Migration and well-being: did internal migration from southern to northern Italy in the mid-twentieth century affect height convergence?

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Assessing human well-being through anthropometric measures, particularly height, is well documented in the literature. However the impact of internal migration on the biological welfare has not been yet documented, mainly for lack of detailed data. The phenomenon of a stature convergence across Italian regions during the second half of the twentieth century has been evidenced by several studies. Increases in stature were indeed higher in southern areas, which were initially characterized by height lower than the national average. However, this trend is also affected by the massive migratory flow of people from southern to northern Italy in the 1950s-60s, which greatly slowed the rate of increase in mean height in the receiving regions, since immigrants were on average shorter than the local residents. Our research question is the following: given the size of migration flows from South to North of Italy and the variety of ethnic profiles, what is the contribution of internal migration, operating through decreased rates of height growth, in explaining convergence stature in Italy?

Based on conscripts' micro-data (1951 and 1980 cohorts), we aim to estimate the contribution of South-North migrations on over-estimation of the height convergence of southern and island areas. We exploit the dataset which includes a representative sample of 111,834 Italian conscripts born in 1951 and 162,295 born in 1980.

We provide estimates of the impact of internal migration during the economic boom in term of speed of stature convergence combining the information concerning the places of residence and municipality where the military conscript was born. Results indicate that migrations may explain about 25-32 percent of the high speed of convergence of stature across areas of Italy, whereas lack of identification of migration flows yields an over-estimation of the well-being changes in people living in the South of Italy.

1. Introduction

During the end of the nineteenth century and throughout the twentieth, the existence of a sudden upsurge in the average height of Europeans is a stylised fact. Changes in adult body size and growth processes across generations have been homogeneously defined “secular trends in height” (Ulijaszek, 1998). Many contributors to this field have taken important steps towards understanding the relationship between height and living standards (see, for example, Komlos, 1998; Steckel, 1995; 2009). Height is recognized as a multidimensional and retrospective measure which reflects several factors such as disease environment, public health and personal hygiene, nutrition. These factors may impair health, affecting the incidence of disease which, in turn, involves nutrition, especially if experienced in childhood. While the long-term evolution of stature is consistent with empirical data in countries worldwide, it is not easy to disentangle the contribution of the various factors underlying this process. The key issue of anthropometrical history is the belief that both environmental and genetic factors are responsible for increases in stature, since they represent an indicator of social welfare (Fogel, 1986; Komlos, 1998).

Secular height trends have been amply investigated also in Italy. In particular, Arcaleni (2006) has documented the increase in height of about 12 cm of military conscripts born during 1854-1980. This significant improvement in well-being leaded researches to investigate how this increase in stature was distributed across the areas of Italy, characterised by an economic North-South divide (Felice, 2011). By reducing the sample to military conscripts born between 1927 and 1980, for which regional data were available, a moderate process of height convergence between southern and northern/central regions was evidenced in particular for individuals born in the 1950s.

There is a recent literature that refers to the stature convergence across administrative areas of Italy. For example, Arcaleni (2006), Peracchi (2008) and A'Hearn *et al*. (2009) use data extracted from Italian military archives to investigate changes in height, regional differences and biological convergence. Peracchi and Arcaleni (2011) also extend the approach of Bozzoli *et al.* (2007) to show the influence of early-life environment on stature outcome.

However, these estimates do not account for the existence of the complex phenomenon of internal migration from the South to the North of Italy, which had been intensified during the second half of the twenties century, mainly for lack of detailed data. The availability of the dataset PRIN 2004, that will be described below, with detailed information that links the place of birth and residence of each conscript allow us to disentangle the effect of stature convergence from the migration bias.

The contribution of this paper is twofold:

- we first present an overview of the height secular trend in Italy during the twentieth century and then estimate the speed of convergence of height of military using conscripts born in 1951 and 1980 aggregated at the provincial level. This allows us to test the existence of stature catching-up patterns between southern and northern areas of Italy;
- we quantify the bias of effects of internal migrations on stature convergence and evaluate it in terms of half time of convergence.

Results show generally that there is a marked reduction in stature disparities across regions for cohorts born after World War II. Increases in stature were indeed higher in southern areas, which were initially characterized by height lower than the national average. This evidence implies that the most backward regions grew faster than the most advanced ones (i.e., definition of β-

convergence), which represents our instrument for evaluating convergence in stature. Then, we test the role of internal migration from Southern to Northern regions in over-estimating the height convergence. We were able to evidence the significant effect of the massive influence in stature of migratory flow of people from southern to northern Italy in the 1950s-60s, which greatly slowed the rate of increase in mean height in the receiving regions, since immigrants were on average shorter than the local residents. Results challenge partially the concept that the height catching-up of the South with respect to the North after World War II was exclusively due to the faster secular increase in height of southern military conscripts. Rather, new evidence suggests that internal migration played a key role in accelerating the stature convergence process in Italy suggesting, under different specifications, an impact over the 30 percent.

2. A brief *excursus* on the social and economic history of Italy in the second half of the twentieth century

Italy is an interesting country in which to analyse the changes in anthropological indicators like adult height and, more recently, body mass index because several large-scale political, social and environmental transformations took place in the second half of the twentieth century. This historical period witnessed the transition from underdevelopment and fascist authoritarianism to prosperity and democracy, although large and persistent differences across regions in economic and social conditions, and access to healthcare, were to be an Italian characteristic for a long time. Indeed, Italian living standards have maintained a considerable North-South divide (Baldi and Cagiano de Azevedo, 1999).

Despite the negative effects of World War II on the Italian economy, in the 1950s and 1960s Italy was transformed from a poor, agricultural country subjected to mass emigration into one of the world's major industrialized powers, an event known as the *Italian economic miracle*. However, this process has not been rapid and homogeneous across the country. In the early 1950s, in fact, the living conditions of many families were still precarious, as evidenced by a survey promoted by the Italian Parliament and carried out in the early 1950 (Braghin, 1978). The results of this survey revealed that southern areas of Italy were characterized by extensive poverty. The number of households in economic difficulties was about 2.7 million (1.4 classified as "very poor", with a very low standard of living, and 1.3 million living in poor conditions) and represented almost a quarter of the total households. Large territorial disparities evidenced the backwardness of the South: 85% of households classified as “very poor” and 70% of those classified as “poor” were in the South (Baldi and Cagiano de Azevedo, 1999). Only 7.4% of Italian houses in 1951 had electricity, drinking water and indoor toilets (Ginsborg, 1998); in addition, most people were employed in the agricultural sector, which was backward in technological development compared with other European countries.

