

## **Human capital and economic growth. An exploration into the Italian regions (1891-2001)**

### **1. Introduction**

During the last fifty years human capital has won a prominent candidature as one of the main sources of economic growth, although its relevance has not always been proven.<sup>1</sup> Few years after the notion of human capital had made its appearance in the economic literature (Schultz 1960, Becker 1964), economic historians began to investigate the relation between the spread of mass education and the development of the Western world (Cipolla 1969). By 1981, in his presidential address published in *The Journal of Economic History*, Easterlin suggested to regard the late establishment of mass primary education in the underdeveloped world as the ultimate cause of its economic backwardness, since it hampered technological transfer; this conclusion was put forward with the avail of a very crude indicator for human capital, the primary school enrolment rate, with no formal modelling (Easterlin 1981). The idea of a very strong link (or even of inseparability) between technology and the human beings who used it had already become central (Rosenberg 1970, Mansfield 1975), paving the way to the so-called new growth theories, whose mathematical formalization was pioneered by Romer (1986, 1990) and Lucas (1988). During the last two decades studies on the role of human capital have been flourishing: on the one side mathematical modelling and statistical tools have been refined and improved, mostly thanks to the work of new growth empiricists; on the other the overall theoretical framework has been revised or expanded, for example trying to take into account the non monetary benefits of education to human welfare.

The aim of this paper is to discuss the role of human capital in the economic growth of the Italian regions, through the conditional convergence methodology employed by new growth empiricists, for a period going from the end of the nineteenth century to 2001. What was the impact of human capital on the Italian regional development? How did it affect different dimensions of economic growth such as productivity and income? Was its influence constant through time or did it vary according to different historical periods? If it varied, how did it and, possibly, why? Last but not least, do significant differences arise due to the way we decide to approximate human capital? To these questions the current research aims to give some answers.

The paper is organized as follows. Section 2 offers a theoretical and methodological framework, first reviewing the empirical studies about human capital and growth, then focusing on the Italian case proposing an approach in the light of previous works. Section 3 deals more in detail with problems of data, evaluating different measures of human capital for the Italian regions. Section 4 illustrates the results of the conditional convergence models, and section 5 shows the main regional and macro-regional dynamics. All the regional data and the regression models are shown in the statistical appendix.

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<sup>1</sup> Geography and institutions being the other two major candidates, the latter gaining recently ground as a result also of the collapse of the Soviet system (see North 2005). For a fascinating historical synthesis of the institutional and human capital approaches, in the long term perspective, see the volume by Joel Mokyr (2002).

## 2. A theoretical and methodological overview

Starting from Ram (1990 and 1991), who first defined the methodology of conditional convergence regressions, new growth empiricists devoted themselves to the task of testing the statistical correlation between education and economic growth; the former was usually measured as literacy, years of schooling (two output values), enrolment rates (an input) or a combination of them; the latter as productivity, Gdp or real wages – although for the underdeveloped countries the use of other human development indicators (*in primis* life expectancy) was advocated too. Yet in many cases the results have been disappointing, with no significance or even with a negative sign for education; so much so that during the nineties a wave of skepticism grew around the role of human capital, ranging from the neo-classical works of Mankiw *et al.* (1992) and Barro and Sala-i-Martin (1995) to the more critical essays of Knight *et al.* (1993), Benhabib and Spiegel (1994), Islam (1995), Caselli *et al.* (1996), Hamilton and Monteaguido (1998), or Pritchett (1999) who also tried to find an explanation for this ‘failure’.

More recent papers have positively reconsidered human capital, stressing that the quality of data and the statistical methodology can significantly affect the final results (Heckman and Klenow 1997, Krueger and Lindahl 2000, De La Fuente and Domenech 2000 and 2002, Cohen and Soto 2001). From a methodological point of view, for example, in order to measure the impact of years of schooling on income growth Heckman and Klenow have suggested to shift from a log-log approach (where both years of schooling and income are on a logarithmic scale) to a log-linear one (where only the years of schooling are expressed as logarithms), hence raising the income disappointing performance of the underdeveloped countries and finding a better correlation with their educational attainment. As for the quality of data, Cohen and Soto have proposed a new educational data set, as close as possible to the source of national censuses and with minimal interpolations, then they have tested it in the Mankiw *et al.* model finding a positive and significant role for human capital; also Domenech and De La Fuente (2002) have proposed a new and normalized schooling data set, relying on the output component (the years of schooling) rather than on the input one (the enrolment rate) and paying specific attention to problems of comparisons among different national censuses as well as to changes in the classification criteria. A part from refining data, new growth economists have begun to measure also the non market returns from education, such as democratization, human rights, health and environment, thus trying to extend the benefits of education to non monetary aspects of human welfare such as life expectancy (McMahon 2002).

Among economic historians, Prados de la Escosura *et al.* (1993) and O’Rourke and Williamson (1995, 1997) have proposed international comparisons for the period going from the late nineteenth century to world war I, through conditional convergence regressions with the stock of human capital as one of the independent variables and the rate of growth as the dependent one. These historical comparisons too face problems of quality, availability and uniformity of data, although not as serious as the economists’ ones since the analysis has been limited to the Western countries, a more homogeneous panel than the whole world. Generally speaking the positive impact of human capital on growth has been confirmed, although other factors – namely mass migration and capital flows – could have played a similar or more important role; indeed, according to O’Rourke and Williamson (1997) education seems to have had a greater influence in the cases of retardation (in Spain and Portugal, but not in Italy as a whole) than in those of catching up (Denmark, Norway, Sweden). For the Scandinavian countries, however, a strong correlation between education and economic growth had already been confirmed by Sandberg (1979, 1982), after having been suggested earlier on by Cipolla in 1969. Referring to the Mediterranean basin, Tortella (1994) had assigned to the low levels of human capital, measured as enrolment and literacy rates, a prominent part in the nineteenth century retardation of Italy, Spain and Portugal (together with agricultural backwardness). Of course, in all of these comparisons Italy was taken as a single unit, hence

bypassing its wide regional disparities of income, growth rates and human capital; the reason was not only the lack of data at the regional level, but also the overall approach of the authors, focused on comparisons among national cases and national policies.

In this paper I test the conditional convergence hypothesis in the case of the Italian regions, estimating the impact of education on regional convergence in income and productivity, with two principal aims. The first one is to shed more light over the Italian regional development, in order to understand why some regions ‘lagged behind’ while others ‘forged ahead’.<sup>2</sup> The present research should be considered as the first attempt to make use of the new available estimates of regional Gdp (Felice 2005a, 2005b) and of regional social indicators (Felice 2007) in order to test for statistical correlations between the two and for cause-effect links, over a relative long term historical perspective. The second one is to contribute to the international debate about the importance of human capital for economic growth, through a case study where problems of comparability are considerably reduced (although not eliminated) by the common institutional framework, while statistical significance and variety are maintained. Indeed Italy represents an extremely valuable field of analysis, probably unparalleled in the developed world: great income and educational disparities can be found among its regions, as well as different paths of both economic and educational convergence running over a century and a half of post-unification history.<sup>3</sup>

Although Italy is well known for its regional economic disparities, in income but also in human capital and other socio-cultural indicators,<sup>4</sup> and there is a huge literature on the North-South divide dating back to the end of the nineteenth century,<sup>5</sup> up to now the only attempts to test for the correlation between human capital and economic growth in historical perspective have been the two performed by Vera Zamagni, published at the end of the seventies and at the beginning of the nineties respectively. The first one (Zamagni 1978), a pioneering work, was focused on the 1871-1911 period: making use of statistical correlations between economic and human capital indicators (illiteracy rates and enrolment ratios), the author argued that human capital was a prerequisite to industrialization, that is a necessary condition to the take-off of the North-West. In her successive work, Zamagni (1993) adopted the new procedure of conditional convergence in order to test the correlation between human capital (measured as average years of schooling) and economic growth (measured as income or productivity) in the Italian regions from 1951 to 1987, finding again a positive role for human capital; this too was a pioneering work substantially without a follow up.

Conditional convergence regressions are taken up again in this paper, but analysis, data and statistical tools have been newly estimated and refined. The following are the main improvements or novelties:

a) research has been extended to all the period ranging from 1891 up to 2001; it was not possible to go further back, since 1891 is at the moment the first year for which we have reliable income estimates on a regional level (Felice 2005b);

b) the 1891-2001 period has been divided in four sub-periods, to allow for the main changes in the paths of regional development as well as in the Italian and international context: 1891-1911, years of internationalization and take-off of the North-West; 1911-1951, years of international crisis and scarce interregional mobility of factors; 1951-1971, the Italian economic miracle, characterized by a new international (and interregional) openness and by a massive and quite effective regional policy in favour of the South; 1971-2001, years of globalization, rise of new industrial regions and ‘agonizing’ regional policies. As a result of this different periodization, conclusions for the post II world war years will be partly different from the Zamagni’s ones;

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<sup>2</sup> I use the expression of the renowned paper by Abramovitz (1986).

<sup>3</sup> The Habsburg Empire displayed economic and educational regional disparities as large as the Italian ones (or even larger), but it collapsed after world war I.

<sup>4</sup> On these the work of Putnam (1993) is probably the best internationally known.

