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The legacy of history or the outcome of reforms? Primary education and literacy in Liberal Italy (1871-1911)

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Abstract

This paper shows how historical institutions, inherited from pre-unification regional states, cast a long shadow on the evolution of literacy across the provinces of Liberal Italy (1871-1911). Although increasing local inputs into public primary schooling were associated with higher literacy, pre-unification schooling is found to be a crucial predictor of literacy in the period under study. New provincial estimates of school efficiency based on Data Envelopment Analysis suggest that pre-unification education and parental literacy were also important determinants of the success in converting schooling into literacy.

JEL codes: E02, H75, I25, N33.

Keywords: schooling, effectiveness, efficiency, human capital, education production function, economic history, institutions, reforms, Italy.

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Introduction

Human capital plays a central role in modern economic performance, as highlighted by theoretical models of growth since the 1980s (Lucas 1988; Romer 1990; Galor 2005). Empirical research has confirmed that education and skills are among the main determinants of per-capita income disparities across countries (Hanushek and Woessmann 2012). New data and estimates on historical schooling, education and human capital formation that has become available in the last decades shows, in turn, that e.g. educational attainments and numeracy in the past are strongly related to contemporary human-capital levels (Morrisson and Murtin 2009; Joerg Baten and Juif 2014).

By stretching the time span of the analysis, recent research within economics and economic history has made some progress in explaining which factors determined human-capital inequality within and across countries. This line of work has focused – among the other things – on landownership concentration and funding of schooling (Cinnirella and Hornung 2016), the gender gap (Baten and de Pleijt 2018), the demand for skills due to industrialization (Diebolt, Le Chapelain, and Menard 2017) and persistent historical legacies vs. school reforms aimed to change the status quo (Chaudhary and Garg 2015; Cvrcek and Zajicek 2018).

Part of this literature has focused on Italy, particularly in the last few years, when a resurgent body of quantitative evidence has prompted new interpretations on the comparative economic performance of the country and of its persistent regional divide – stressing that human capital is central to explain the country's comparative economic performance and the persistence of a very large regional inequality (Di Martino and Vasta 2017; Cappelli 2017a).

While recent contributions on the historical determinants of human capital accumulation in Italy and its regions – which are discussed more in depth in the literature review below – have mainly dealt with the supply of primary schooling (Cappelli 2016; A'Hearn and Vecchi 2017), other considerations concerning the demand for schooling and the efficient use of available inputs have been largely neglected. Furthermore, although a recent article by Carlo Ciccarelli and Jacob Weisdorf (2018) has put forward some new interpretations concerning this, no empirical research has been rigorously carried out on the relationship between public schooling in pre-unification regional states and post-unification human capital accumulation. Indeed, some questions originally raised by the Italian historiography of the 1990s remain

unanswered to date: did the supply of schooling matter for human capital accumulation, against the alternative argument that literacy was mainly demand-driven? Did the culture and capability to provide public schooling inherited from the pre-unification period cast a shadow on the educational fortunes of post-unification Italian regions, even when we factor in other aspects in the analysis? Although some progress has been recently made, a systematic assessment of such mechanisms has been impossible until now, due to both methodological limitations and data constraints.

We answer such questions by implementing a new two-step methodology, based on the distinction between the concepts of effectiveness and efficiency. Effectiveness can be defined as the association between inputs and outputs and captures the process by which inputs are transformed into outputs: it tells us to what extent each input determines or contributes to the production of a certain level of output, which in our case is literacy. Efficiency might be defined as effectiveness at the lowest possible cost. Thus, the production of literacy may be deemed efficient if it is the best result that can be reached with the inputs provided by the education system.

Following this framework, we first investigate to what extent the spread of youngsters' literacy (those aged 15-19) across Italy's provinces was due to (i) varying primary-school inputs, (ii) a different demand for skills linked to the structure of the economy or (iii) historical traditions of supplying public primary schooling by pre-unification (pre-1861) regional states. To do so, we estimate provincial Education Production Functions (henceforth EPFs). We find that going to (public) schools was crucial, as more inputs – particularly enrolments – are always linked to higher literacy, even when controlling for demand-side features. At the same time, pre-unification schooling is correlated with post-unification literacy, suggesting a high degree of inertia to change and path dependence of past institutional settings.

Secondly, we estimate primary-school efficiency by relying on Data Envelopment Analysis (henceforth DEA). We find that the capability to improve literacy based on a given supply of inputs varied greatly across Italy's provinces – although our series show that North-South convergence accelerated between 1901 and 1911. Based on a Simar-Wilson econometric model (Simar and Wilson 2007), we find that demand-side features do not explain territorial disparities in school efficiency; instead, our results highlight that the provinces characterized by higher literacy at the beginning of the 19th century were the most efficient in converting

school inputs into literacy between 1871 and 1911. This aspect of persistence is also reinforced by the fact that post-1871 literacy is positively related to parental education.

This paper thus relates to the economic literature on the role of historical institutions and their persistence over time (see Valencia Caicedo 2019 for an overview). Indeed, the fortunes of Italy's regions were persistently linked to their pre-unification development – particularly concerning education: those that fared better were the ones that had accumulated human capital by the early 19th century. Even in the presence of a major shock that harmonized formal institutions across regions, such as the Italy's unification, culture and informal norms concerning schooling and education cast a long shadow on Italy's South. Persistence does not mean destiny, though: our results show that the link between pre-unification education and literacy faded out over time, and that convergence in school efficiency between the North and the South occurred in the first decade of the 20th century. Although testing the following argument formally goes beyond the scope of this analysis, we argue that the observed pattern is consistent with Italy's governments making the first steps towards a change in the primary-school system, bringing about more funding and more centralized management (Cappelli and Vasta 2017.