The context above described may explain why the 1950s were also characterized by massive internal migration from the underdeveloped South to the rich North and from rural to urban places, starting in the early 1950s and reaching its peak during the second half of the 1960s. The principal destination of migration was towards northern cities which were experiencing great industrial development. Between 1951 and 1965, almost 1.5 million people a year moved (nearly 30 per 1000 inhabitants), while the so-called "industrial triangle" (Turin, Milan, Genoa) absorbed a net migration of 113,000 people a year. In addition, East-West movements were another distinguishing feature of migration, although to a lesser extent, especially from the Veneto and Lombardy to Piedmont. Proof of these internal flows emerges from the census of 1961, indicating that 36% of the population resided in a municipality different from the place of birth.

After 1964, for a time Italy maintained a constant growth rate of over 8% every year, boosted by reconstruction and modernisation: the net national income, calculated in constant prices of 1963, increased from 17,000 billion in 1954 to 30,000 billion in 1964, almost doubled in a decade. The result was that it had been transformed from an economy which had lagged behind its counterparts in Europe to an economy that matched those of northern Europe. During the same period, per-capita income rose from 350,000 to 571,000 lire. The number of employed in agriculture were still more than 8 million in 1954, but less than 5 million ten years later. Only the 1973 oil crisis temporarily halted the economic boom, causing an economic recession which went on into the mid-1980s, until a reduction in public costs and spending.

The processes of mass education, especially related to school reforms, also promoted social mobility (Pugliese, 2002). The compulsory age of education was raised to 14 years in 1962[1], and did not involve the 1951 cohort[2]. However, in 1962, the '*avviamento al lavoro'* was abolished, and all children up to the age of 14 had to follow a single programme, encompassing primary education (*scuola elementare*) and secondary school (*scuola media*). Progressive economic development also contributed to changing demographic behavior, as the two phenomena are closely interrelated.

From a demographic point of view, high fertility persisted until the 1970s, when it plunged below replacement rates, whereas overall mortality and infant mortality were considerably reduced. Mortality rates decreased by 10%, whereas the infant mortality rate dropped by 34% with respect to

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[1] Law no. 1859 of December 31 1962 abolished training schools to achieve work status more easily and established a unified school "media" allowing access to all high schools. This reform extended compulsory education to the age of 14.

[2] After the first five years of primary education, children could choose the 'scuola media', which would give further access to the "liceo" and other forms of secondary education, or the 'avviamento al lavoro', which was intended to allow quick entry into the lower strands of the workforce and lasted 2-3 years.

the negative period after the Second World War. Life expectancy at birth for men rose steadily from 66 years, with two three years' gap between men and women, to 71 years in 1981 (Baldi and Cagiano de Azevedo, 1999). The significant reduction in mortality during the 1950s was due to better medical care, more accurate information on health and hygiene, progress in medical technology, significant improvements in nutrition, and decreased rates of infections, especially in the most deprived southern areas of the country. Notwithstanding these improvements, the infant mortality rate was about 67 per thousand, much higher than those of other developed European countries, falling to 15 per thousand only in 1980.

Summing up, an overall increase in the standard of living throughout the second half of the twentieth century was observed, and the interrelation of many factors - economic, social and epidemiologic - certainly contributed greatly to this.

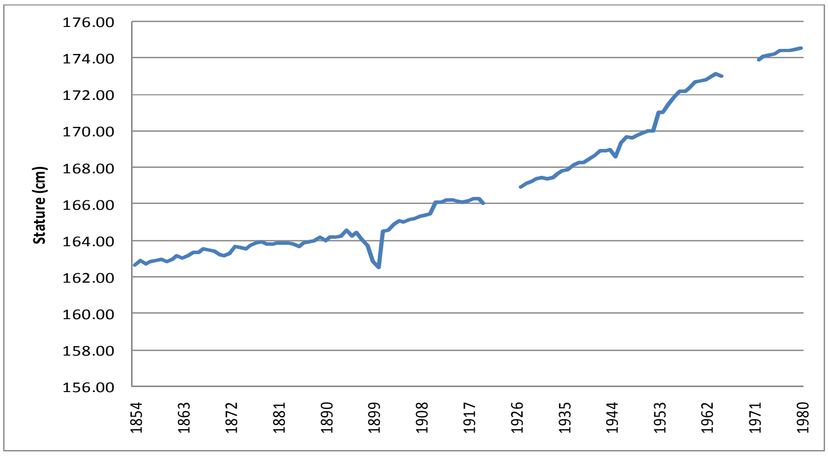
3. Preliminary evidence on secular trend and height convergence in Italy from late 1800 to twentieth century

Secular trends refer to long-term fluctuations in the patterns of growth and development in a given population, usually over successive generations (Tanner, 1981). Figure 1 gives the stature pattern of Italian conscripts born between 1854 and 1980, showing an increase in mean stature from 162 cm to 174.5 cm. Height data were drawn from the *Sommario di Statistiche Storiche* for birth cohorts 1854-1920 and the *Annuario Statistico Italiano* for birth cohorts 1927-1980. As clearly evidenced by Arcaleni (2006) "the height national trend followed an S-shaped pattern: after a long initial period in which the mean height increased slowly, a phase of accelerated increases started with the generations born in the early 1950s, and a final phase of diminishing rates of increase".

If we concentrate our attention on the second half of the twenty century we may note that, despite worsened economic and health conditions during World War II, cohorts of young men born immediately before and during the war (birth cohorts 1930-45) show increasing mean statures. This means that, although war-related deprivation during the war years led to a burden of disease in childhood, it did not compromise the process of stature increase. On the contrary, throughout this period, the highest rates of growth were recorded for the generations born in the 1940s and 1950s.