<sup>5</sup> For an updated review, see Felice 2007.

c) updated productivity and income data have been employed, from my estimates of regional Gdp in 1891, 1911 (Felice 2005b) and 1951 (Felice 2005a), linked with Svimez [1993] and Istat [2006] for 1971 and 2001 respectively;

d) human capital has been approximated through the educational component of the Hdi index, a composite indicator of literacy and enrolment rate or years of schooling (Felice 2007); however, the other most common indicators – literacy, enrolment rate and years of schooling – have been tested and discussed;

e) for the 1891-1911 years, the role of another convergence variable, namely mass migration, has been included;

f) in order to facilitate comparisons and solve the log-log or log-linear approach dilemma, all figures have been normalized to the Italian average;

g) regional and macro-regional paths have been shown and discussed;

h) finally, for each region the convergence impact of education has been estimated, following a methodology adopted by O'Rourke and Williamson (1997) in their international comparison for the 1870-1913 years.

### 3. Measuring growth and human capital

As a dependent variable in the models testing the impact of education on economic growth there are basically two alternatives. The first one is productivity, measured as Gdp per worker: according to new growth theories, human capital would foster economic growth since it would make technological transfer easier, thus raising workers' productivity; this can be regarded as its most direct impact. The second one is income, measured as Gdp per capita, which better reflects the standard of living, taking into account also the non working people, that is demographical and social features not embodied in Gdp per worker.

Human capital is usually measured as literacy, enrolment rates, years of schooling (when available), or as a combination of them. In a previous work (Felice 2007) I have proposed a composite indicator labelled 'education', which is a combination of literacy and enrolment rates (for 1891 and 1911) or average years of schooling (from 1951 onwards), with variable weights according to the different historical periods, to allow for changes in the basic educational levels.

The importance of literacy grew smaller, for two reasons. First, by the time of Unification illiteracy affected much of the Italian population, varying greatly among the regions, with peaks of almost 90% in some Southern ones, but since then literacy spread throughout the country, both in the Centre-North and in the South, although at different rates; however, by the end of the nineteenth century illiteracy still affected half of the Italian population, showing the level of human capital underdevelopment still existing. The second reason is a more 'qualitative' one: in the early stages of industrialization, technologies were still relatively simple, a good rate of literacy being a necessary and sufficient condition to successfully adopt them; things were bound to change with the growing complexity of technology, making an indicator as literacy more and more inadequate. Yet in the early industrial context its importance can hardly be overstated. In the economic literature literacy is widely recognized as a necessary pre-requisite to the start of modern economic growth; for example some authors (Bowman and Anderson 1963; Sandberg 1982; Nuñez 1990) have proposed a literacy rate of 40% as the threshold beyond which it is possible to embark on the industrial revolution; it is worth stressing that North-western regions had passed this threshold already in the first half of the nineteenth century, while the Southern ones had to wait until the end of the century. In order to build the composite educational indicator, literacy is given a weight of 1/1 in 1871, 2/3 in 1891 and 1911; by 1951 literacy rate weight has fallen to 50%, hence every ten years it loses 5% of its weight, so that by 1971 it has become 40%.

The remaining share of the indicator is assigned to the per capita years of schooling or to the enrolment ratio when years of schooling are not available, which have a growing importance over time, both in quantitative and qualitative terms. Like literacy, years of schooling are a stock (and an output), more coherent than the enrolment rate that instead is a flow (and an input); in order to estimate them, literate population has been divided into five groups, holders of university degree, of tertiary school diploma, of secondary school certificate, of primary school certificate and literates without any certificate; then 18, 13, 8, 5 and 2 years of schooling have been assigned to each of these groups respectively.<sup>6</sup> Problems arise because the necessary data to estimate the years of schooling at a regional level are available only since 1951, in the population censuses. This means that for the previous years we have to resort to the gross enrolment ratio, i.e. the number of students as a percentage of the population in the relative age brackets. For a comparison among the Italian regions the use of enrolment ratio reveals additional flaws, although probably not as serious as in the case of international comparisons: the main one is that in the elementary and secondary school it does not consider school dispersion, quite hard to quantify, especially for the past, but almost surely higher in the South; secondly, with regard to university attendance it does not allow for

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<sup>6</sup> For every group, the 'extra' years of schooling, those of the students who leave a study order before the diploma, have not been considered, in other words – since all figures are on the Italian average – it has been supposed that their share out of the total would be the same in all the regions.

interregional mobility, which however has grown quite notably only during the last decades,<sup>7</sup> when the enrolment rate is replaced by years of schooling. It should also be reminded that the enrolment ratio is used in my indicator when its share is relatively small, 1/3 in 1891 and 1911 (the same share adopted in the educational component of the Hdi international standard formula); from 1951 onwards I always employ the years of schooling, with a growing share starting from 50%.

One could ask why from 1951 onwards I do not employ only years of schooling, dropping literacy; after all, the average years of schooling include also illiterate people. There are two reasons for keeping literacy. First, the overall coherence of the educational indicator should be maintained; I could use only the years of schooling if I started to measure human capital from 1951, as Vera Zamagni (1993) did, but since I start from 1891, and I aim to offer a long-term picture, I need comparable series; moreover, I am measuring the impact of human capital on variables – productivity and income – whose composition does not change over time. Keeping literacy, although with a decreasing weight over time, seems to me to be a good way to ensure comparability.

Yet there is another reason in favour of keeping literacy, more of substance. The educational indicator I propose is a composite index: on one side there is a dichotomic component (literacy), with 0/1 values (literate, illiterate), on the other there is a scale one (years of schooling), with ordinal values (3 years, 4 years, ecc.). As mentioned above, this latter is an approximation of the average level of human capital of the population, while the former is a threshold, roughly telling us how much of the population can fully participate into modern economic growth.<sup>8</sup> By 1951 illiteracy still affected one fourth of the Southern population, by 1971 more than one tenth of it; in the North-West, by 1951 the illiteracy rate was just 2.8%, by 1971 1.3% (Felice 2007, 147; Vasta 1999, 1052-53). Thus in the second half of the twentieth century regional disparities in literacy were still very high, so much that they could affect economic performance.

The comparative explanatory power of the educational indicator can be tested. In table 1 I have compared some results from the conditional convergence models, taking as dependent variable the rate of growth of productivity or income and as the two independent variables the ‘economic’ one (productivity or income at the beginning of the period respectively) and ‘human capital’ (educational indicator, literacy, enrolment rate/years of schooling) disparities at the beginning of each period (1891, 1911, 1951 and 1971).  $\lambda$  is the rate of convergence, which derives from the standardized coefficient of the convergence independent variable (productivity or income disparities).<sup>9</sup> The coefficient of determination,  $R^2$ , is the goodness-of-fit measure of the linear model, showing the proportion of variation in the dependent variable explained by the regression model. F value (higher, better) and its significance (possibly smaller than 0,05 or 0,01) indicate whether the results are or not due to random factors.

Results are encouraging, first of all because there are not serious differences among the measures; whatever indicator of human capital we choose, education, literacy, enrolment rate or years of schooling, the human capital impact on convergence does not change much. Secondly, we can conclude that education is the best indicator for human capital. In the 1891-1911 and 1911-1951 periods, it scores higher or partially equal values of F and  $R^2$  than both literacy and the enrolment rate. Results for the following two periods are more controversial, but not at all clearly in favour of the average years of schooling; on the contrary, maybe surprisingly, there is still a very good explanatory power of literacy, hence justifying its use up to these years. For the 1951-1971 period, as one would expect, per capita years of schooling seem to explain productivity and income convergence better than education, but with a minimum difference (in F, no difference at all in  $R^2$ ); moreover, using the years of schooling the rate of convergence would be lower, since they still have

<sup>7</sup> Usually from the Southern regions to the Northern ones, yet also from the smallest to the most densely populated ones.

<sup>8</sup> In a sense, it is like measuring income disparities by a combination of per capita income and the share of people living above the poverty threshold.

<sup>9</sup> According to the formula:  $\lambda = (1/t)\ln(\beta + 1)$ , where t is the time span and  $\beta$  is the standardized coefficient of the convergence independent variable.

a milder impact than literacy. For the 1971-2001 period, years of schooling perform better in the case of productivity, but not in that of income; in this latter regression literacy produces higher values of  $R^2$  and F, yet an impact on convergence lower than education. Hence for these two periods, 1951-1971 and 1971-2001, on the whole education can still be regarded as the most appropriate indicator. In the remaining regressions I will therefore use my composite indicator.

Table 1. *A comparison among different measures of human capital for the Italian regions*

Conditional convergence on:	1891-1911				1911-1951				1951-1971				1971-2001			
	$\lambda$	$R^2$	F	F sign.	$\lambda$	$R^2$	F	F sign.	$\lambda$	$R^2$	F	F sign.	$\lambda$	$R^2$	F	F sign.
<i>Productivity</i>																
Education	0.048	0.32	3.7	0.048	0.016	0.85	44.8	0.000	0.082	0.91	99.8	0.000	>0.23	0.67	19.3	0.000
Literacy	0.048	0.31	3.7	0.049	0.016	0.84	42.4	0.000	0.088	0.91	98.6	0.000	>0.23	0.47	8.3	0.000
Enrolment rate	0.045	0.32	3.8	0.045	0.015	0.81	34.2	0.000								
Years of school.									0.080	0.91	100.1	0.000	>0.23	0.72	24.9	0.000
<i>Income</i>																
Education	0.052	0.45	6.4	0.009	0.025	0.88	58.6	0.000	0.050	0.87	62.2	0.000	0.053	0.38	5.8	0.011
Literacy	0.054	0.44	6.3	0.010	0.025	0.87	53.6	0.000	0.058	0.86	59.1	0.000	>0.23	0.52	10.4	0.001
Enrolment rate	0.044	0.44	6.2	0.010	0.019	0.83	38.3	0.000								
Years of school.									0.049	0.87	63.7	0.000	0.033	0.32	4.4	0.026

Sources and notes: See text.