The rest of the paper is organized as follows: Section 1 discusses the relevant literature. Section 2 briefly describes Italy's education system. Section 3 presents the data employed in the analysis and some relevant stylized facts. Section 4 presents our estimates of Education Production Functions and the evidence on the persistent legacy of pre-unitarian human capital accumulation. Section 5 measures the efficiency of the schooling system and then investigates its determinants across provinces. Section 6 concludes.

1. Selected literature review

An important line of research within economics has focused on the role played by historical institutions as key determinants of economic growth and development (see seminal work by Acemoglu, Johnson, and Robinson 2001; Engerman and Sokoloff 2002). Such work highlights the persistence and inertia of both formal and informal institutions over time (Nunn 2008; Michalopoulos and Papaioannou 2013; Maloney and Caicedo 2016; Waldinger 2017; Valencia Caicedo 2019). Granted that most institutions evolve slowly, recent research

has shown that important changes in beliefs, norms and rules might be prompted by effective policy interventions (Chaudhary and Garg 2015; Alston 2017).

Among institutions affecting economic growth, the norms that regulate a school system and provide the framework for human-capital accumulation are influenced by historical legacies. Due to this, a large body of research in economics and economic history has explored the determinants of human-capital inequality within and across countries – in the past and in the long run. An important line of work has focused on soil endowments and land inequality in a political-economy framework, stressing that the concentration of land in the hands of a restricted elite limited investment in schooling for all (Cinnirella and Hornung 2016; Joerg Baten and Hippe 2018). Although the view that elites did not invest in public education has been recently challenged by new empirical research – particularly on Sweden and Austria (Andersson and Berger 2018; Cvrcek and Zajicek 2018) –, this mechanism certainly is a valid explanation of regional schooling inequality in many parts of Europe and North America during the 19th century (Go and Lindert 2010; Goñi 2018; Beltrán Tapia and Martinez-Galarraga 2018). Gender inequality held back the development of education, too, thus hampering long-term human capital accumulation (Hippe and Perrin 2017; Baten and de Pleijt 2018). A complementary line of research has stressed that the rise of mass education in the past often depended on demand. This mechanism is confirmed by research on the spread of steam engines in France (Franck and Galor 2017; Diebolt, Le Chapelain, and Menard 2017) and evidence on the industrialization of the US (Katz 2016). Instead, de Pleijt, Nuvolari and Weisdorf (2016) find mixed evidence on the role that new-technology adoption played for education, while de Pleijt and Weisdorf (2017) argue that a decrease in average skills occurred in England from the end of the 16th century to the beginning of the 19th century.

Recently, similar issues have been addressed referring to Italy's comparative economic performance and the role that human capital accumulation played in determining the country's persistent regional divide (Felice 2013, 2015). Di Martino and Vasta (2017) argue that limited human capital and a deficient national innovation system hampered Italy's growth in the long run. Concerning the country's regional divide, Federico, Nuvolari and Vasta (2019) have estimated real wages for all provinces in the Liberal Age (1861 – 1913). They find that provinces with better human-capital endowments – as measured by literacy – experienced the largest increase in wages in the 50 years preceding the Great War. The

positive link between regional growth and human capital has also been shown by Felice (2012) and Ciccarelli and Fachin (2017). Missiaia (2018) has relied on an empirical model based on the New Economic Geography to test what factors determined the location of industry across Italian regions from unification to the eve of WWI. She finds that human capital was one of the most important determinants of industrial location – similarly to what Basile and Ciccarelli (2018) find when performing a similar test across Italy's provinces for the same period.

A'Hearn and Vecchi (2017) argue that the political-economy mechanism, through which landowning elites hampered the spread of schooling – especially in the South – was at work in Italy in the 19th century, even though they do not provide econometric evidence supporting this claim. Cappelli (2016) captures such a mechanism by using access to local election (suffrage) as a proxy for wealth and land inequality – but finds no consistent relationship between electoral franchise and primary schooling. According to his quantitative results, local fiscal capacity – itself a proxy of income per capita – was a major determinant of school investments under Italy's decentralized education system: indeed, Cappelli and Vasta (2017) show that the shift to centralized education in 1911 (the Daneo-Credaro Reform) prompted more rapid human capital accumulation and regional convergence in schooling. The Italian regional education divide was also affected by a large gender gap, as shown by Bertocchi and Bozzano (2016), who argue that female education was more prominent in provinces linked to medieval-commerce routes – and that such an effect dissipates on the eve of the 20th century due to the implementation of national school reforms.

Ciccarelli and Weisdorf (2018, henceforth CW) have provided the first-ever estimates of literacy encompassing all of Italy's provinces in the long 19th century, from 1821 to 1911. They rely on back-casting to estimate the literacy of adults by relying on the age structure of the population, as recorded by coeval censuses. They find that the North-South educational gap widened up to the unification of Italy (which occurred in 1861), to decline thereafter; despite this, the North-South gap was the same in 1911 as it had been in 1821. Furthermore, CW show a reduction in the gender gap within the North before 1911, while gender inequality stagnated (at very high levels) in the South. The authors conclude that, "although the state school initiative after unification helped close the rising gap in literacy between the north and the south, progress in the south was slow and average male literacy in Southern

Italy in 1911 was no higher than in Northern Italy in 1821" (Ciccarelli and Weisdorf 2018: 3).