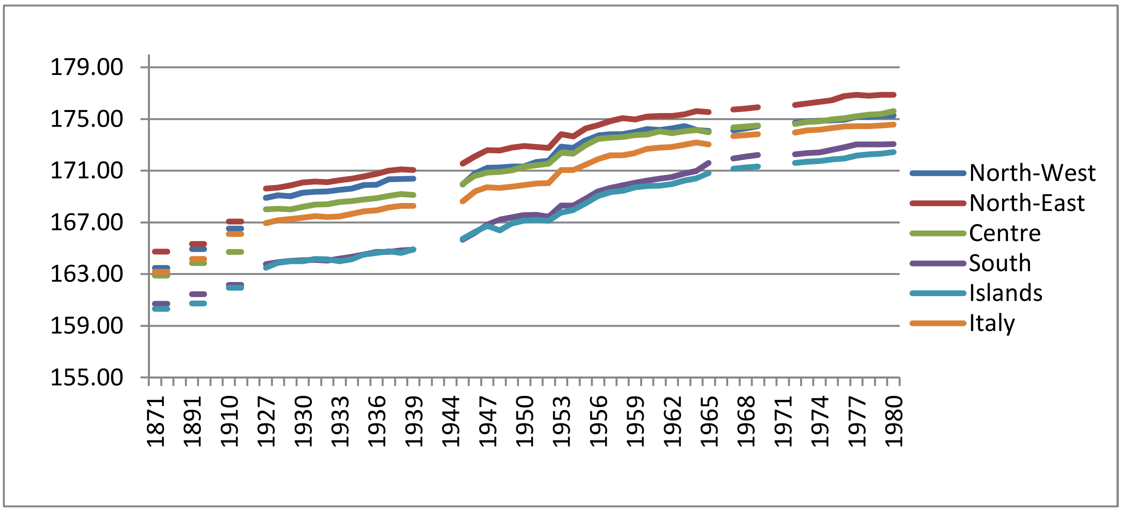
If we analyze data on mean stature disaggregated by region, and available almost continuously from 1927 birth cohort, we notice that the secular trend in Italy was characterized by initial large height disparities across Italian regions, gaps progressively reduced thanks to the stature convergence process particularly pronounced in the second half of the twentieth century. Figure 2 shows the evolution of stature of military conscripts for five Italian macro-areas (North-West, North-East, Centre, South, and Islands); a marked reduction in stature disparities across regions is evident only for cohorts born after World War II and until those born around 1965.

Figure 1 - Pattern of conscripts' stature in Italy (1854-1980)



Increases were higher in southern and island areas, which were initially characterized by lower statures, with respect to the North and the Centre. However, the right hand of the Figure shows the permanence of a wide, although reduced, gap in height between North-Centre and South-Islands; this evidence implies that regional variability has not yet disappeared for younger birth cohorts although growth rates in Southern Italy and Islands were significantly higher than those of other regions. Table 1 shows the growth rate of regional mean stature for sub-periods and aggregates.

Figure 2 – Patterns of military conscript stature (cm) in Italy by macro-area (1871-1980)



The average increase in stature was far less in the South, slightly more than half a centimetre. Instead, the rates of stature increase in the first two decades after World War II show how the South recovered. Although the generalized economic boom which Italy enjoyed at the end of the 1950s, certainly retarded the catch-up in stature, we note a sharp rise, more than double, in the stature of young soldiers during the decade 1961-1971.

Table 1 – Growth rate of stature by Italian macro-area

	1871-1891	1891-1911	1911-1931	1931-1951	1951-1961	1961-1971	1971-1981
Annual growth rate							
North-West	0.0453	0.043	0.091	0.067	0.143	0.033	0.030
North-East and Centre	0.0255	0.031	0.100	0.077	0.144	0.041	0.050
South and Islands	0.0225	0.026	0.071	0.072	0.159	0.102	0.047
Growth rate							
North-West	0.9065	0.862	1.82	1.351	1.430	0.330	0.308
North-East and Centre	0.5100	0.628	2.008	1.557	1.445	0.411	0.505
South and Islands	0.4501	0.528	1.423	1.459	1.592	1.042	0.474

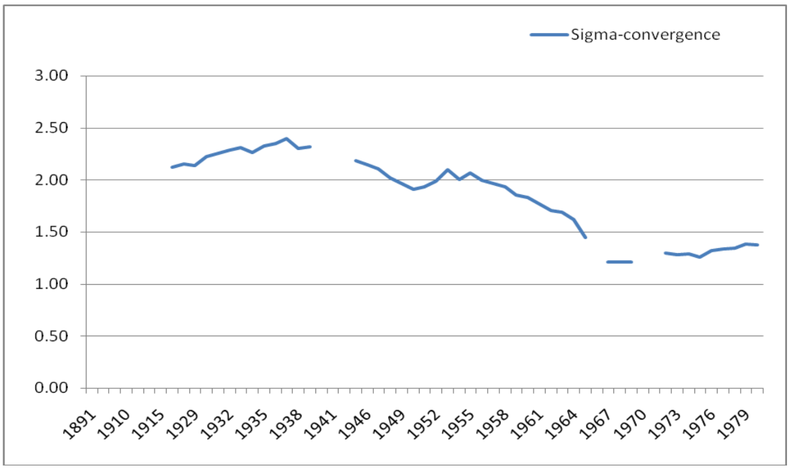
Descriptive statistics have just evidenced that the most backward regions grew faster than the most advanced ones. As evidenced by numerous studies, Italy has been marked by pronounced geographical disparities and persistent backwardness of the regions in the South at least until the '50s, when the economic and social gap between South and North was reduced significantly and over a protracted period. As evidenced by several author, from the economic point of view, a convergence process between the regions of Southern and Central-Northern Italy were developed through the period 1950-70, for then slowing down. The intense economic growth for the regions of the South coincided with the development of the Italian economy, as a whole and the expansion of infrastructures and productive activities in the South, supported by the "Intervento Straordinario", a plan which allowed channeling huge flows of resources from the North to the South.