A final remark *a latere* of this comparison. If for the Italian regions the explanatory strength of literacy is still very high up to the second half of the twentieth century, it can be argued that, for the same years, in the underdeveloped countries its explanatory power would be at least as relevant. If this is true, literacy would still be a very effective variable in international comparisons, maybe the most effective one, not least because its use would help to overcome some (though not all) of the problems of data comparability.

#### 4. Unconditional and conditional convergence

Looking at the bivariate correlations can be a useful step before passing to linear regression models. From a mere glance at the Pearson correlations we can find the sign and the overall strength of the ties between education on one side, productivity and income on the other, as well as their persistence over time.

Table 2. *Pearson correlations between education and per capita income for the Italian regions (1871-2001)*

Education	Income				
	1891	1911	1951	1971	2001
1871	0.612(**) (0.005)	0.741(**) (0.000)	0.951(**) (0.000)	0.922(**) (0.000)	0.834(**) (0.000)
1891	0.643(**) (0.003)	0.766(**) (0.000)	0.958(**) (0.000)	0.933(**) (0.000)	0.865(**) (0.000)
1911		0.780(**) (0.000)	0.965(**) (0.000)	0.951(**) (0.000)	0.915(**) (0.000)
1951			0.908(**) (0.000)	0.890(**) (0.000)	0.947(**) (0.000)
1971				0.847(**) (0.000)	0.911(**) (0.000)
2001					0.850(**) (0.000)

Notes: Number of cases: 19 for 1871, 1891 and 1911, 21 for 1938, 22 from 1951 onwards; significance (2-tailed) in parentheses; \* correlation is significant at the 0.05 level (2-tailed); \*\* correlation is significant at the 0.01 level (2-tailed).

Throughout Italian history, there has always been a strong correlation between education and income (table 2): the poorest regions are also those with the lowest levels of education, and viceversa. Indeed, this correlation seems to have increased during the first half of the twentieth century, particularly from 1911 to 1951: late nineteenth century educational disparities are correlated with 1951 income disparities more than with the 1891 or 1911 ones. This is probably unusual: in Spain, for example, after 25-35 years the correlation gets weaker and less significant (Nuñez 1993); but in Italy this link weakens only after 60-80 years, and it does not lose significance. This means not only that regional rankings did not change in this time span, but also that up to 1951 income disparities widened according to the educational ones. Things changed slightly during the 1951-1971 years, but then the positive correlation picked up again in the 1971-2001 years: in this last period too a positive role of education can be inferred.

Table 3. *Pearson correlations between education and productivity for the Italian regions (1871-2001)*

Education	Productivity				
	1891	1911	1951	1971	2001
1871	0.398 (0.092)	0.505(*) (0.027)	0.885(**) (0.000)	0.780(**) (0.000)	0.821(**) (0.000)
1891	0.451 (0.053)	0.551(*) (0.014)	0.906(**) (0.000)	0.821(**) (0.000)	0.848(**) (0.000)
1911		0.587(**) (0.008)	0.930(**) (0.000)	0.866(**) (0.000)	0.884(**) (0.000)
1951			0.883(**) (0.000)	0.818(**) (0.000)	0.879(**) (0.000)
1971				0.858(**) (0.000)	0.930(**) (0.000)
2001					0.890(**) (0.000)

Notes: See table 2.

If we now turn to productivity, at the end of the nineteenth century educational disparities appear uncorrelated with productivity ones (table 3); the correlation took shape, quite strongly, in the first half of the following century, remaining high also in the second half – with a slight decrease in the 1951-1971 years, and a revival in the last period. Thus from 1911 to 1951 educational disparities affected income divergence via augmenting the productivity gap; by the end of the nineteenth century education was probably better correlated with the share of active population (for example through higher female employment rates in the North, which could go with better female education).

In order to estimate the contribution of education to the growth of productivity and income, we have to examine the models of linear regressions, where the results of unconditional convergence (that is: convergence of productivity or income without checking for any other variable) and conditional convergence (adding education) are compared. Table 4 shows the results of the regressions for what concerns the rate of convergence ( $\lambda$ ), the  $R^2$  value and the F test; full data output is reported in the statistical appendix (tables A.5-A.8).

Table 4. *Main results of the conditional and unconditional convergence models*

	Productivity			Income		
	$\lambda$	$R^2$	F	$\lambda$	$R^2$	F
<i>Unconditional convergence</i>						
1891-1911	0.0283	0.187	3.907	0.0048	0.008	0.144
1911-1951	-0.0041	0.033	0.572	-0.0087	0.172	3.527
1951-1971	0.1518	0.907	194.920	0.1276	0.850	113.110
1971-2001	0.0320	0.381	12.299	-0.0048	0.024	0.494
<i>Conditional convergence: adding education</i>						
1891-1911	0.0476	0.317	3.708	0.0522	0.446	6.448
1911-1951	0.0161	0.849	44.835	0.0251	0.880	58.610
1951-1971	0.0817	0.913	99.777	0.0503	0.867	62.151
1971-2001	>0.2303	0.670	19.253	0.0530	0.381	5.836

Referring to the 1891-1911 period we cannot argue for unconditional convergence, for both variables: F values are very low and not significant,  $R^2$  is quite small, especially for income. Things improve substantially if we add education. Its strongest impact is on income convergence, the resulting model scoring the highest  $R^2$  and F values; also the rate of convergence rises substantially, more than ten times<sup>10</sup>. However,  $R^2$  is still relatively modest, indicating that not even half of the variation in the dependent variable is explained by the regression (if we considered the adjusted  $R^2$ , it would be a little more than one third); the F value is relatively low. We can conclude that, although surely positive, education was not the only variable at stake in the convergence process: this finding should not come as a surprise, since this was a time of international openness where other factors, endogenous or exogenous (like mass migration), could have played an important part too; we'll come back to this point in the next paragraph.

The impact of education is much stronger in the following period, the 1911-1951 years. In this case the highest benefits are to productivity, as one would expect, but also the impact on income is relevant. In both cases the unconditional models prove to be inadequate, yet if we introduce education the resulting conditional models are extremely satisfactory, with high  $R^2$  and F values; in this period not only education is positive, but it seems to be the key variable in order to explain productivity and income *divergence* (educational and income disparities were positively correlated, thus education was a factor of divergence and not of convergence).

The picture is different for the 1951-1971 years. Indeed, this is the only period where education does not seem to be relevant, for no one of the two dependent variables. In both of these cases there is unconditional convergence, and results worsen if we add education. Zamagni (1993) noticed a

<sup>10</sup> While the two independent variable coefficients become significant, with better values in the case of education: see table A.5 in the statistical appendix.

rise in the productivity and income convergence for the 1951-1986 period, but this does not seem to be the case limiting the period to the 1951-1971 years. So we can argue that during this period a strong convergence process took place, but it was independent from human capital: we could call it ‘convergence without education’. This could have been a consequence of the massive regional policies pursued by the state – which at that time proved to be quite effective, with top-down plants in the heavy sectors raising productivity of the most backward regions, in most cases without links with the local economy – as well as of the great and unprecedented North-South migration, which should have favoured wage and income convergence. However, testing the impact of regional policies and interregional migration (also in combination with education) would go beyond the scope of this paper, not least due to the need of a different statistical methodology. This does not exclude that higher human capital in the most backward regions could have further improved their rate of convergence: indeed, this could be tested by a counterfactual, assigning to the Southern regions a better level of human capital, for example that of the Italian average<sup>11</sup>.

From the seventies onwards overall Southern convergence came to a halt (with some regional exceptions), at the same time as the rise of the North-East-Central (NEC) regions took place. It is not surprising that in the 1971-2001 years unconditional convergence models turn out to be much less effective; a result consistent with the Zamagni’s ones, education came back to be relevant, for both productivity and income. Although the higher benefits of education went to income, overall the most reliable statistical model is that of productivity conditional convergence, which can explain about two-thirds of the variance of the dependent variable, has a good F value and shows a great improvement in the rate of convergence. In the case of income, the  $R^2$  and F values of the conditional convergence model are considerably lower, although education is still significant; as one would expect, after all.

We can summarize these findings in table 5. The benefits of education to productivity and income growth are significant through most of Italian history, although we can notice relevant differences among the periods. A lower impact in the 1891-1911 years, the strongest in 1911-1951; in the fifties and the sixties there is ‘convergence without education’ and finally, in the 1971-2001 years, the positive role of education comes up again. Productivity and income follow the expected trend, with the exception of the 1891-1911 years, when income seems to benefit from education more than productivity.

Next paragraph is devoted to a short review of the single regional paths, with the aim of better clarifying relationships and dynamics.

Table 5. *Adding education: the impact on the convergence models*

	Productivity			Income		
	Improvement on the rate of convergence	Significance of the model	Significance of the educational variable	Improvement on the rate of convergence	Significance of the model	Significance of the educational variable
1891-1911	Yes	No	No	Yes	Yes	Yes
1911-1951	Yes	Yes	Yes	Yes	Yes	Yes
1951-1971	No	No	No	No	No	No
1971-2001	Yes	Yes	Yes	Yes	Yes	Yes

Notes: See text.

