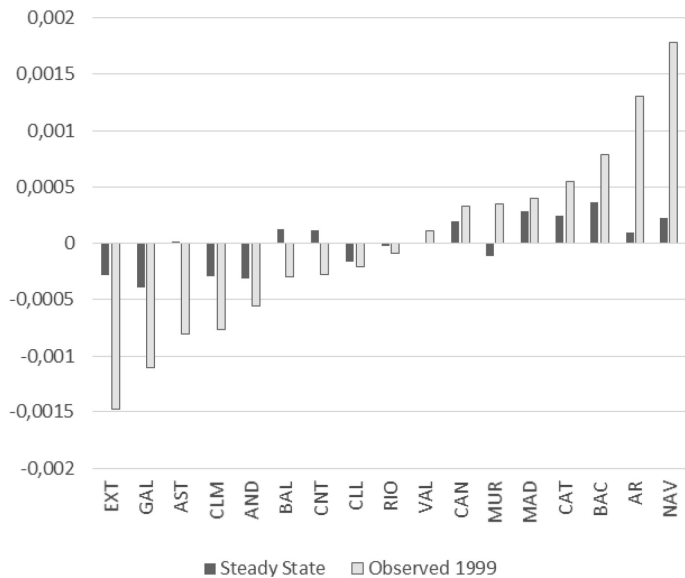
The α parameter in this case is estimated for each of the regions and denotes the fixed effects defined by the structural parameters of the region. To calculate the steady state we use:

$$\log(height_*^i) = \frac{\alpha^i}{\beta}$$

We can observe that there is a convergence between the Spanish regions of between 5 and 15%. These results are similar to those found by De la Fuente (1995, 2002a, 2002b) using the pcGDP. We can see that the speed of convergence for the period 1955-1999 is 3.95% if we do not include fixed effects, while De la Fuente (2002b) finds a speed of 2.2% (for the period 1955-93). When fixed effects are included in the data panel, the speed of convergence (conditional) increases to 9.3%, while De la Fuente's results estimate a speed of 8% for the period 1955-93. Therefore, it could be deduced that, for the Spanish case, the height variable is a good proxy for the per capita income variable, with similar results being obtained in this exercise.

Figure 9 shows the possibly undefined continuity of the income disparities between the autonomous regions of Spain using height data. It can be observed that the regions

Figure 9: DISPARITIES IN HEIGHT IN THE SPANISH
REGIONS BY DRAFTS YEAR (1955-1999)

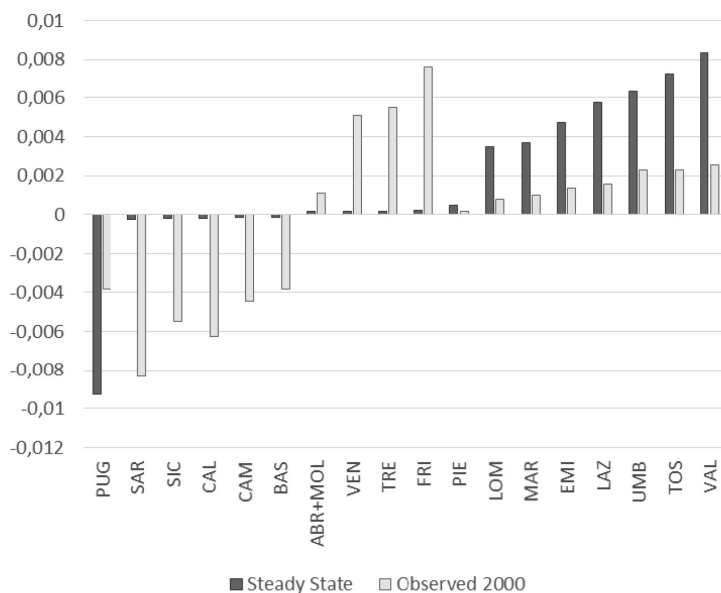


Source: Own elaboration.

with the lowest per capita income are far below the steady state while autonomous regions such as Madrid, Catalonia and the Basque Country are above the steady state. In the case of Italy, our estimation of the convergence of the Italian regions of between 1% and 9% is very low in comparison with the results observed for the Spanish case where figures of between 5% and 15% were obtained (Figure 10). The poorest regions of Italy are far below the steady state and the richer regions are far above their steady state.

The analysis shows that Italian regions have, to a reasonable degree, converged towards a steady state. It should be noted that these measurements are similar to those found in the literature on the growth of per capita income which takes a long time to reach the steady state in terms of height. As indicated in the previous section with respect to the estimates of regional convergence of the biological indicator of well-being, the internal migrations could have played a decisive role. The large flow of migrants from the south to the north of Italy in the 1950s and 1960s, caused by a desire to improve their standards of living and adapt to the growing labour demand of the industrial triangle in the north, could have significantly affected the height results.