Here, we show the results of the regional convergence in height by using a descriptive statistic of the time-variability of the well-being indicator, known in the economic literature as σ-convergence (Barro and Sala-i-Martin, 1991). Instead, we will return in the next section to implement the formal model based on the definition of β-convergence to test the catching up patterns of height between southern and northern areas of Italy[3].

[3] The concepts of σ and β regional convergence here used are borrowed from Barro and Sala-I-Martin (1992), with the difference that height is used instead of per capita income.

Figure 3 shows yearly measures of regional σ-convergence of the cohorts of military conscripts born between 1927 and 1980. The estimates of this indicator, corresponding to the coefficient of variation (CV), are characterized by a general declining trend. However, note that a rise in stature variability for the cohorts born between the World Wars is highlighted. According to the historical economic literature, one explanation for this finding is that the asymmetric shocks of epidemic disease or deterioration in gross nutritional status affected regions to different extents, being particularly intense in the most retarded and least developed populations (Felice, 2011).

Figure 3 – Regional disparities in stature: σ-convergence



Instead, Figure 3 shows a reduction of the gap in stature after World War II; this implies that disadvantaged areas of Italy in terms of enhanced well-being reduced disparities with respect to more prosperous areas. As a main motivation of this performance, data show that the South as a whole experienced a powerful growth in per capita income, sustained by heavy public and private investments flowed with the "Intervento Straordinario", and correlated better levels of well-being, as indicated by the rise in life expectancy at birth and literacy rate (REF).

4. Catching-up in stature: conceptual framework

As outlined above, to test a significant convergence of well-being, we use stature as a biological welfare indicator and extend the economic framework of the Solow model to obtain a closed form for its growth rate. It is worth noting that, under general assumptions, the estimated speed of "well-being convergence" assumes the same parameterisation of an "economic convergence", generally measured by the cross-section reduction of per-capita income (Bassino, 2006).

Formally, consider a differential equation in logarithm of stature (log H) with the solution:

$$\log H(t) = (1-e^{-\beta t})\log(H^*) + e^{-\beta t}\log(H(0)). \tag{1}$$

In discrete time, corresponding to annual data, the stature for a population i, irrespective of group of regions or families, may be approximated by[4]:

$$\gamma_{i,t} = \log\frac{H_{i,t}}{H_{i,t-1}} = a - \beta\log H_{i,t-1} + u_{i,t} \tag{2}$$

where a and β are constant, with $0<\beta<1$ and $u_{i,t}$ is a disturbance term. Condition $\beta>0$ implies β-convergence because annual growth rate, $\log H_{i,t}/H_{i,t-1}$, is inversely related to $\log H_{i,t-1}$ which is easily estimated from available datasets. A higher coefficient β corresponds to a greater tendency for convergence among groups of populations. The disturbance term captures temporary shocks to the production function, the saving rate and, in general, of the components that define the growth model. For empirical treatment, we assume that $u_{i,t}$ has mean zero, the same variance, $\sigma_u^2>0$, for all groups of populations and is independent over time and across groups of populations. If the estimate of β-coefficient of initial stature, $\log H_{i,t-1}$, is negative in a simple regression, then we interpret this result in the sense that data display absolute convergence.

Following Barro and Sala-i-Martin (1991) and Mankiw *et al.* (1992), we can also characterise another measure of convergence, i.e., conditional convergence. In a theoretical point of view, the estimate of β indicates how quickly the height of a country or region tends to its steady-state (i.e. mean of the countries or regions) by the partial correlation between growth and initial stature. Thus, the negative coefficient on initial stature should be found by running a cross-sectional regression of growth on stature, holding a number of additional variables constant. In this case, the model becomes:

$$\gamma_{i,t} = \log\frac{H_{i,t}}{H_{i,t-1}} = a - \beta\log H_{i,t-1} + \sum_{k=1}^{K}\bar{z} + u_{i,t} \tag{3}$$

where $\bar{z}$ is the vector of conditional variables.

[4] A first-order Taylor approximation of $e^{-\beta t}$ is used in order to linearise parameter β of equation (2.18), with $e^{-\beta t}\cong 1-\beta$ and $a = x + (1-e^{-\beta})\left[\log H^* + x(t-1)\right]$. See Barro (1991) for a formal derivation.

Since the theoretically predicted length of time required by an economy to fully attain its balanced growth equilibrium is infinity, it is conventional to use the notion of half-life to compare convergence speeds. Short half-life times indicate high speeds of convergence and long half-life times low speeds of convergence. In terms of logarithmic variables, half-life is defined as the time taken for logarithm distance $(\log H - \log H^{*})$ to be halved. Consider Γ_h to denote half-life times, in which the condition satisfied by Γ_h is:

$$\frac{1}{2}(\log H - \log H^{*}) = \log H(\Gamma_h) - \log H^{*} \tag{4}$$

which yields:

$$H(\Gamma_h) = \sqrt{HH^{*}} \tag{5}$$

Equation (5) indicates that the logarithmic version of half-life corresponds to the time at which H_t equals the geometric mean of H and H^{*}. Substituting equation (1) into equation (5) yields the approximate value for this indicator:

$$\tilde{T} = \frac{1}{\beta}\log 2 \tag{6}$$

Note that the half-life is independent of the initial distance from steady state, but depends only on the estimated parameter β in percentage.

5. The empirical analysis of convergence

Following the “facts” in stature growth highlighted above, in this section we present an empirical test for well-being convergence in Italy after World War II. With respect to the current literature that use country or regional data, and that we use in a descriptive way to investigate the catching-up hypothesis, we use individual data of military conscripts to evaluate the stature convergence at the provincial level. As a novelty in the literature, by exploiting the data on the birth place and the residence at the date of the medical examination we are able to estimate the contribution (e.g., overestimation) of the consistent flow of internal migration from South to North Italy on the convergence process of this well-being indicator.

5.1. The hypothesis of catching-up by Italian regional data (1951-1980)

As a baseline model, we estimate a growth model for stature at the regional level and test if the hypothesis of β-convergence exists. The growth of the mean regional stature is calculated by using official data from National Institute of Statistics (ISTAT). We are interested in comparing results for a long period, such as we use the cohorts of 1951 and 1980 as reference years in according with our military micro-dataset. Traditional analyses of economic convergence usually use a cross-sectional framework in which growth rates and explanatory variables are observed only in one time-period.