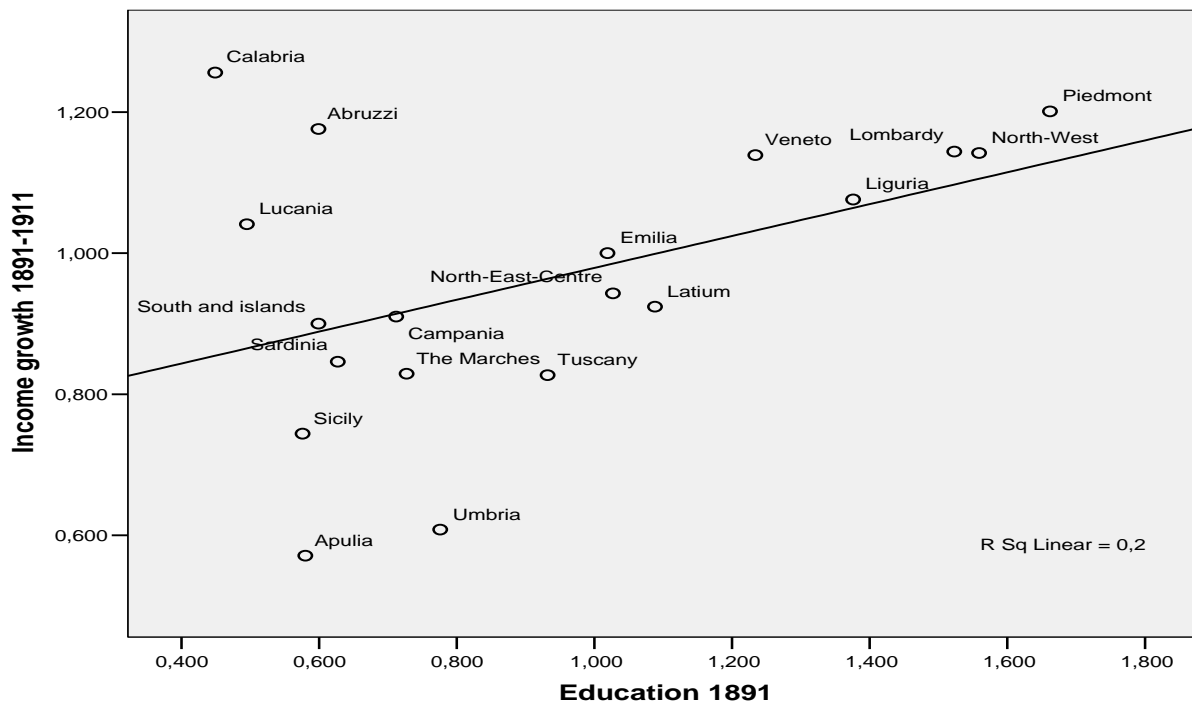
<sup>11</sup> In the case of income, while  $R^2$  and F would remain quite high (0.85 and 53.4 respectively), the rate of convergence would rise from 0.1276 (unconditional) or from 0.0503 (conditional) to 0.1352. Also more significant would be its impact on productivity, as expected ( $R^2$  0.91, F 94.7 and  $\lambda$  bigger than 0.3454).

## 5. A glance at regional paths

In the following figures (1-4, drawn from tables A.1 and A.3 in the statistical appendix), a visual representation of the correlation between education and economic growth is displayed, with labels for the single regions. These figures can be helpful to trace a first overview of regional paths.

Let's start with the 1891-1911 years (figure 1), with all the northern regions at the upper end of the fit line. We can spot some outliers: three Southern regions, Calabria, Abruzzi and to a minor extent Lucania, have low education but high economic growth (the situation would be the same if we considered productivity), while there are other two regions, Apulia in the South and Umbria in the Centre, scoring too low economic growth given their educational level (although this is low too). If we excluded the first three cases the correlation would be much higher, with a  $R^2$  of 0.729, comparable with the 1911-1951 value; the impact of education on the conditional convergence model would be stronger too, the same on the statistical fitness; we would have similar results if we excluded also the other two outliers, Apulia and Umbria. Do these regions share some special features in this period? Calabria, Abruzzi and Lucania are by far the regions with the greater emigration to overseas countries, whose numbers were impressive; conversely, Apulia and Umbria are among those with the lowest overseas emigration (see table A.4 in the statistical appendix). For both productivity and income, if we add overseas emigration as the third independent variable (table A.9 in the appendix) the statistical fitness of the model becomes satisfactory, with a significance for education and overseas emigration, although the rate of convergence would not improve; we could have some multicollinearity,<sup>12</sup> yet not so critical: the condition indices would be just above the threshold of 15, which indicates a possible collinearity, well below the threshold of 30 which entails a serious problem.

Figure 1. *Educational levels in 1891 and income growth, 1891-1911*



Linear correlation between education and income growth can be clearly observed for the 1911-1951 years (figure 2), although also in this case we have an outlier, Latium, with lower economic

<sup>12</sup> When correlations among the independent variables are strong, with small changes of the data values leading to large changes in the estimate of the coefficients.

growth compared with its educational level in 1911; given that all estimates are at the borders of the time, it can be due to the fact that the borders of Latium changed significantly during the 1911-1951 years, incorporating densely populated but less prosperous areas from Campania, beside than areas from Abruzzi and Umbria (with a resulting disappointing economic performance in Gdp per capita).<sup>13</sup>

Figure 2. Educational levels in 1911 and income growth, 1911-1951

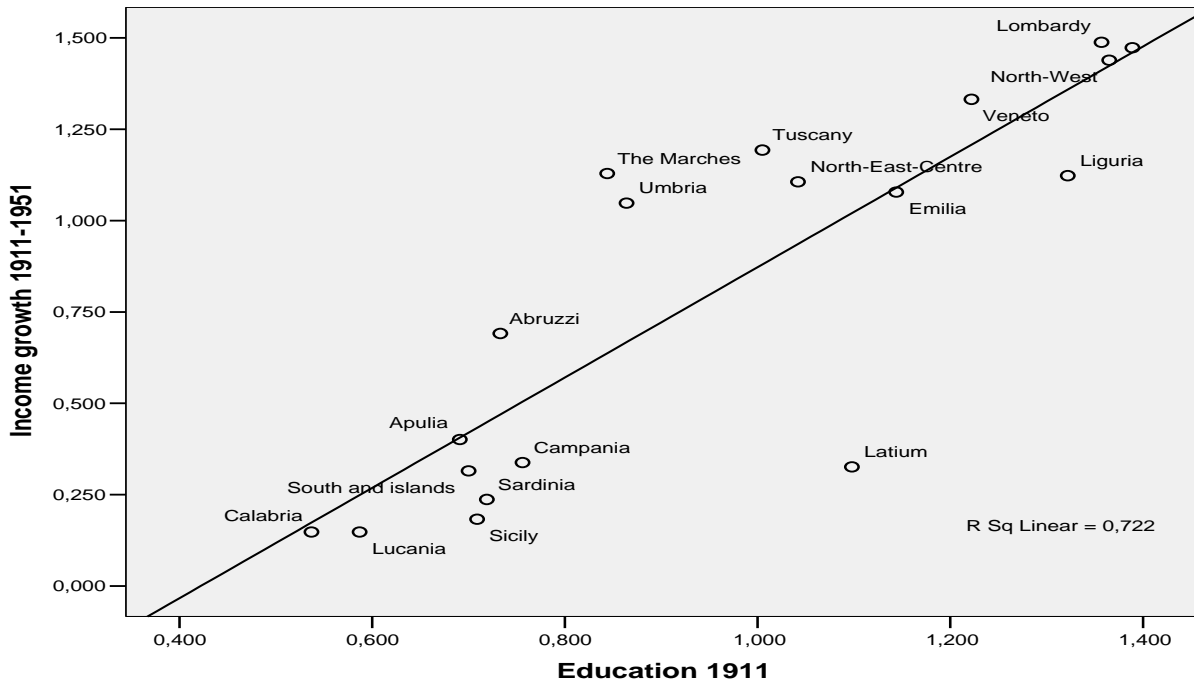
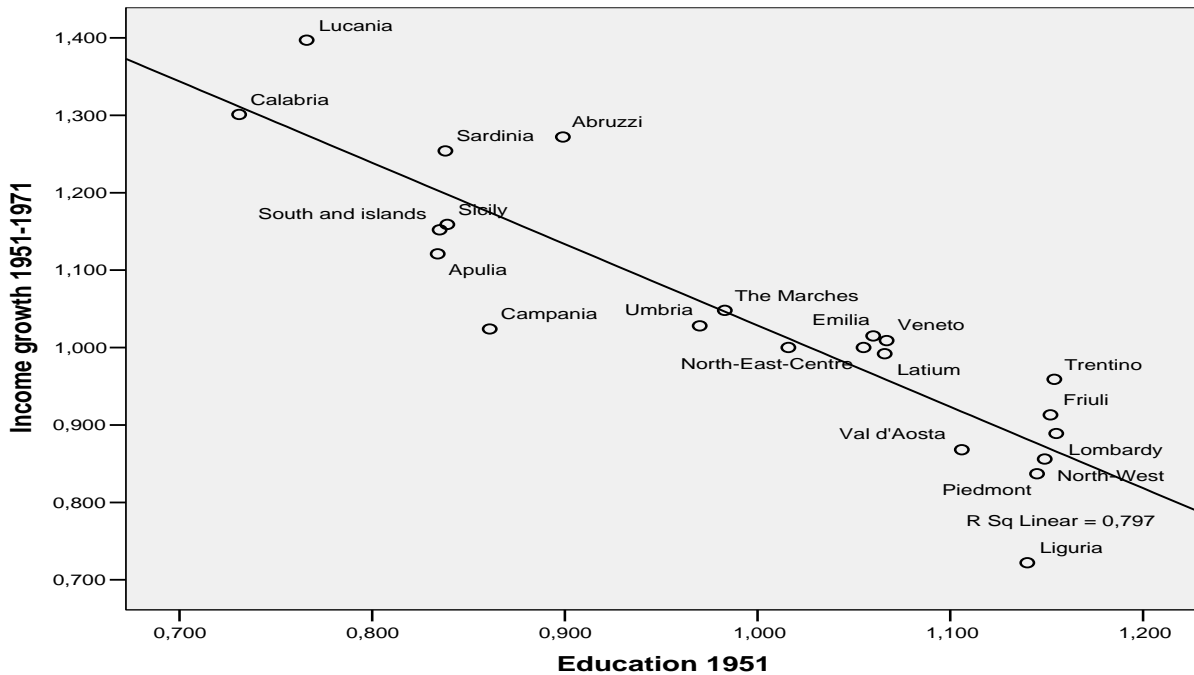
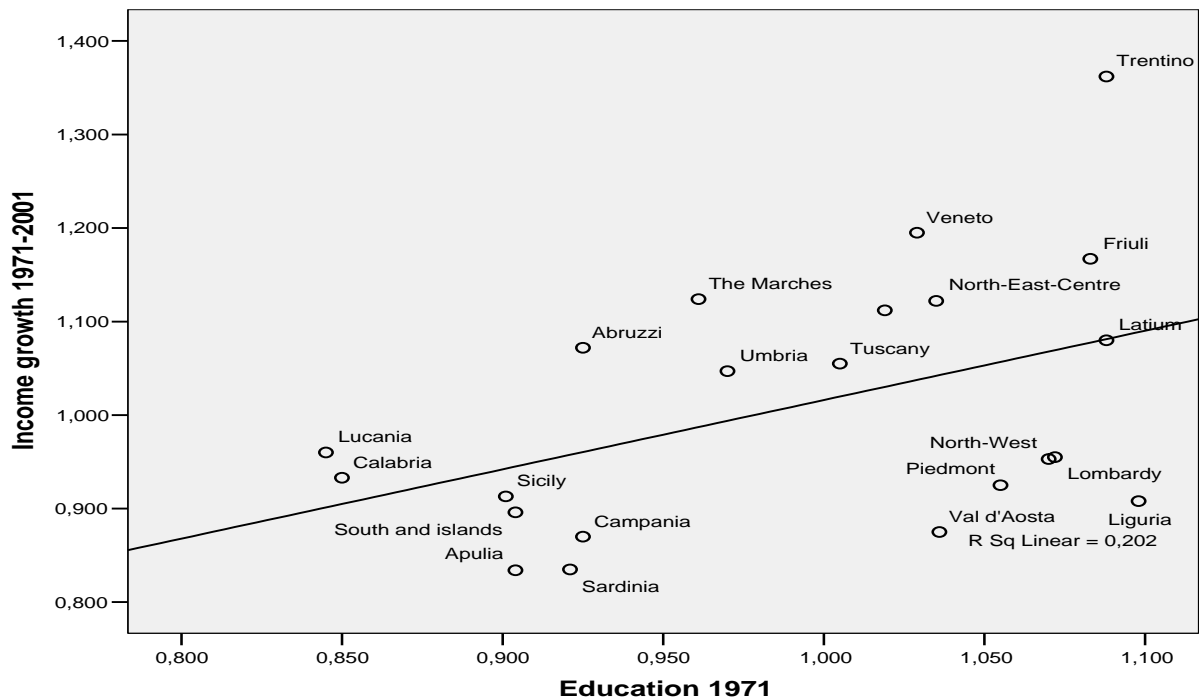