Despite this recent wave of research on human capital accumulation in Italy and its regions, some hypotheses remain unexplored. For example, although CW show educational trends in the long 19th century, their analysis remains silent on the respective role played by historical legacies vs. school reforms, school inputs and the demand for schooling in Liberal Italy – that is, post-unification. Under Italy's decentralized primary-school system, based on local management and funding by the municipalities, whether persistent regional educational inequality was due to limited local inputs, limited demand for literacy and numeracy, or to a deficient organizational and administrative knowledge due to the legacy of the past, still is a contended issue. Indeed, although Cappelli (2016) has shown that some local institutional and socioeconomic aspects affected inputs into primary schooling, his analysis does not explore the link between inputs and educational outputs, for example literacy.

To sum up, to date, it is still a matter of speculation whether the provision of mass schooling did matter to improve literacy in Liberal Italy, against the alternative argument that human capital accumulation was mainly demand-driven; nor we know whether the culture and capability to provide public schooling inherited from the pre-unification regional states cast a gloomy shadow on the educational fortunes of post-unification Italian regions.

2. Italy at school in the 19th century: pre-unitary education and the national system of primary education (1871 – 1911)

This section illustrates the pervasive regional differentiation in human accumulation and educational policies inherited from the pre-unification period (1815-1861) and then by describing the new national system of primary education implemented in the subsequent period (1861-1911).

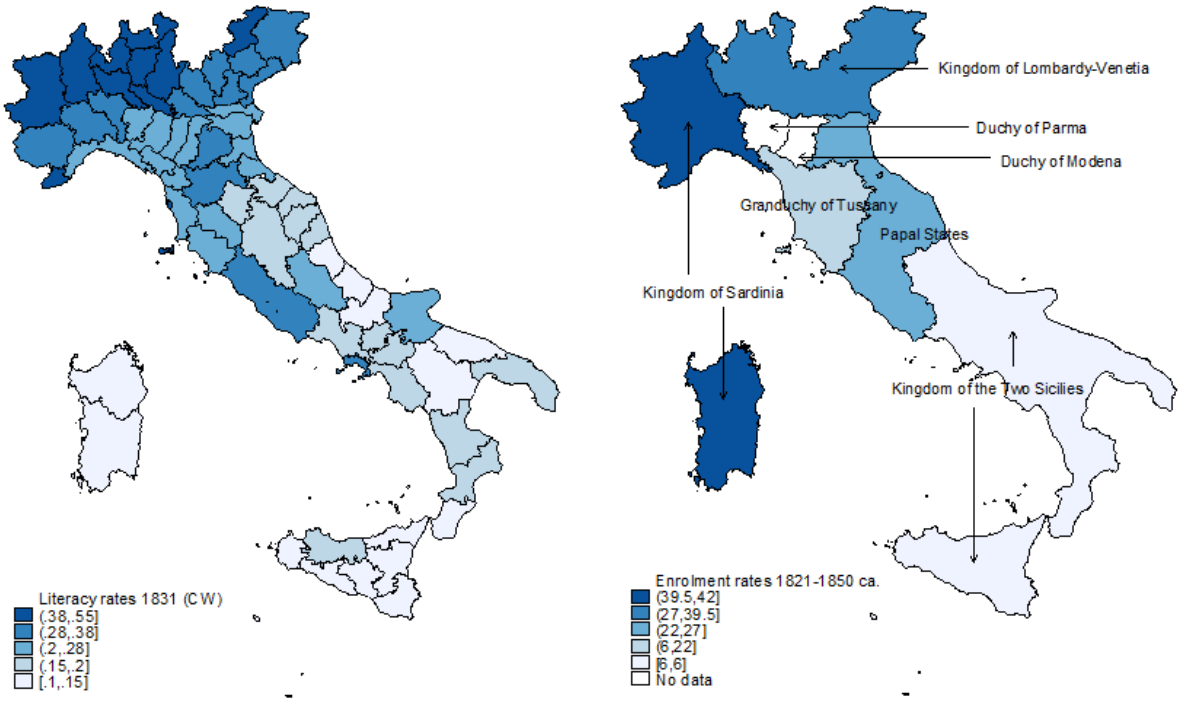
At unification, Liberal Italy had not yet embarked on sustained industrialization and economic growth: a substantial share of its labour force was employed in agriculture, very limited railway and road infrastructure had been built, extensive poverty and land inequality characterized large areas and low literacy rates and enrolments into schooling. Despite its low level of development, the country was already characterized by regional economic inequality.

If little regional disparities could be discerned by 1871 concerning industrial activity and GDP per capita, large regional inequality was evident in terms of infrastructures (Ciccarelli and Groote 2017), innovation capacity (Nuvolari and Vasta 2015, 2017) and literacy and schooling (Bertocchi and Bozzano 2016; Cappelli 2016).