However, as suggested by Barro (1992) and Sala-i-Martin (1996), we extend the analysis to other benchmark years, 1961 and 1971, to obtain a panel set-up; the main advantage is that the time-series dimension provides some additional information in cases in which the number of cross-section observations is small. Note that, this allows consistently estimating a system in more than one equation, testing sub-period convergence (for example, the growth rate of stature associated with the period of the Italian economic miracle). These supplementary years have also been chosen because they are linked with census data, obtaining eventually a larger availability of data from the cited source.

The dependent variables are growth rates of stature over the period 1951-1980 or over the three decennial intervals; in the latter case, the sample includes the time-spans 1951-1961, 1961-1971 and 1971-1980**.** Estimates obtained by OLS and seemingly unrelated regression estimator (SURE) are shown in Table 2. Note that the use of mean growth stature as a response variable instead of growth of per-capita income consistently reduces problems of measurement bias. Column 1 lists different estimation procedure of absolute convergence. Each regression contains three members. The first is the estimate of β parameter followed by the standard error of β. Lastly, we show the adjusted R^2 of the regression (all equations are estimated with constant terms).

Results in terms of the annual height growth rate suggest that the regional height tends to approach its long-run position at the rate indicated by the magnitude of the coefficient. The estimated coefficient of β=-0.011, (s.e.=0.002) is highly significant and implies a rate of convergence of 1.1 percent per year. Below, they are shown point estimates of β-convergence for the periods 1951-1961, 1961-1971 and 1971-1981. Parameters have the expected negative signs and are significant for the first two periods (-0.0081, s.e.= 0.0033 and -0.0246, s.e.= 0.0041, respectively); instead, the point estimate is not significant for the last period. The large value of R^2 can also be appreciated from the first two equations; in addition, we report a scatter plot in Figure 4 of the average rate of stature increase between 1951 and 1980 based on the significant interpolated estimated parameter (point estimate -0.011; s.e=0.002) listed in the last part of Table 2.

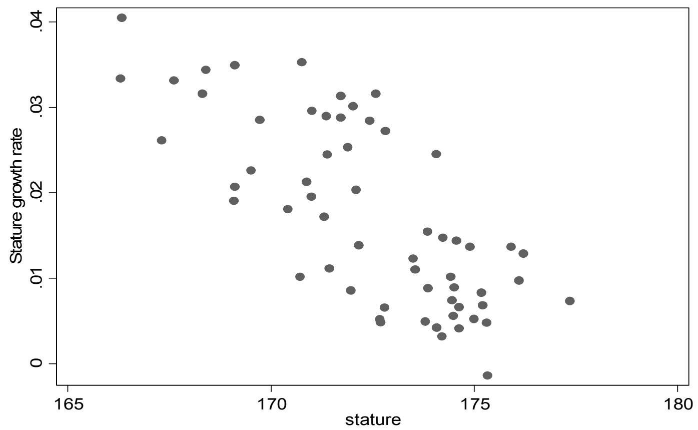
To summarise, the analysis of the post-World War II period (1951-1981) show therefore that Italian regions reasonably converge towards a steady state of stature; the negative relationship between the rate of stature increase and log stature at the initial year (1951, 1961 and 1971, respectively) would show up.

Table 2 – *OLS and seemingly unrelated regression (SURE) of height regional β-convergence*

Periods	Beta	Standard error	Adjusted R^2
OLS estimates 1951-1980	-0.0112	0.0021	0.5824
SUR estimates, by periods			
1951-1961	-0.0081**	0.0033	0.2322
1961-1971	-0.0246**	0.0041	0.6503
1971-1980	-0.0037	0.0041	0.0001
Interpolated estimates			
(1951-1980)	-0.0121**	-0.0025	

Notes: Asterisks indicates significant levels of the estimated parameter: p-value ** < 0.05, *< 0.1.

Figure 4 - Absolute convergence in Italian regional stature (1951-1980)



As outlined in the previous sections, the estimates of the regional convergence of biological indicator of well-being, a role may have been played by internal migration. That is, the large flow of migrants from southern towards northern of Italy in the 1950s-1960s, caused by their desire to overcome their poor conditions and match the increased labour demand of the northern industrial triangle, may have significantly affected stature outcomes, over-estimating the speed of convergence when aggregate data were used[5]. Another issue linked with the estimate of regional convergence is the low numbers of Italian administrative areas (i.e., 20) that may influence the consistence of the estimates. This would be particularly evident if we include conditional variables to evaluate how these affect the speed of convergence towards the (conditional) steady state.

For the reasons above, in next section we use individual data aggregated at the provincial level, to compare the point estimates of stature β-convergence in samples which do and do not include migrants.

5.2. Estimating stature convergence by using conscript cohorts (1951-1980)

In this section, we test the hypothesis of β-convergence in stature by using a unique dataset built from the National Project "Stature, health and migration of Italian conscripts" for the 1951 and 1980, which includes a representative sample of 111,834 Italian conscripts born in 1951 and 162,295 born in 1980[6]. These data contain information on Italian young men living in the North, Centre and South of Italy, who underwent the compulsory medical examination to ascertain their fitness for military service in the Army in 1970 and 1998, when they were 19-18 years old[7]. However, this difference should not bias our results, if we consider the relatively long time-span (30 years) between the two cohorts and, more importantly, the phenomenon of acceleration of maturity which implies that, over time, final adult stature is achieved at earlier ages (Sanna, 2002). The data collected from military recruitment documents contains socio-demographic (surname, date of birth, municipality of birth and residence, profession, education), anthropometric (height, chest and abdominal perimeter, weight) and health information (pathologies, disabilities, physical and mental impairments recorded for conscripts judged temporarily or permanently unfit)[8].

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[5] See, for example, Golini (1978); Baldi and Cagiano de Azevedo (1999) and Pugliese (2002), for a deeper discussion on internal migration in Italy in the second half of the twentieth century.