Figure 3. Educational levels in 1951 and income growth, 1951-1971



<sup>13</sup> Other changes of regional borders from 1891 to 1951 are by far less significant; there have been no changes during the 1951-2001 years.

Figure 4. *Educational levels in 1971 and income growth, 1971-2001*

In 1951-1971 we have a strong correlation too, but with a ‘wrong’ sign of the coefficient (figure 3); we know that this was due to the high unconditional income convergence of this period, the ‘convergence without education’ is thus visibly expressed.

Figure 4, concerning the 1971-2001 years, deserves more attention. As we can see, there are three groups of regions, roughly corresponding to the macro-region classification adopted in the current research: North-West, North-East-Centre (NEC) and Southern Italy. On the upper end of the fit line, we have the NEC regions, with higher education and higher income growth; on the lower end there are the Southern regions, with less education and less income growth; if we only had these two groups the positive correlation between education and growth would be confirmed (with a  $R^2$  of 0.624). Problems arise with the third group, the North-western regions, which score higher education (and higher income too) but relatively low economic growth. This disappointing performance is the reverse of the NEC regions catching-up. It could well mean that the falling behind of the North-West was not due to education; although the Southern lagging behind compared to the Nec can still be imputable to it.

We can estimate, for each region, the share of deviant growth explained by education (table 6), where ‘deviant’ stands for the difference between the real growth of a region and the growth one would expect, given its ranking and the conditional convergence model.<sup>14</sup> Thus we need a good statistical model (otherwise our results would be unreliable), besides a significant educational coefficient in each model (otherwise in most of the cases the education effect would be of no significance). Since in 1891-1911 adding overseas emigration we have a more satisfactory result on productivity and income, in this case we should estimate the impact of education using such

<sup>14</sup> According to the following equation:  $y-1 = \beta_1(w-1) + \beta_2(e-1) + \varepsilon$ . Where 1 is the Italian average, y is the dependent variable (rate of growth of productivity or income, on the Italian average), w is the convergence independent variable (productivity or income), e is the education independent variable and  $\beta_1$  and  $\beta_2$  are the corresponding standardized coefficients of the conditional convergence model. Hence the percentage of ‘deviant’ growth attributable to education is given by the formula:  $[\beta_2(e-1)] / [(y-1) - \beta_1(w-1)]$ . It should be born in mind that in order to make correspond the macro-regional figures to (the average of) the regional ones, these should be weighted with the respective amounts of deviant growth, not with their growth rates.

improved model;<sup>15</sup> this gives us the opportunity of estimating also the impact of overseas emigration for each region. In 1951-1971 the impact of education on productivity and income growth turns out to be irrelevant for most of the regions, thus the 1951-1971 period can be left out.

Table 6. *Share of 'deviant' growth explained by education*

	1891-1911				1911-1951		1971-2001	
	Education		Overseas migration		Education		Education	
	Product.	Income	Product.	Income	Product.	Income	Product.	Income
Piedmont	(+)All	(+)All	(-)None	(-)None	(+)All	(+)89.0	(+)All	(+)67.0
Val d' Aosta							(+)31.8	(+)14.5
Liguria	(+)All	(+)All	(-)None	(-)None	(+)87.6	(+)94.3	(+)54.2	(+)All
Lombardy	(+)All	(+)All	(-)None	(-)None	(+)All	(+)76.5	(+)47.1	(+)35.8
North-West	(+)All	(+)All	(-)None	(-)None	(+)All	(+)83.0	(+)56.9	(+)44.7
Trentino-Alto	-	-	-	-	-	-	(+)All	(+)26.7
Veneto	(+)All	(+)All	(-)None	(-)None	(+)All	(+)All	(+)None	(+)None
Friuli	-	-	-	-	-	-	(+)None	(+)55.8
Emilia	(+)None	(+)81.5	(-)All	(-)None	(+)All	(+)All	(+)37.7	(+)9.5
Tuscany	(-)19.6?	(-)44.5?	(-)All?	(-)All?	(+)7.1	(+)4.0	(+)16.2	(+)5.9
The Marches	(-)All	(-)All	(+)None	(+)None	(-)All	(-)None	(-)24.6	(-)None
Umbria	(-)51.6?	(-)62.9?	(-)All?	(-)All?	(-)All	(-)All	(-)23.0	(-)60.5
Latium	(+)98.9	(+)All	(-)None	(-)None	(+)None	(+)None	(+)45.4	(+)72.8
North-East-C.	(+)None	(+)None	(-)All	(-)All	(+)All	(+)56.6	(+)88.1	(+)25.5
Abruzzi	(-)None	(-)None	(+)All	(+)All	(-)77.3	(-)69.2	(-)33.9	(-)96.6
Campania	(-)All	(-)All	(+)None	(+)None	(-)97.7	(-)46.8	(-)58.0	(-)23.3
Apulia	(-)All?	(-)All?	(-)All?	(-)All?	(-)68.8	(-)60.4	(-)36.1	(-)54.2
Lucania	(-)None	(-)All	(+)All	(+)None	(-)46.6	(-)53.3	(-)54.5	(-)72.8
Calabria	(-)None	(-)None	(+)All	(+)All	(-)65.4	(-)59.7	(-)54.6	(-)51.1
Sicily	(-)All	(-)All	(+)None	(+)None	(-)56.2	(-)42.9	(-)76.8	(-)34.1
Sardinia	(-)All?	(-)All?	(-)All?	(-)All?	(-)44.3	(-)45.7	(-)88.1	(-)31.2
South and isl.	(-)All	(-)All	(+)None	(+)None	(-)63.3	(-)51.3	(-)52.6	(-)50.2

Notes: In parentheses the sign of the difference between regional education (or overseas migration) and the national average.

Concerning the 1891-1911 period, these are the main results: for all the Northern regions, Veneto included, higher growth in both productivity and income is attributable to education, while lower overseas migration had no negative impact; overall for the Southern regions the disappointing performance is attributable to low education; there are some exceptions, Abruzzi, Lucania and Calabria, whose higher productivity and income growth rates are due to overseas migration. Because of the moderate multicollinearity of the models, for four regions there is no correspondence between the education and migration shares. These are the cases of Apulia, Sardinia, Umbria and Tuscany, whose figures are followed by a question mark; however the disappointing performance of Tuscany and Umbria seems to be mostly attributable to lower overseas migration; for Apulia and Sardinia it is not clear whether the variable with the major negative impact on economic performance was education or overseas migration.