More specifically, the profound territorial heterogeneity in human capital accumulation was largely inherited from pre-unification regional states, due to very diverse education policies (A'Hearn and Vecchi 2017). Pre-unification regional inequality in schooling persisted to the Liberal Age, highlighting a high level of inertia from one period to the other. Figures 1 shows adult literacy rates in 1831 and enrolment rates in pre-unification states, approximately between the 1820s and the 1850s, while Figure 2 illustrates adult literacy rates in 1871 and 1911.[3] This descriptive evidence confirms that the distribution of human capital accumulation across the country was highly persistent through time and remained fairly unchanged for almost a century.

[3] Data on literacy rates in 1831 are taken from Ciccarelli and Weisdorf (2018), who employ a backcasting methodology in combination with post-unification censuses.

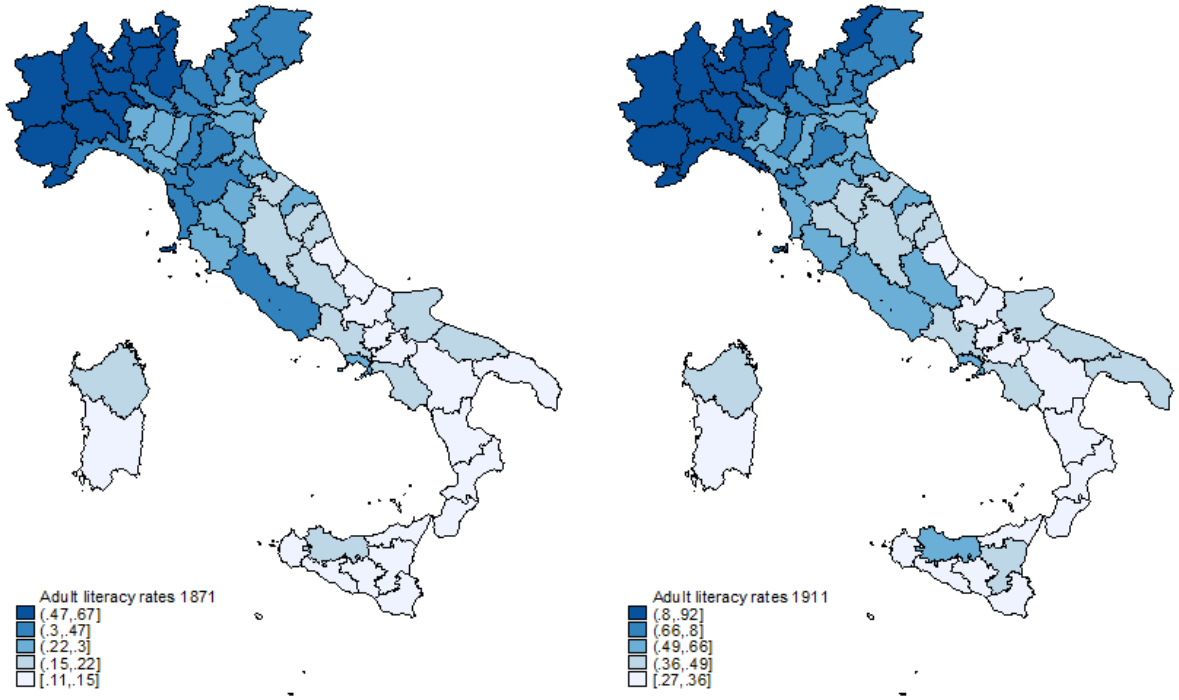
Figure 1: Literacy and Enrolment rates in pre-unitarian States



a) Literacy rate 1831 b) Pre-unitarian Enrolment rate

Notes: adult literacy rates in 1831 refers to adult population aged 30-40. Sources: literacy rates in 1831 are taken from Ciccarelli and Weisdorf (2018). Data on enrolment rates are taken from Vigo (1971).

Figure 2: Adult literacy rates in 1871 and 1911



1871 1911

Notes: Adult literacy rates in 1871 and 1911 refer to population aged 15+. Sources: census data.

Already in the early 19th century, a well-functioning schooling system was present in the Kingdom of Sardinia (including Piedmont, Liguria and the isle of Sardinia), which had the highest literacy in the period, followed by Lombardy and Venetia under the Habsburg Empire (Genovesi 1998): as Figure 1 shows, literacy in Piedmont and Lombardy ranged between 38 and 55 percent, in line with foreign neighbouring countries. The very same pre-unification states are also the leading ones when considering enrolment figures, as Figure 1-b clearly points out. Instead, human capital was low in the territories that belonged to the Papal States and to the Kingdom of the Two Sicilies, in the Centre-South of the peninsula, where no such policies were implemented. Notice, for example, that in 1831 in some southern territories of the Kingdom of the Two Sicilies only 10 to 15 people out of 100 were able to at least read.

During unification (started during the 1860s and completed by 1871), the Kingdom of Italy began to implement a series of education policies.[4] This new trend started with the establishment of a national education system, based on the imprint given by the Casati Law, passed in the Kingdom of Sardinia in 1859 and later extended to the newly annexed areas of the unified Kingdom. As far as primary education was concerned, the central government set all the formal norms regulating the primary schools. The Law stated that primary schooling had to be provided free of charge, for at least two years. Additional two years were compulsory in larger municipalities, and where a secondary school had already been established.