[6] The database "Banca Dati Prin 2004" used in this study is not the original one collected by each Research Unit participating in the Project. We used the database which had been corrected by De Iasio, who was asked to edit the database for errors, incongruence, etc.. We thank him for his valuable work.

[7] The Army's rigorous selection procedures, aimed at recruiting individuals who were free from disease and physically and mental robust. For a detailed description of Italian laws which, over time, have modified the age at which military conscripts were required to undergo a medical examination, see Corsini (2008), p. 15.

[8] Many efforts were made to create a common platform for the two cohorts of conscripts, in order to facilitate both temporal and geographical comparisons between the two datasets. Some issues related to information subject to change over time (between the two cohorts) were raised. One example is the changing structure of schooling of recruits born in 1951 and 1980. Some adjustments were also necessary to guarantee comparability between the municipalities of two datasets referring to 1970 and 1998 because in the meantime several provinces, which had not previously existed, were created.

Based on this dataset, we aggregated individual data using municipality of birth and of residence variables of interest at provincial level. In particular, the dataset was collected by matching the 92 old administrative provinces in 1951 with the 107 new ones. A sample was therefore obtained to investigate whether catching up of stature at provincial level was at work; then, we derive the provincial annual growth rate of stature between the two cohorts.

Based on the economic convergence studies in Italy (see, for example, Paci and Pigliaru, 1998), here we remove the hypothesis of an identical steady state across areas of Italy (e.g, absolute convergence) and admit the existence of a conditional β-convergence across provinces; thus, the initial conditions in stature may be correlated with other provincial disparities in socio-demographic and health conditions yielded in the steady state of stature.

As already argued, stature in adulthood is a measure of conditions in early childhood 15 to 20 years earlier (Fogel 1997 p. 455). Consequently, the increase in heights of military recruits born in 1951 and 1980 were assumed to be affected by economic and epidemiological conditions at birth.

We collected data for 92 provinces, drawn from in the period 1951 Census. Since many studies have demonstrated that maternal education has a significant positive impact on child health (Thomas, Strauss and Henriques, 1991), we took into account this variable by considering the fraction of women aged 6+ who had at least a high school degree (high school or degree) (*educ_mother*) and the fraction of women who were illiterate (*non_educ_mother*) (see, Peracchi and Arcaleni, 2011), we considered women aged 6+ and not the fraction of women in the reproductive age (15-49) since we verified that the bias in using the first indicator was very small considering that a high school degree can be attained only after 18 years and the decreasing probability for women with increasing ages to have a high school degree. In addition, we include the percentage of people who had not completed compulsory education (*non_educ*) able to suggest a large difference in potential human capital across these areas.

We also exploited the "Annuario di statistiche demografiche" in 1951 to collect other conditional variables related to infant mortality rate (IMR) which may be considered a proxy of the childhood disease environment. Following Bozzoli et al. (2009) we specified male mortality during the first month of life (*neonatal mortality*) and between the first month and one year (*post-neonatal mortality*). While neonatal mortality is mostly driven by technological improvements, post-neonatal mortality, by contrast, is more influenced by the improved disease environment, availability and ease of access to health care, something that had already been accomplished in Italy by the early

1950s, but with large disparities between North and South. These indicators are often summarized in the literature through the infant mortality rate (*IMR*).

Table 3 - OLS estimates of the provincial beta convergence (1951-1980)

	(1)	(2)	(3)	(4)
Log H_{t-1}	-0.0266***	-0.0286***	-0.0303**	-0.0312**
	[0.0021]	[0.0019]	[0.0021]	[0.0024]
IMR		0.0061**		
		[0.0025]		
non_educ		-0.0021**		
		[0.0003]		
Neonatal mortality			0.0161**	0.0131*
			[0.0077]	[0.0087]
Post-neonatal mortality				-0.0067
				[0.0029]
non_educ_mother			-0.0018**	
			[0.0003]	
Constant	0.13796	0.1481	0.1565	0.1612
Adjusted R^2	0.6076	0.7311	0.7311	0.6673
Number of provinces	102	87	87	87

Table 3 reports β point estimates of the speed of convergence, in the absolute (1) specifications. Results show the existence of a β-convergence, as Italian provinces with the lowest initial height showed a tendency to catch up. The point estimate of -0.026 (s.e.=0.0021) is highly significant and implies a convergence rate of stature of 2.66 per cent per year. Since the speed of reduction of well-being disparities is also assumed to depend on the economic and social environment, in columns (2)-(4), we test conditional β-convergence, including alternatively the proxies described above. As an example, there is a significant positive correlation of about 0.7 between *Post-neonatal mortality* and *non_educ_mother*, in which the simultaneous inclusion will generate evident issues of multicollinearity. Our findings, consistently, indicate an increase of the β point estimates in each specification.

With respect to Bassino (2006), that studied the stature convergence among Japanese provinces, the inclusion of infant mortality rate (*IMR*) and the percentage of people who have not attained compulsory education (*non_educ*) significantly affects the speed of convergence of the Italian provinces (column 2, Table 3). To show the relationships of stature and controlling variables on growth rate of stature, Figures 5-7, show the estimated partial correlations of initial level of stature on growth rate (i.e. conditional β-convergence), *IMR* and *non_educ*.

As expected, we find significant β estimates of the conditional convergence of height (Figure 5), while plotting the relationship between stature growth and *non_educ* (Figure 6) we find a negative partial correlation, suggesting that constraints of stature growth are predicted in the provinces where this indicator is highly important.

Based on studies in developing countries, we also offer an explanation of the counterintuitive result that emerges from Figure 7 which shows the positive partial correlation between infant mortality rate and the average of height growth rate.

In line with Deaton's (2007) arguments and with the findings of Peracchi and Arcaleni (2011), in reconciling high mortality and mean heights within a framework of scarring and selection, the positive estimated parameter of *IMR* on height growth may be attribute to selection able to remove frail and shorter individuals through mortality. In turn, similar to results for developing countries people born in less developed areas of Italy may have been subjected to selective mortality, increasing the adult height of survivors and favouring a higher speed of convergence of macro-regions with shorter height.