For the 1911-1951 years there is a very significant impact of education on both productivity and income divergence, higher on the former: education contributed remarkably to the widening gap between the Southern and both the Northern and the NEC regions (although in the cases of the Marches and Umbria it has slowed a little their convergence rates, since it was slightly lower than Italian average).

Results are similar for the 1971-2001 years, although in this case they are less reliable since the model fitness is lower. Education kept on badly affecting Southern regions' growth rates, while it helped North-western ones to maintain their economic primacy, via moderating their relative decline (compared to the NEC). On the whole education didn't play a significant role for the catching-up of the NEC towards the North-West; more specifically, higher education doesn't seem to have contributed to the economic rise of Veneto and (partly) of Friuli, this result not being unexpected since also productivity had a minor impact on income growth in Veneto than in other

<sup>15</sup> The equation changes accordingly:  $y-1 = \beta_1(w-1) + \beta_2(e-1) + \beta_3(m-1) + \varepsilon$ . Where  $m$  is the level of transoceanic migration and  $\beta_3$  its standardized coefficient in the conditional convergence model. Of course, the formula is the same:  $[\beta_2(e-1)] / [(y-1) - \beta_1(w-1)]$ ; or  $[\beta_3(m-1)] / [(y-1) - \beta_1(w-1)]$  for the share of deviant growth attributable to transoceanic migration.

regions (see tables A.1 and A.2 in the appendix) and since according to new growth theories education should have a major impact on productivity; the education positive impact on Emilia and Tuscany was modest, but on the other side its lower level doesn't seem to have hampered the Marches' performance.

## 6. Main conclusions

This paper has explored the consequences of human capital on the productivity and income growth rates of the Italian regions, from 1891 to 2001, by way of conditional regression models. After comparing different indicators, human capital has been approximated through a composite indicator of literacy and schooling, named ‘education’; however, changes on the way human capital is measured do not affect the models results.

The impact of human capital on growth was not uniform over time, varying of intensity and significance according to the historical periods. In both the cases of income and productivity, it was relevant during the 1891-1911 years, decisive in the 1911-1951 period; statistically not significant in the 1951-1971 interval, and again relevant during the 1971-2001 period.

During the 1891-1911 years, human capital favoured the North-western take-off, while hampering the Southern regions economic rise. Yet in this period other factors were at stake; although overall less relevant than human capital, overseas migration had also an impact on productivity and income growth rates, benefiting in particular the most backward southern regions (Abruzzi, Lucania and Calabria) and thus counterbalancing the negative effects of lower human capital. However, according to the conditional convergence models, in this period human capital and mass migration together explain no more than two-third of the productivity and income growth; hence still other factors could have had an important role as well.

The impact of human capital was greater during the 1911-1951 years, which up to now had been relatively overlooked by the (few) previous studies on this matter, thus contributing to enlarge the already existing productivity and income regional disparities. Since these were the years of closure of the Italian economy and of scarce interregional mobility of factors (labour and capital), this finding should not come as a surprise: they can be in line with the endogenous growth theories, which focus on the role for economic growth of the internal stock of human capital.

In the 1951-1971 years a process of regional convergence in both productivity and income took place, human capital notwithstanding. In this period productivity and income growth rates were highly negatively correlated with productivity and income relative levels at the start of the period respectively, with a resulting high fitness of the unconditional convergence models, and the negative impact of lower human capital on the performance of Southern Italy was more than offset by other factors at stake. However, it is worth stressing that higher human capital would have further improved the rate of convergence of the most backward regions.

The role of human capital ‘comes up’ again in the 1971-2001 years, contributing to the retardation of Southern Italy compared with the Centre-North, although on the whole human capital did not have a relevant impact on the economic catching-up of the NEC regions, especially of Veneto, towards the North-West.

Generally speaking the expected role of human capital on regional performance in Italy is confirmed, and so its negative impact on Southern Italy disappointing growth, also on the long run. Yet human capital was really decisive only when internal mobility of labour and capital and international openness were both at a minimum, during the 1911-1951 years. In the remaining periods other factors – such as overseas migration during the 1891-1911 years – counterbalanced or even reversed its impact.

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## Statistical appendix

All estimates are at the borders of the time.

Table A.1. *Per capita Gdp, 1891-2001 (Italy=1)*

	Absolute levels					Growth rates			
	1891	1911	1951	1971	2001	1891-11	1911-51	1951-71	1971-2001
Piedmont			1,47	1,21	1,15			0,837	0,925
Val d'Aosta	1,10	1,18	1,58	1,35	1,24	1,201	1,473	0,868	0,875
Liguria	1,49	1,53	1,62	1,16	1,09	1,076	1,123	0,722	0,908
Lombardy	1,16	1,22	1,53	1,34	1,30	1,144	1,488	0,889	0,955
<i>North-West</i>	<i>1,18</i>	<i>1,24</i>	<i>1,52</i>	<i>1,28</i>	<i>1,24</i>	<i>1,142</i>	<i>1,439</i>	<i>0,856</i>	<i>0,953</i>
Trentino-Alto Ad.	-	-	1,06	1,01	1,29	-	-	0,959	1,362
Veneto	0,80	0,84	0,98	0,99	1,13	1,139	1,332	1,009	1,195
Friuli	-	-	1,11	1,00	1,12	-	-	0,913	1,167
Emilia	1,08	1,08	1,12	1,14	1,23	1,000	1,078	1,015	1,112
Tuscany	1,02	0,96	1,05	1,05	1,09	0,827	1,193	1,000	1,055
The Marches	0,86	0,81	0,86	0,91	0,99	0,829	1,129	1,048	1,124
Umbria	1,01	0,88	0,90	0,93	0,96	0,608	1,048	1,028	1,047
Latium	1,52	1,48	1,08	1,07	1,13	0,924	0,326	0,992	1,080
<i>North-East-Centre</i>	<i>1,01</i>	<i>0,99</i>	<i>1,04</i>	<i>1,04</i>	<i>1,13</i>	<i>0,943</i>	<i>1,106</i>	<i>1,000</i>	<i>1,122</i>
Abruzzi	0,63	0,67	0,58	0,80	0,84	1,176	0,691	1,272	1,072
Campania	0,97	0,94	0,69	0,71	0,65	0,910	0,338	1,024	0,870
Apulia	1,00	0,86	0,65	0,75	0,67	0,571	0,401	1,121	0,834
Lucania	0,69	0,70	0,47	0,75	0,73	1,041	0,148	1,397	0,960
Calabria	0,64	0,70	0,47	0,67	0,64	1,256	0,148	1,301	0,933
Sicily	0,93	0,85	0,58	0,70	0,66	0,744	0,183	1,159	0,913
Sardinia	0,95	0,90	0,63	0,85	0,76	0,846	0,237	1,254	0,835
<i>South and islands</i>	<i>0,87</i>	<i>0,84</i>	<i>0,61</i>	<i>0,73</i>	<i>0,68</i>	<i>0,900</i>	<i>0,315</i>	<i>1,152</i>	<i>0,896</i>

Sources and notes: Felice 2007.

Table A.2. *Per worker Gdp, 1891-2001 (Italy=1)*

	Absolute levels					Growth rates			
	1891	1911	1951	1971	2001	1891-11	1911-51	1951-71	1971-2001
Piedmont			1,24	1,03	1,02			0,859	0,994
Val d'Aosta	0,99	1,00	1,12	1,13	1,02	1,011	1,371	1,008	0,921
Liguria	1,49	1,50	1,66	1,14	1,11	1,017	1,174	0,715	0,982
Lombardy	1,06	1,13	1,37	1,11	1,10	1,146	1,332	0,842	0,989
<i>North-West</i>	<i>1,08</i>	<i>1,12</i>	<i>1,36</i>	<i>1,09</i>	<i>1,08</i>	<i>1,087</i>	<i>1,332</i>	<i>0,832</i>	<i>0,992</i>
Trentino-Alto Ad.	-	-	1,00	0,98	1,08	-	-	0,984	1,077
Veneto	0,84	0,87	0,96	1,01	0,96	1,066	1,178	1,037	0,965
Friuli	-	-	1,06	0,97	0,99	-	-	0,936	1,012
Emilia	1,09	1,05	1,09	1,04	1,03	0,924	1,056	0,966	0,995
Tuscany	1,06	0,94	1,00	1,05	0,99	0,735	1,107	1,034	0,962
The Marches	0,80	0,77	0,80	0,90	0,88	0,907	1,060	1,095	0,981
Umbria	1,03	0,89	0,88	0,88	0,94	0,673	0,980	0,998	1,046
Latium	1,53	1,54	1,08	1,13	1,14	1,001	0,403	1,033	1,003
<i>North-East-Centre</i>	<i>1,02</i>	<i>0,99</i>	<i>1,01</i>	<i>1,03</i>	<i>1,02</i>	<i>0,920</i>	<i>1,033</i>	<i>1,019</i>	<i>0,991</i>
Abruzzi	0,60	0,67	0,59	0,82	0,87	1,242	0,771	1,257	1,043
Campania	0,99	0,96	0,83	0,91	0,91	0,936	0,739	1,071	1,005
Apulia	1,06	0,93	0,71	0,80	0,82	0,714	0,531	1,097	1,018
Lucania	0,65	0,68	0,42	0,77	0,82	1,104	0,162	1,474	1,050
Calabria	0,58	0,67	0,46	0,76	0,84	1,340	0,369	1,382	1,083
Sicily	1,09	1,04	0,74	0,90	0,92	0,909	0,402	1,154	1,017
Sardinia	1,20	1,10	0,71	1,01	0,87	0,797	0,245	1,275	0,886
<i>South and islands</i>	<i>0,91</i>	<i>0,91</i>	<i>0,68</i>	<i>0,86</i>	<i>0,88</i>	<i>0,982</i>	<i>0,515</i>	<i>1,180</i>	<i>1,014</i>

Sources and notes: Felice 2007.