Despite a bulk of centralized formal provisions, the funding and management of schooling was fully decentralized: hiring teachers, paying them, building and running schools and enforce attendance was the responsibility of the municipalities, i.e. the city councils.[5] When it was set forth in 1859, the Casati primary-education Law lacked any redistributive mechanism to make up for large regional economic disparities, which translated into large regional inequalities in the capability to fund primary education, causing education to spread quite slowly at the national level. Such issue was first tackled by the Coppino Reform of 1877, which strengthened the very weak sanctions for the families of children who did not enrol, failing to comply with the Casati Law. Compulsory education was also brought to three years (up from two), yet this had little effect on enrolments and the growth of literacy – even though a weak system of subsidies aimed at the poorest municipalities was implemented.

[4] The provinces of Mantua and those belonging to today's Veneto were annexed in 1867, whereas the province of Rome (and Comarca) was annexed in 1871.

[5] Decentralized education can be defined as the devolution of school management to lower levels of public administration. Centralization, instead, is the inverse process, i.e. a concentration of power in the hand of the central government (Bray 1991). According to this definition, Italy's education system from 1859 to 1911 was very decentralized, although the norms and curricula were set forth by the central administration.

State intervention became more decisive at the turn of the 20th century, although a real step towards centralization was only taken in 1911, with the Daneo-Credaro Reform. Still, in 1903 and 1904 the Orlando and Nasi Laws increased teachers' salaries and improved their legal position vis-à-vis the city councils, which up to that point could discretionarily hire or lay-off them.

To sum up, given the history of primary schooling in Liberal Italy, it is perhaps unsurprising to observe a high persistence of regional educational inequality – as shown by Figure 2. However, next, we test whether such differences are a mere legacy of the pre-unification period (whereby provinces inherited different stocks of human capital due to very distinct education models implemented by early-19th century polities), against the alternative hypothesis that the main factor hindering regional education was limited school inputs, which in turn can be linked to the decision to provide primary education through a decentralized system up to 1911.

3. Data and stylized facts

To explore whether historical legacies affected the diffusion of literacy across the provinces of Italy, the first issue that we need to tackle is how to measure inputs into schooling, educational outcomes and school efficiency in the long 19th century. Although collecting fine-grain data concerning this period is normally difficult, Italy's historical statistics provide rich and reliable data. We rely on a newly assembled panel dataset (Bozzano and Cappelli 2018) on educational outcomes and school inputs at the provincial level (roughly today's NUTS-3) and at ten-year intervals between 1861 and 1911.

Education and schooling variables

The literacy rates of the youngsters (aged 15 to 19), which is our dependent variable, are calculated based on the population censuses.[6] State inquiries into primary education provide information on the number of pupils enrolled in primary (state and private) schools, the number of teachers and the number of schools, from which we calculate the primary Gross

[6] Since the unification of Italy in 1861 censuses specifically inquired about the literacy of population. More specifically, the question about literacy was asked to the head of the family who answered for all components of the household.

Enrolment Ratio[7], the pupil-teacher ratio, and the density of state schools (as the number of schools per squared km). We collected information on expenditures on education from the municipalities' balance sheets (*Bilanci comunali*), published by the Ministry of Agriculture, Industry and Trade (see *Ministero di Agricoltura Industria e Commercio*, various years), from which we calculate expenditure on education per pupil. Expenditure figures are in current Lire pro capita; yet, one may note that, in the period concerned by our analysis, the mean rate of inflation was basically zero, due to the influence exerted by the Gold Standard: hence, our figures approximate those in constant prices.

Geographic, demographic and socio-economic variables

To run our analysis, we complement our dataset with a series of variables that are not pertaining to the education system itself, and divide them into three groups: geography, demography, and socio-economic aspects.

Geography controls include latitude, longitude, average temperature, and average rainfall.

Demographic variables include population density (residents per squared km) and a proxy for the dependency ratio (children aged 6 to 10 as a share of total population) in order to capture the potential differences in the age structure of the population. We also collect and calculate the infant mortality rate and the rate of outward migration (emigrants as a share of total residents). The latter is added to control for potential brain drain (Gomellini and O'Grada 2013; Giffoni and Gomellini 2015). Figures on emigrants are obtained from the Yearbook on Italian Migration (*Commissariato generale dell'emigrazione 1926*). Infant mortality rates are calculated from vital statistics (*Direzione generale della statistica, various years*), while population density and the dependency ratio are elaborations from census figures.

Socio-economic variables include the height of conscripts[8] aged 20 organized by birth cohort, obtained from A'Hearn and Vecchi (2017) as a proxy for economic well-being; industrial Value Added per capita obtained by combining data from Ciccarelli and Fenoaltea (2013) with population figures; the share of the labour force in agriculture, thanks to data kindly provided by Anna Missiaia (2014); electoral franchise, represented by the share of adult males (21+) entitled to vote in local (e.g. municipal) elections (Cappelli 2016); finally, we

[7] The primary Gross Enrolment Ratio is defined here as the total number of pupils enrolled in primary schools, regardless of age, divided by the number of children of the age group that officially corresponds to the primary level of schooling, in our case children aged 6-10. The GER does not account for actual attendance.

[8] Height is commonly employed in economics and economic history as a proxy for wealth and living standard because it provides important information on the stock of nutritional investment, and therefore on changes in the well-being of populations. For an in-depth presentation of the methodology, see A'Hearn and Vecchi (2011) and (2014).

also include a measure of parental literacy collecting data on the percentage of spouses who were able to sign wedding acts, which are obtained from vital statistics (smoothed on three years and centred at the years of the censuses).