Figure 5 – Conditional convergence in stature, by province (1951-1980)

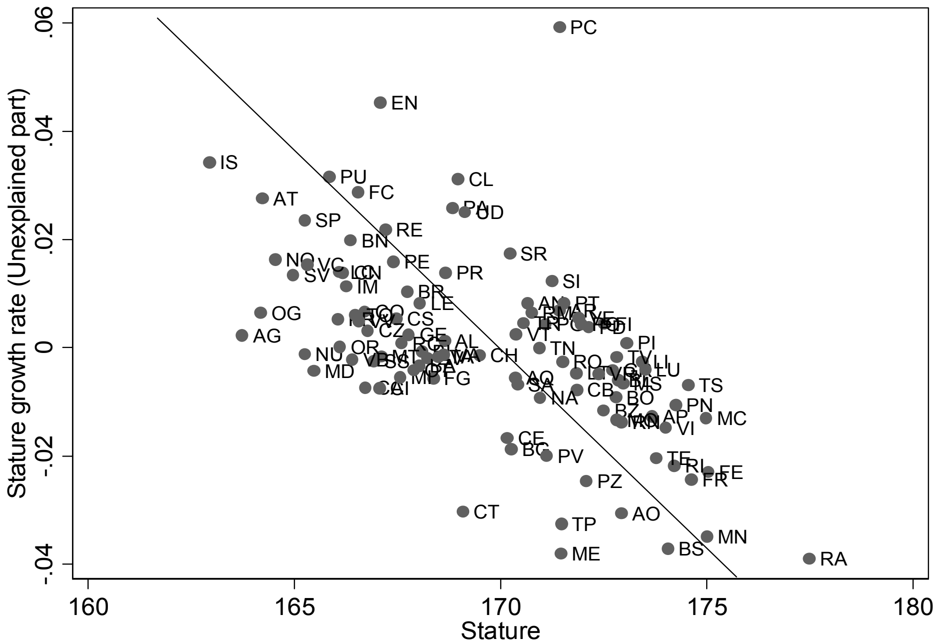


Figure 6 – Partial correlation between stature growth rate and % people who did not complete compulsory education, by province (1951-1980)

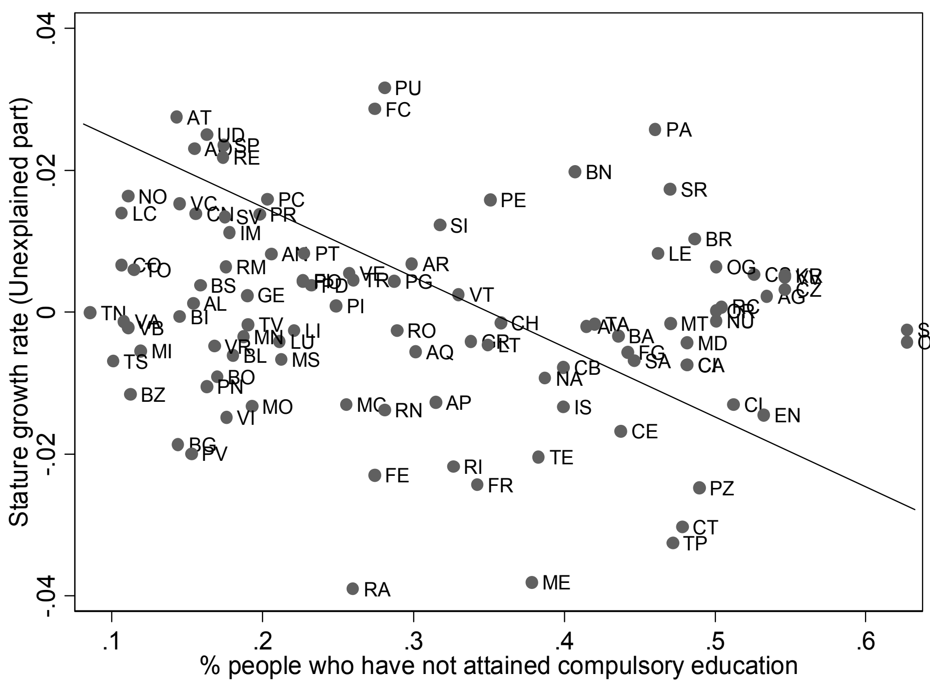
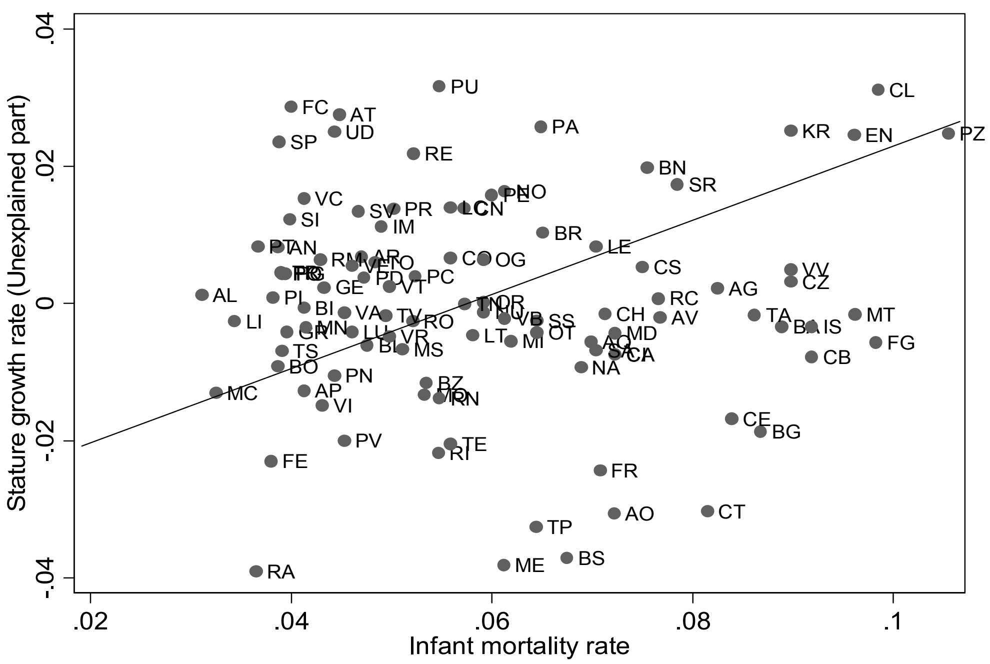


Figure 7– Partial correlation between stature growth rate and infant mortality rate, by province (1951-1980)



We estimated the conditional convergence by including in (3) *non_educ_mother and neonatal mortality* and then, in (4), *neonatal mortality* and *post-neonatal mortality*. Concerning *neonatal mortality*, the results are in line with the finding of IMR in which there is a positive selective effect on height growth rate. On the other hand, our results are consistent with the findings of Bozzoli (2007) of a negative impact of *post-neonatal mortality* on well-being.