Table A.3. *Human capital, 1871-2001 (Italy=1)*

	Education						Literacy				Enrolment rates		Years of schooling	
	1871	1891	1911	1951	1971	2001	1891	1911	1951	1971	1891	1911	1951	1971
Piedmont	1,849	1,662	1,389	1,145	1,055	1,005	1,684	1,430	1,117	1,039	1,615	1,314	1,173	1,066
Val d'Aosta				1,106	1,036	1,007			1,117	1,044			1,095	1,031
Liguria	1,401	1,376	1,322	1,140	1,098	1,040	1,452	1,334	1,099	1,038	1,220	1,305	1,182	1,138
Lombardy	1,756	1,523	1,357	1,155	1,072	1,030	1,587	1,391	1,116	1,043	1,399	1,295	1,194	1,091
<i>North-West</i>	<i>1,753</i>	<i>1,559</i>	<i>1,365</i>	<i>1,149</i>	<i>1,070</i>	<i>1,024</i>	<i>1,609</i>	<i>1,398</i>	<i>1,114</i>	<i>1,042</i>	<i>1,462</i>	<i>1,305</i>	<i>1,185</i>	<i>1,089</i>
Trentino-Alto Ad.	-	-	-	1,154	1,088	1,021	-	-	1,136	1,051	-	-	1,173	1,113
Veneto	1,131	1,234	1,222	1,067	1,029	1,002	1,245	1,203	1,073	1,035	1,219	1,267	1,062	1,025
Friuli	-	-	-	1,152	1,083	1,035	-	-	1,099	1,041	-	-	1,206	1,111
Emilia	0,901	1,019	1,144	1,060	1,019	1,013	1,013	1,081	1,054	1,026	1,033	1,276	1,067	1,016
Tuscany	1,022	0,932	1,005	1,016	1,005	1,000	1,004	1,006	1,022	1,011	0,790	1,010	1,012	1,002
The Marches	0,673	0,727	0,844	0,983	0,961	0,996	0,707	0,791	0,988	0,998	0,770	0,952	0,979	0,936
Umbria	0,638	0,776	0,864	0,970	0,970	1,011	0,738	0,826	0,986	0,995	0,853	0,943	0,954	0,953
Latium	1,035	1,088	1,098	1,066	1,088	1,072	1,095	1,073	1,033	1,015	1,080	1,152	1,102	1,136
<i>North-East-Centre</i>	<i>0,968</i>	<i>1,027</i>	<i>1,042</i>	<i>1,055</i>	<i>1,035</i>	<i>1,023</i>	<i>1,040</i>	<i>1,058</i>	<i>1,047</i>	<i>1,022</i>	<i>0,999</i>	<i>1,019</i>	<i>1,065</i>	<i>1,045</i>
Abruzzi	0,487	0,599	0,733	0,899	0,925	0,988	0,553	0,682	0,919	0,962	0,692	0,838	0,880	0,901
Campania	0,641	0,712	0,756	0,861	0,925	0,968	0,664	0,745	0,888	0,948	0,811	0,781	0,836	0,911
Apulia	0,497	0,580	0,691	0,834	0,904	0,946	0,562	0,653	0,875	0,951	0,623	0,771	0,795	0,872
Lucania	0,385	0,495	0,587	0,766	0,845	0,950	0,439	0,558	0,813	0,910	0,612	0,648	0,721	0,802
Calabria	0,417	0,449	0,537	0,731	0,850	0,953	0,403	0,488	0,778	0,894	0,539	0,638	0,686	0,821
Sicily	0,471	0,576	0,709	0,839	0,901	0,949	0,534	0,675	0,868	0,942	0,663	0,781	0,811	0,874
Sardinia	0,446	0,627	0,719	0,838	0,921	0,965	0,579	0,676	0,899	0,961	0,722	0,810	0,778	0,895
<i>South and islands</i>	<i>0,510</i>	<i>0,599</i>	<i>0,700</i>	<i>0,835</i>	<i>0,904</i>	<i>0,958</i>	<i>0,558</i>	<i>0,666</i>	<i>0,869</i>	<i>0,943</i>	<i>0,686</i>	<i>0,771</i>	<i>0,801</i>	<i>0,880</i>

Sources and notes: Felice 2007. For 1891 enrolment rates, elaborations from Maic 1893.

Table A.4. *Emigrants, 1890-1910*

	Total Emigrants				Only overseas countries			
	Absolute figures (000)		Per capita figures		Absolute figures (000)		Per capita figures	
	Total 1891- 1910	Aver. annual rate	over 1.000 pop.	Italy=1	Total 1890- 1909	Aver. annual rate	over 1.000 pop.	Italy=1
Piedmont	816,2	40,8	12,303	0,901	322,7	16,1	4,864	0,682
Liguria	108,3	5,4	5,028	0,368	88,2	4,4	4,093	0,574
Lombardy	721,7	36,1	8,426	0,617	243,0	12,1	2,837	0,398
North-West	1.646,3	82,3	9,486	0,695	653,9	32,7	3,768	0,528
Veneto	2.015,4	100,8	32,149	2,356	232,4	11,6	3,707	0,520
Emilia	464,6	23,2	9,500	0,696	132,6	6,6	2,711	0,380
Tuscany	456,4	22,8	8,952	0,656	135,4	6,8	2,656	0,372
The Marches	270,7	13,5	12,761	0,935	169,7	8,5	8,001	1,122
Umbria	109,2	5,5	8,180	0,599	30,8	1,5	2,307	0,323
Latium	138,2	6,9	5,773	0,423	105,3	5,3	4,397	0,616
North-East-Centre	3.454,5	172,7	15,626	1,145	806,1	40,3	3,646	0,511
Abruzzi	635,1	31,8	22,029	1,614	518,6	25,9	17,988	2,521
Campania	1.028,2	51,4	16,266	1,192	908,1	45,4	14,367	2,014
Apulia	253,5	12,7	6,469	0,474	181,7	9,1	4,635	0,650
Lucania	234,3	11,7	24,373	1,786	217,9	10,9	22,660	3,176
Calabria	601,5	30,1	21,948	1,608	534,6	26,7	19,507	2,734
Sicily	944,8	47,2	13,383	0,981	793,2	40,0	11,236	1,575
Sardinia	63,2	3,2	3,989	0,292	18,2	0,1	1,147	0,161
South and islands	3.760,6	188,0	14,766	1,082	3.172,2	158,6	12,456	1,746
Italy	8.861,4	443,1	13,647	1,000	4.632,2	231,6	7,134	1,000

Sources: Elaborations from Commissario generale dell'emigrazione 1926; see also Rosoli 1978.

Table A.5. *Unconditional and conditional convergence, 1891-1911*

Dependent variable: 1891-1911 productivity growth rate							
Unconditional convergence (Independent variable: productivity in 1891)							
Constant	1.275			Unstand. coefficient	-0.300	<i>Impact of education on the model</i>	
Y standard error	0.160672	Number of cases	19	Standard error	0.152		
R	0.432	F	3.907	Stand. Coefficient	-0.432		$\lambda^*-\lambda$
R <sup>2</sup>	0.187	F significance	0.065	Coefficient t value	-1.977		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	0.139	Rate of convergence ( $\lambda$ )	0.0283	Coeffic. t significance	0.065		F*/F
Conditional convergence (Independent variables: productivity and education in 1891)							
Constant	1.235			Unstand. coefficient	-0.426	0.180	
Y standard error	0.151822	Number of cases*	19	Standard error	0.160	0.103	
R*	0.563	F*	3.708	Stand. Coefficient	-0.614	0.404	
R <sup>2</sup> *	0.317	F significance*	0.048	Coefficient t value	-2.653	1.744	
Adjusted R <sup>2</sup> *	0.231	Rate of convergence ( $\lambda^*$ )	0.0476	Coeffic. t significance	0.017	0.100	
Dependent variable: 1891-1911 income growth rate							
Unconditional convergence (Independent variable: income in 1891)							
Constant	1.037			Unstand. coefficient	-0.075	<i>Impact of education on the model</i>	
Y standard error	0.200663	Number of cases	19	Standard error	0.197		
R	0.092	F	0.144	Stand. Coefficient	-0.092		$\lambda^*-\lambda$
R <sup>2</sup>	0.008	F significance	0.709	Coefficient t value	-0.380		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	-0.050	Rate of convergence ( $\lambda$ )	0.0048	Coeffic. t significance	0.709		F*/F
Conditional convergence (Independent variables: productivity and education in 1891)							
Constant	1.086			Unstand. coefficient	-0.530	0.436	
Y standard error	0.154564	Number of cases*	19	Standard error	0.199	0.123	
R*	0.668	F*	6.448	Stand. Coefficient	-0.648	0.864	
R <sup>2</sup> *	0.446	F significance*	0.009	Coefficient t value	-2.666	3.557	
Adjusted R <sup>2</sup> *	0.377	Rate of convergence ( $\lambda^*$ )	0.0522	Coeffic. t significance	0.017	0.003	

Notes: See text.