All the socio-economic controls should capture features that may affect the expansion of education, like its opportunity cost, the fact the poorer provinces would not be able to fund primary schools, and the varying degree of support for the diffusion of mass education, which likely depended on enfranchisement and parental human capital (Lindert 2004).

Finally, we include a proxy of land inequality to further capture the delaying effect of landed élites in the process of expansion of mass schooling (Beltrán Tapia and Martinez-Galarraga 2018). This index, elaborated by Gabriele Cappelli (Cappelli 2017b) and referring to c. 1871, is the share of large landowners[9] on the total number of landowners.

Early 19th century variables

We exploit data on early-19th-century literacy rates (1831) as estimated by Ciccarelli and Weisdorf (2018), which were presented in the previous section. Data are based on the backcasting methodology, a procedure in which literacy rates recorded in 1881 and 1911 are projected backwards to estimate literacy rates before unification.[10]

To complement this part of the analysis, we also include the following pre-unification schooling variables: the GER, the pupil-to-teacher ratio, and the supply of teachers (here as the number of teachers over total population). The pre-unification data are available at the province level but for a reduced number of provinces, because of missing observations.[11] Data are provided by Vigo (1971)[12] and concern various years over the pre-unification period between 1824 and1858.[13] Since the inaccuracy of pre-unification statistics has already been broadly emphasized in the literature (Vigo 1971), we employ them with caution and mostly interpret them as suggestive evidence for our argument.

Descriptive statistics

[9] The landowners classified as large are those who paid, annually, more than 40 Lire of land-related tax.

[10] The authors decide to focus on the literacy rates of the age group 30-40 because, as they explain, they assume that male literacy was only complete after the age 30.

[11] The former two variables are available for 50 provinces out of 69, whereas the latter is available for 52. When these variables are introduced the total number of observations in the regressions is reduced. For more information of the data see the Appendix.

[12] For the supply of teachers, we calculate the values referring to Lucca and Parma from Genovesi (1998).

[13] Refer to the Appendix for further details.

Our dataset covers 69 Italian provinces (at 1871 boundaries) for 5 points in time (1871, 1881, 1891, 1901, and 1911), spanning the initial fifty years of the unified Kingdom of Italy. These figures are uncommonly rich for a 19th-century country and give us the opportunity to gain new insights into the performance of the Italian education system before more pervasive and coherent education policies were introduced starting during the first decade of the 20th century. More details on the definitions and sources for all variables can be found in the Appendix.

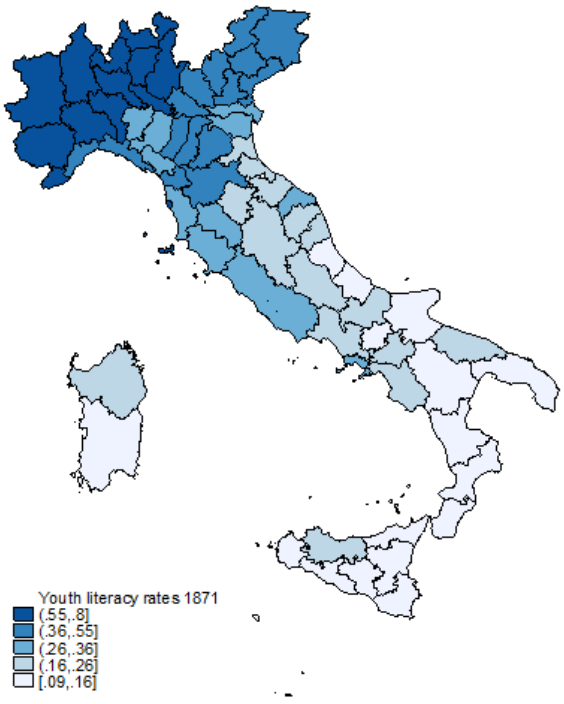
Table 1: Descriptive Statistics of Dependent Variables and School Inputs: 1871-1911.

	1871		1881		1891		1901		1911	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Literacy Rate 15-19	0.343	0.195	0.428	0.222	0.514	0.224	0.601	0.231	0.719	0.202
GER 6-10	0.626	0.360	0.810	0.348	0.840	0.313	0.934	0.288	1.087	0.254
Pupil-teacher ratio	41.71	9.436	44.308	9.834	45.068	9.090	47.841	7.955	51.591	8.126
Expenditure per pupil	18.33	6.977	30.02	11.238	32.45	10.04	38.555	13.38	44.99	22.086
School density	0.141	0.103	0.177	0.131	0.201	0.153	0.238	0.189	0.282	0.237

Selected descriptive statistics are reported in Table 1. The data show that, on average, of all young people aged 15 to 19, only 34 percent were literate in 1871. This share increased considerably throughout time, reaching 71 percent in 1911.[14] Figure 3 shows a map plotting provincial literacy rates for youngsters aged 15 to 19 in 1871, where darker areas are characterized by high literacy: as seen in Section 2, literacy rates of people aged 15 to 19 show strong regional inequality, with very low level of human capital in the South of the peninsula.

[14] In 1871, among children aged 6 to 10, only 18 percent were literate.

Figure 3: Literacy rates for youngsters (age 15-19) in 1871.



Source: own elaboration from census data. See text.