5.2.1. ***The effects of internal migration on speed of convergence***

We wish to emphasise the richness of our conscript dataset to identify the effects of migration on stature, since individuals' place of birth and residence were recorded. According to this information, a quasi-experimental approach is developed to compare measures of β-convergence among individuals who were born and residing in the same area (i.e., non-migrants group) with those of the full sample, which includes internal migration (i.e., non-migrants and migrants) in Italy.

We take into account as "internal migration" all movements of conscripts born in a macro-area towards another one, specifically the macro-area in which the municipality of residence is located (i.e., North-East, North-West, Centre, South, and Islands). Instead, non-migrants are individuals that are born in a municipality and still live there where the medical examination was due. Second, we measure the stature mean at provincial level of the individuals that are included in the non-migrants group and full sample for each cohort. However, we have to stress the existence of a territorial heterogeneity between datasets of 1951 and 1980 cohorts: in fact, only some regions or macro-areas for the 1951 cohort were included, whereas all regions were included in the 1980 database. To ensure the spatial homogeneity of the areas investigated, we selected those provinces included in both databases which had a statistically significant amount of observations, at least as regards stature. Consequently we did not consider provinces which were recorded in one dataset (e.g., the 1951 dataset) but not in the other (1980 dataset), or vice versa.

To estimate the stature increase equation for the non-migrant group, that represents our treatment group (TG), we calculated growth rate stature for 83 (out of 107) Italian provinces of TG, which included a significant number of individuals. The estimates for this group were then compared with a control group (CG) of the same 83 Italian provinces, extracted as a restriction of the full sample that includes migrants and non-migrants. Note that these provinces also kept consistent statistical representativeness within the various geographical areas.

The point estimates of β are shown in Table 4. As expected, the magnitude of β related to CG is very close to that estimated in the full sample. Point estimates range from -0.025 (s.e.=0.0022) for absolute convergence to -0.031 (s.e.=0.0024) for the extended conditional specification. However, point estimates for TG are lower in each specification, with highly significant estimated β

parameters ranging between -0.0196 and -0.0215. Note that we restrict to 73 comparable provinces to estimate conditional convergence.

The results effectively indicate that the exclusion of migration effects on stature increase, significantly reduces the speed of convergence, both absolute and conditional. These findings, reported in Table 5, indicate that internal migrations may explain in the conditional convergence specification from 24 to 32 percent of the high speed of convergence in stature, whereas lack of identification of migration flows yields an over-estimation of the well-being changes in people living in the South of Italy.

Table 4 - Migration effects on beta convergence in stature (1851-1980)

Sample	Abs. Convergence	Conditional Convergence		
	(1)	(2)	(3)	(4)
TG: Migration excluded				
Beta	-0.0196***	-0.0215***	-0.0199***	-0.0206***
Standard error	[0.0024]	[0.0023]	[0.0026]	[0.0029]
Adjusted R^2	0.44	0.552	0.454	0.409
(Number of Italian provinces)	83	73	73	73
CG: Migration included				
Beta	-0.0254***	-0.0283***	-0.0293***	-0.0306***
Standard error	[0.0022]	[0.0018]	[0.0019]	[0.0024]
Adjusted R^2	0.615	0.778	0.784	0.701
(Number of Italian provinces)	83	73	73	73

Notes: TG: treatment group; CG control group, selecting same provinces of TG but including migration from South to North. Model (2)-(4) include the specifications reported in Table 3. These conditional variables are all significant at the 5%.

The explanation of these facts can be also seen by the rapidity of reversion to the mean to height. From the equation (6), the half-life times calculated by β-convergence in all specifications of TG presented estimates that range from 35 years in absolute convergence to 32 years in the conditional specifications, a time restricted to 22-27 years when we do ot account for internal migration (CG group). Note that these measures are similar to those found in the literature for growth of per-capita income requiring long time to gain the steady-state of stature.

Table 5 - Estimated bias of internal migration and half-life times

	Bias of the Migration	Half-life times	
	%	TG	CG
Absolute Convergence			
(1)	22.834	35.364	27.289
Conditional Convergence			
(2)	24.028	32.239	24.492
(3)	32.081	34.831	23.656
(4)	32.679	33.647	22.651

Conclusions

In this paper, we propose an empirical strategy grounded on a Solow-type growth model of well-being, which relates mean growth stature to initial well-being of Italian conscripts and tests the hypothesis of convergence across geographical areas in the post-World War II period. In the tradition of economic models the reduced form, that regress per-capita growth income on the initial level of per-capita-income, measures the speed of convergence across states or regions and bases the mechanism of convergence on the size of physical capital and on the decreasing returns of scale of the production function. “Economic convergence”, or reduction in the level of per-capita income inequality, is predicted if, under the hypothesis of long-run growth of per-capita income, gaps across state or regions become smaller.

We extend the growth model to stature to test the hypothesis of convergence across Italian provinces. To do this, we use a dataset of two cohorts (1951 and 1980) of military conscripts that includes a large numbers of individual variables, but in particular between the place of birth and residence of each conscript. This allowed answering to the main research question to estimate the contribution of internal migration during the economic miracle as over-estimate of the well-being improvements of the population of the southern Italy.

Our benchmark estimates are in line with the expectation of significant convergence, in absolute and conditional terms. Comparing the speed of height convergence between individuals aggregated at provincial level that included or not migrants, we estimated that about 25-30% of the point estimates of the speed of convergence on height were affected by those who migrated from the South to the North of Italy during the examined period.

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