Figure 10: DISPARITIES IN HEIGHT IN THE ITALIAN
REGIONS BY DRAFTS YEAR (1948-2000)



Source: Own elaboration.

5. CONCLUSIONS

The analysis of the secular trend and the regional inequality in heights over the long term in Southern Europe shows interesting results for human well-being in the two Latin countries, Italy and Spain. Both nations have similar historical backgrounds and underwent significant processes of economic and social transformation as from the end of the nineteenth century. In addition, they both experienced spectacular economic growth and improvements in health and overall welfare during the twentieth century.

First, we have shown that there is a close relationship between wealth measured in per capita income and health expressed in height. The secular trend of height experienced spectacular growth during the twentieth century in both Italy and Spain. Second, particularly for much of the twentieth century, it can be observed that the inequalities in income matched the inequalities in health. The regional disparities in biological welfare and nutritional health diminished, and have been converging to a lesser or greater degree since the 1930-1940 generation. The phenomenon can be explained by the economic improvements, the effects of the social policies, the educational achievements and, in general, the great transformations suffered by both countries and the more developed world after the Second World War. In Italy, the increase in the average height and regional convergence reflects the period known as

the “Italian economic miracle”. The height increase in Spain was the greatest in the whole of Europe after the slump caused by the Civil War and the reduction in height during the Franco autarchy (the years of hunger). The remarkable increase in height occurred from the 1950s.

The results show that height can be used as a proxy for inequality in studies on the standard of living and welfare in general. A more in-depth comparison on a regional scale of the relationships between per capita income, life expectancy, child mortality and height in a similar line as previous studies is recommended [Arcaleni (2006); María-Dolores and Martínez-Carrión (2011); Felice and Vasta (2015)]. It would be interesting to explore the impact of the decentralisation policies on biological welfare during the last third of the twentieth century. The case of Spain requires special attention, given the role of the autonomous regional governments in social, health-care a welfare policies since the beginning of the 1980s.

Although convergence processes are occurring in both countries, the anthropometric evidence shows that the inequality is more pronounced between the Italian regions than it is between the Spanish regions. This aspect was prevalent in the past and has persisted until recent times, and is undoubtedly connected to the strong economic disparities that still exist between the north and the south. The results reveal that the convergence in height observed in Spain in recent decades has not been observed between the Italian regions with the intensity expected. As already mentioned, this is due to the wide economic disparities within the Italian territory, where the difference between the regions of the north which have a high level of income and employment and those of the south with low income and employment levels has been, and continues to be, extraordinary. Undoubtedly, the inequality of the Italian regions at the starting point at the beginning of the twentieth century in terms of regional GDP and per capita income was much greater than in the Spanish case, which explains why the regional convergence process in the Italian case still has room for improvement. However, the role played by internal migrations could also be significant. The large flow of migrants from the south to the north of Italy and also in Spain could have significantly affected the height results. Future studies should analyse this issue using microdata. Furthermore, it would also be interesting to analyse how policies implemented by national and regional governments in order to provide preferential public goods and services, principally related to welfare, such as health and education have affected height at different ages and sexes.

APPENDIX: REGIONAL HEIGHT DATA IN ITALY AND SPAIN

Military recruitment data constitute the main sources. In Italy, national compulsory recruitment of young men was established in 1863 (birth cohort 1842), two years after Unification. More detailed information on the sources of military recruitment in Italy can be found on the ISTAT website: http://timeseries.istat.it/fileadmin/allegati/Sanita/testi_inglese/4_Height_of_military_service_recruits.pdf. The height data of the Italians was published by the ISTAT, which enables us to reconstruct a national series for the recruits born between 1854 and 1980 (recruits of the period between 1874 and 2000), while the annual regional series correspond to the period between 1927 and 1980 (recruits of the period between 1947 and 2000). Av-

erage height data of men cohort born during the years 1854-1980 and average height of men cohort born during the years 1918-1980, by region, are in ISTAT. Time Series. Italian Historical Statistical Repository.

More recently, decennial data has been compiled by A'Hearn and Vecchi (2011) for the cohorts born during the period 1861 to 1980. Compulsory drafting was abolished in 2005, being replaced with a voluntary enrolment programme. Data for the 1980 birth cohort were the last to be released by the Ministry of Defence.

For Spain, the male height data have been extracted from the *Estadísticas de Reclutamiento y Reemplazo del Ejército* [Recruitment and Army Draft Statistics, hereafter ERRE] that elaborated the *Servicio de Estadística* [Statistics Unit] for the *Anuario Estadístico Militar* [Military Statistical Yearbooks, hereafter AEM], from 1955 to the abolition of the service of military conscription obligator in 2001 (cohorts from 1934 to 1982). The enrollment age was 21-years-old until the end of the twentieth century when it became 18-19-years-old, while in Italy it was usually 20-years-old. These differences are not a problem for our comparative analysis: human growth ends at about 18-20-years-old. Our analysis ends with the 1980 cohorts in both countries (recruitment of 2000 for Italy and 1999 for Spain).