Table A.6. *Unconditional and conditional convergence, 1911-1951*

Dependent variable: 1911-1951 productivity growth rate							
Unconditional convergence (Independent variable: productivity in 1911)							
Constant	0.529			Unstand. coefficient	0.305	<i>Impact of education on the model</i>	
Y standard error	0.402549	Number of cases	19	Standard error	0.403		
R	0.180	F	0.572	Stand. Coefficient	0.180		$\lambda^*-\lambda$
R <sup>2</sup>	0.033	F significance	0.460	Coefficient t value	0.756		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	-0.024	Rate of convergence ( $\lambda$ )	-0.0041	Coeffic. t significance	0.460		F*/F
Conditional convergence (Independent variables: productivity and education in 1911)							
Constant	0.137			Unstand. coefficient	-0.800	1.557	
Y standard error	0.164153	Number of cases*	19	Standard error	0.203	0.168	
R*	0.921	F*	44.835	Stand. Coefficient	-0.474	1.115	
R <sup>2</sup> *	0.849	F significance*	0.000	Coefficient t value	-3.945	9.286	
Adjusted R <sup>2</sup> *	0.830	Rate of convergence ( $\lambda^*$ )	0.0161	Coeffic. t significance	0.001	0.000	
Dependent variable: 1911-1951 income growth rate							
Unconditional convergence (Independent variable: income in 1911)							
Constant	-0.035			Unstand. coefficient	0.849	<i>Impact of education on the model</i>	
Y standard error	0.473863	Number of cases	19	Standard error	0.452		
R	0.415	F	3.527	Stand. Coefficient	0.415		$\lambda^*-\lambda$
R <sup>2</sup>	0.172	F significance	0.078	Coefficient t value	1.878		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	0.123	Rate of convergence ( $\lambda$ )	-0.0087	Coeffic. t significance	0.078		F*/F
Conditional convergence (Independent variables: income and education in 1911)							
Constant	-0.197			Unstand. coefficient	-1.299	2.388	
Y standard error	0.186009	Number of cases*	19	Standard error	0.284	0.246	
R*	0.938	F*	58.610	Stand. Coefficient	-0.634	1.344	
R <sup>2</sup> *	0.880	F significance*	0.000	Coefficient t value	-4.580	9.712	
Adjusted R <sup>2</sup> *	0.865	Rate of convergence ( $\lambda^*$ )	0.0251	Coeffic. t significance	0.000	0.000	

Notes: See text.

Table A.7. *Unconditional and conditional convergence, 1951-1971*

Dependent variable: 1951-1971 productivity growth rate							
Unconditional convergence (Independent variable: productivity in 1951)							
Constant	1.591			Unstand. coefficient	-0.566	<i>Impact of education on the model</i>	
Y standard error	0.056452	Number of cases	22	Standard error	0.041		
R	0.952	F	194.92	Stand. Coefficient	-0.952		$\lambda^*-\lambda$
R <sup>2</sup>	0.907	F significance	0.000	Coefficient t value	-13.961		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	0.902	Rate of convergence ( $\lambda$ )	0.1518	Coeffic. t significance	0.000		F*/F
Conditional convergence (Independent variables: productivity and education in 1951)							
Constant	1.718			Unstand. coefficient	-0.478	-0.212	
Y standard error	0.055981	Number of cases*	22	Standard error	0.086	0.183	
R*	0.956	F*	99.777	Stand. Coefficient	-0.805	-0.167	
R <sup>2</sup> *	0.913	F significance*	0.000	Coefficient t value	-5.579	-1.157	
Adjusted R <sup>2</sup> *	0.904	Rate of convergence ( $\lambda^*$ )	0.0817	Coeffic. t significance	0.000	0.262	
Dependent variable: 1951-1971 income growth rate							
Unconditional convergence (Independent variable: income in 1951)							
Constant	1.439			Unstand. coefficient	-0.409	<i>Impact of education on the model</i>	
Y standard error	0.066412	Number of cases	22	Standard error	0.038		
R	0.922	F	113.11	Stand. Coefficient	-0.922		$\lambda^*-\lambda$
R <sup>2</sup>	0.850	F significance	0.000	Coefficient t value	-10.635		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	0.842	Rate of convergence ( $\lambda$ )	0.1276	Coeffic. t significance	0.000		F*/F
Conditional convergence (Independent variables: income and education in 1951)							
Constant	1.684			Unstand. coefficient	-0.281	-0.373	
Y standard error	0.064007	Number of cases*	22	Standard error	0.089	0.235	
R*	0.931	F*	62.151	Stand. Coefficient	-0.634	-0.317	
R <sup>2</sup> *	0.867	F significance*	0.000	Coefficient t value	-3.177	-1.591	
Adjusted R <sup>2</sup> *	0.853	Rate of convergence ( $\lambda^*$ )	0.0503	Coeffic. t significance	0.005	0.128	

Notes: See text.

Table A.8. *Unconditional and conditional convergence, 1971-2001*

Dependent variable: 1971-2001 productivity growth rate							
Unconditional convergence (Independent variable: productivity in 1971)							
Constant	1.226			Unstand. coefficient	-0.232	<i>Impact of education on the model</i>	
Y standard error	0.036554	Number of cases	22	Standard error	0.066		
R	0.617	F	12.299	Stand. Coefficient	-0.617		$\lambda^*-\lambda$
R <sup>2</sup>	0.381	F significance	0.002	Coefficient t value	-3.507		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	0.350	Rate of convergence ( $\lambda$ )	0.0320	Coeffic. t significance	0.002		F*/F
Conditional convergence (Independent variables: productivity and education in 1971)							
Constant	0.982			Unstand. coefficient	-0.570	0.578	
Y standard error	0.027395	Number of cases*	22	Standard error	0.097	0.142	
R*	0.818	F*	19.253	Stand. Coefficient	-1.515	1.046	
R <sup>2</sup> *	0.670	F significance*	0.000	Coefficient t value	-5.900	4.075	
Adjusted R <sup>2</sup> *	0.635	Rate of convergence ( $\lambda^*$ )	>0.2303	Coeffic. t significance	0.000	0.001	
Dependent variable: 1971-2001 income growth rate							
Unconditional convergence (Independent variable: income in 1971)							
Constant	0.913			Unstand. coefficient	0.098	<i>Impact of education on the model</i>	
Y standard error	0.137062	Number of cases	22	Standard error	0.140		
R	0.155	F	0.494	Stand. Coefficient	0.155		$\lambda^*-\lambda$
R <sup>2</sup>	0.024	F significance	0.490	Coefficient t value	0.703		R <sup>2</sup> */R <sup>2</sup>
Adjusted R <sup>2</sup>	-0.025	Rate of convergence ( $\lambda$ )	-0.0048	Coeffic. t significance	0.490		F*/F
Conditional convergence (Independent variables: income and education in 1971)							
Constant	-0.334			Unstand. coefficient	-0.505	1.853	
Y standard error	0.112036	Number of cases*	22	Standard error	0.215	0.560	
R*	0.617	F*	5.836	Stand. Coefficient	-0.796	1.123	
R <sup>2</sup> *	0.381	F significance*	0.011	Coefficient t value	-2.343	3.307	
Adjusted R <sup>2</sup> *	0.315	Rate of convergence ( $\lambda^*$ )	0.0530	Coeffic. t significance	0.030	0.004	

Notes: See text.

Table A.9. *Conditional convergence with education and overseas emigration, 1891-1911*

Dependent variable: 1891-1911 productivity growth rate					
Independent variables: productivity 1891, education 1891, rate of overseas emigrants 1890-1909					
Constant	0.562	Unstandardized coeff.	-0.085	0.332	0.176
Y standard error	0.106339	Standard error	0.139	0.081	0.042
R	0.828	Standardized coeffic.	-0.122	0.745	0.937
R <sup>2**</sup>	0.686	Coefficient t value	-0.611	4.106	4.197
Adjusted R <sup>2</sup>	0.623	Coefficient t significance	0.551	0.001	0.001
Number of cases	19	<i>Impact of overseas emigration on the model</i>			
F**	10.910	$\lambda^{**}-\lambda^*$	<b>-0.0411</b>	$\lambda^{**}-\lambda$	<b>-0.0218</b>
F significance	0.000	R <sup>2**</sup> /R <sup>2*</sup>	<b>2.1640</b>	R <sup>2**</sup> /R <sup>2</sup>	<b>3.6684</b>
Rate of convergence ( $\lambda^{**}$ )	0.0065	F**/F*	<b>2.9422</b>	F**/F	<b>2.7924</b>
Condition Index (CI**)	17.947	CI*/CI**	<b>0.5782</b>	CI/CI**	<b>0.4666</b>
Dependent variable: 1891-1911 income growth rate					
Independent variables: income 1891, education 1891, rate of overseas emigrants 1890-1909					
Constant	0.544	Unstandardized coeff.	-0.260	0.551	0.155
Y standard error	0.112731	Standard error	0.161	0.094	0.040
R	0.851	Standardized coeffic.	-0.318	1.091	0.731
R <sup>2**</sup>	0.724	Coefficient t value	-1.616	5.846	3.883
Adjusted R <sup>2</sup>	0.669	Coefficient t significance	0.127	0.000	0.001
Number of cases	19	<i>Impact of overseas emigration on the model</i>			
F**	13.107	$\lambda^{**}-\lambda^*$	<b>-0.0331</b>	$\lambda^{**}-\lambda$	<b>0.0143</b>
F significance	0.000	R <sup>2**</sup> /R <sup>2*</sup>	<b>1.6233</b>	R <sup>2**</sup> /R <sup>2</sup>	<b>90.500</b>
Rate of convergence ( $\lambda^{**}$ )	0.0191	F**/F*	<b>2.0327</b>	F**/F	<b>91.021</b>
Condition Index (CI**)	16.794	CI*/CI**	<b>0.7219</b>	CI/CI**	<b>0.5154</b>

Notes: See text.