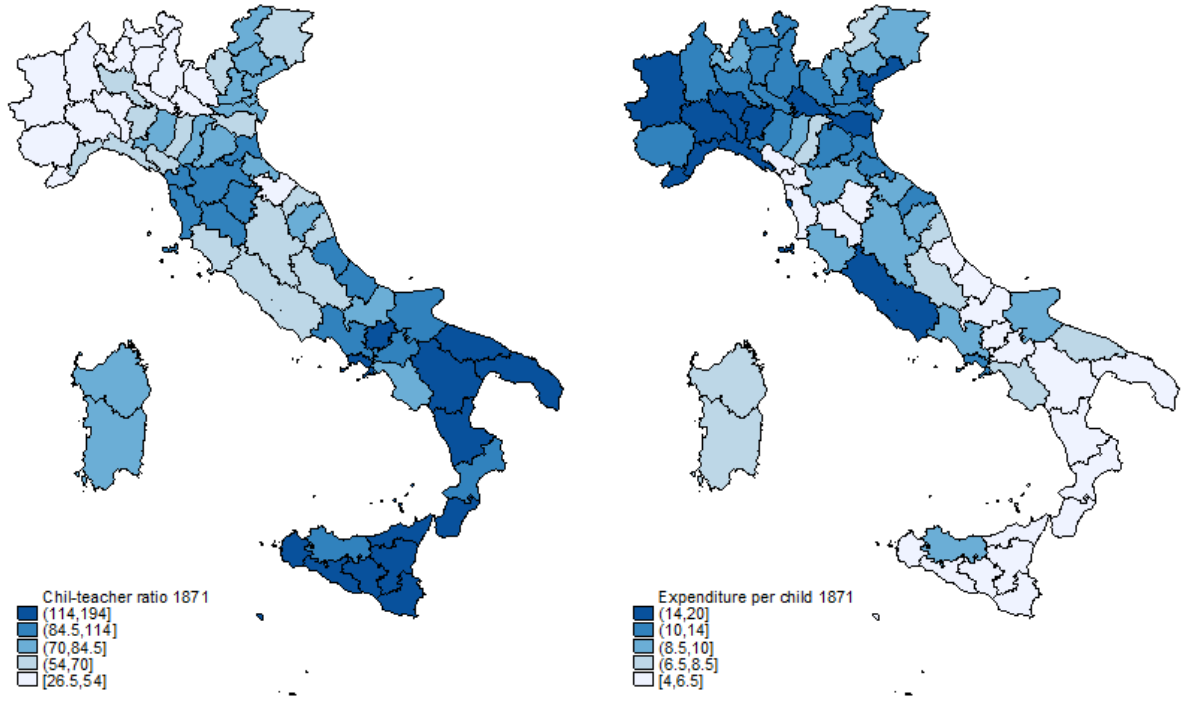
Like literacy, the share of primary-school-age children who were enrolled (GER) increased from an average of 63 percent in 1871 to 110 percent by 1911.[15] We rely on the cohort dimension of our dataset to compare enrolment rates (while in schooling) and literacy rates for the same cohort ten years later. 63 children in primary-school age (6 to 10) out of 100 were enrolled in 1871, but only 43 of them were literate ten years later. This observation clearly shows that the efficiency of the schooling system in producing literacy is a dimension of Liberal Italy's education system that is worth exploring more in depth.

Expenditures per pupil and the density of municipal schools increase through time as expected. Finally, the pupil-teacher ratio (henceforth class size), which is seen in the literature as a measure of quality of education, also shows growing values through time. Although this may seem odd at first (at least from priors in development economics), Johannes Westberg and Cappelli (2019) show that class size in c. 1881 was positively related to enrolment rates across Italian provinces, while there was no correlation with expenditure per school-age children. The authors argue that expenditure (and thus teachers) was just increased to allow for a slow expansion of enrolments, in a very adaptive way: indeed, there is no correlation between expenditure per school-age child and class size, whereas the same

[15] A gross enrolment rate greater than 100 percent is generally due to a high incidence of early or late enrolment with respect to the school age being considered, in our case the class of age 6-10.

study shows that the relationship between expenditure and class size was clear and strong in Sweden. Figure 4, which is aimed at capturing the supply of primary schooling, plots the child-teacher ratio and municipal expenditure per child in 1871. Here, the denominator of both indices is based on all school-age children, not just those enrolled.

Figure 4: Supply of public schooling: child-teacher ratio and expenditure per child, 1871.