Together with the *Instituto Nacional de Estadística* [Statistics National Institute, hereafter INE] that edited the *Anuarios Estadísticos de España* [Statistical Yearbooks of Spain, hereafter AEE], the Ministry of Defence (or corresponding ministries until its creation in 1977) provides anthropometric information on the entire military population of recruitment age (height, weight and thoracic perimeter). While the INE provides anthropometric data classified by anthropodemographic regions (according to Luis de Hoyo), the Ministry of Defence provides data by provinces. In both cases, the anthropometric information is presented in centimeters in a frequency distribution in which the statures are grouped in intervals. Thus, between 1955 and 1964, heights are grouped as follows: Less than 150 cm, 150-154, 155-159, 160-164, 165-169, 170-174, 175-179 and more than 180 cm. From 1965 to 1986, two more intervals were added: 180-184 cm and more than 185 cm. From 1987 to 2000, a further two more were included: 185-189 cm and over 190 cm, while the lowest interval was set at less than 155 cm, finally ending in nine intervals. An important collection of military statistical yearbooks has been accessible since 1960 in: <http://www.defensa.gob.es/defensa/estadisticas/#>

Data corresponding to years before 1955 are available for only a few years (1858 and 1912-29). Until 1955, the heights are classified into three groups, which makes it difficult to calculate the average height of the population due to the lack of information of shorter heights and the large width of the intervals (Gómez Mendoza and Pérez Moreda 1985; González Portilla 2001, Martínez-Carrión 2016, and Martínez, Cámara and Pérez 2016).

The estimates of the average heights of Spain's autonomous regions are made through the Quantile Bend Estimator (QBE) method, proposed for height samples by Watcher and Trusell (1982). This method is based on the quasi-normal frequency distribution of the adult population statures. Heights are flared and symmetrical or, in other words, the data are arranged with the same frequency and the same distance values above and below the average. The method has been used with Spanish data by Gloria Quiroga (2003) and Cámara and García-Román (2015). In this article, we use the regional estimates elaborated by Quiroga (2003) since 1955 (from the cohorts of 1934) and we estimate the own ones from 1987 with AEM data.

In addition to the provincial data published by the ERRE (AEE), in Spain there is anthropometric information on a local scale available in the municipal archives that enables to analyse the evolution of height from 1858. Personal records of recruits are also preserved in the *Archivo General Militar* [General Military Archive] of Guadalajara from 1893 replacement. With these data, Coll and Quiroga (1994) created a national height series with a random sample of 46,385 Spanish recruits for the period 1893-1954. The authors indicated that the first part of the series (1893-1910) was “biased by the presence of young men coming from low income families who were less representative of the Spanish population as a whole” and contained a higher agricultural representation until 1930 (Quiroga, 2002).

With aggregated municipal data that contain the whole of the population of the municipalities analysed, Martínez-Carrión and Puche (2010) presented a series of average heights (Levant Series) based on a wide sample for the period 1857-1969 (cohorts 1837-1948). Composed of 328,000 observations of conscripts from five provinces of Spain’s Levant region (Alicante, Almería, Castellón, Murcia and Valencia), the series is representative of the average total population of Spain. Previous anthropodemographic studies show that heights in the Levant region (Murcia and Valencia Community) are similar to the national average throughout the contemporary period (Martínez-Belmonte 1983, Martínez-Carrión and Pérez-Castejón 2000, Quiroga 2001). In this article also the Levant series is extrapolated to the Spanish case for the years prior to 1955. This series links with the national series developed by the INE-Ministry of Defence.



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RESUMEN

Este trabajo analiza el crecimiento de la estatura y su variabilidad regional en España e Italia entre las cohortes generacionales de 1850 y 1980. Con estaturas masculinas de los reemplazos de 1870 a 2000 explora la desigualdad y la convergencia regional en ambos países, un largo periodo caracterizado por el crecimiento económico y la expansión del bienestar humano. La desigualdad y la convergencia regional son analizadas empleando *sigma* y *beta* convergencia, una metodología basada en datos de panel para obtener la velocidad de convergencia. Los resultados demuestran que, partiendo de estándares bajos de estatura en ambos países hacia 1850, los dos países registraron un notable incremento de los promedios de talla en el largo plazo, más intenso para Italia desde inicios del siglo XX, mientras España lo hizo desde 1950; así, hubo divergencia durante la primera mitad del siglo y firme convergencia al final de la centuria. La desigualdad regional fue más significativa en el caso italiano. Ambos países muestran procesos de convergencia regional en el curso de la segunda mitad del siglo XX, pero, final del periodo, la desigualdad fue menor en España que en Italia.

Palabras clave: estatura, bienestar biológico, España, Italia, desarrollo económico, desigualdad regional, convergencia.

Clasificación JEL: I14, N33, N94, R13.