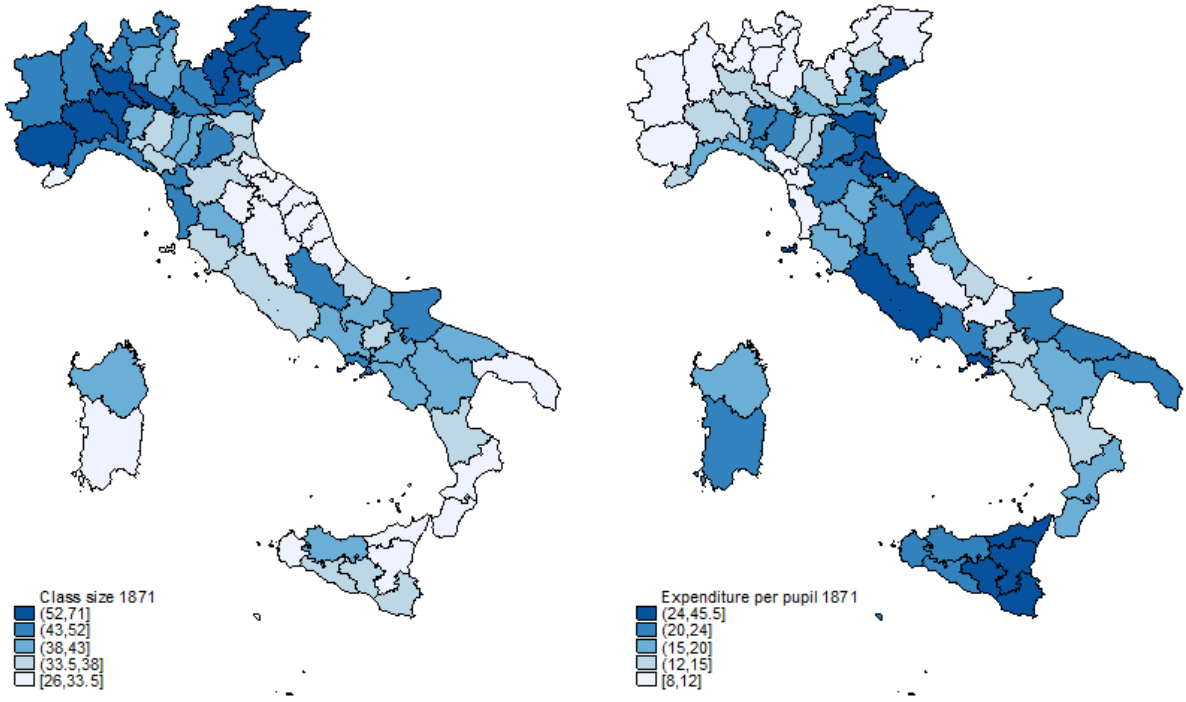


a) Child-teacher ratio b) Expenditure per child

Notes: the child-teacher ratio is measured as the number of children (aged 6 to 10) per primary-school (state) teacher while expenditure per child is calculated as municipal expenditure on education per child aged 6 to 10. Source: see text.

Despite large differences in the supply of public education, the regional distribution of inputs into schooling appears to have been far more homogeneous – partly because of the mediating effect of a lower demand for education in the poorer regions of the country. Figure 5 shows the pupil-teacher ratio (class size) and the expenditure per pupil. For this reason, it is crucial to control for demand-side aspects when estimating the provincial EPFs. It is also very important to explore school efficiency since a relatively high expenditure per pupil in e.g. Sicily is associated to low literacy rates. By the same token, even though the average class size was similar across the country's provinces, educational outcomes varied greatly.

Figure 5: Territorial distribution of school inputs: class size and expenditure per pupil, 1871.



a) Class size b) Expenditure per pupil

Notes: Class size is measured by the number of pupils enrolled in state primary schools per teacher and expenditure per pupil is calculated as the amount of municipal expenditure on education per pupil enrolled in primary schools. Sources: see text.

4.1. Measuring Effectiveness: Education Production Functions and the determinants of literacy

We now define and estimate a historical aggregate EPF at the province level to explore whether and how provincial inputs into schooling, as well as social, economic, demographic and political factors – including historical legacies – correlate with provincial literacy rates.

Most contributions aimed to estimate EPFs rely on modern data. For example, David Card and Alan Krueger (1992) have underlined the positive role of school quality on economic returns to education in the US. Eric Hanushek and Lei Zhang (2006) have analysed educational outcomes at both the individual and aggregate levels for developed and developing countries since the 1960s. They have explored resources into schooling and student achievements to conclude that the relationship between them is weak at best. Hanushek and Ludger Woessmann (2010) have reviewed the economic literature on international educational achievements granted the new availability of international cross-

country data. They have confirmed previous findings, which suggest that policies aimed to put more resources into schooling are unlikely to foster educational outcomes if they are not accompanied by complementary interventions.

There is little research investigating the relationship between school inputs and outputs in a long-term perspective. David Mitch (1984) has estimated the return to male literacy in Victorian England while, more recently, Ruth Schüler (2016) has explored the relationship between school inputs and earnings by using original cross-section data on Prussian counties between 1886 and 1891. The present paper is therefore the first study in a historical and long-term perspective to estimate the relationship between inputs into schooling and educational outcomes.

Following Amy Schwartz and Jeffrey Zabel (2013) our province aggregate production function is:

$$Q_{pt} = f_{pt}\,(SC_{pt}, X_{pt}, ST_{pt}) + \varepsilon \text{ , } (1)$$

which produces the output Q_{pt} by combining educational inputs (SC_{pt}), province-specific environmental characteristics (X_{pt}), and social or parental inputs (ST_{pt}).

We assume a simple linear specification as follows:

$$Q_{pt} = \beta_0 + \beta 1\, SC_{pt} + \beta 2\, X_{pt} + \beta 3\, ST_{pt} + \varepsilon_{pt} \text{ , } (2)$$

where Q_{pt} is represented in our framework by the literacy of children aged 15-19. All school inputs, SC_{pt}, included in the regression analysis are taken as a first lag (ten years earlier), so that we employ school data for 1861 as well to study literacy in the 1871-1911 period.[16]

Educational inputs (SC_{pt}) include the primary Gross Enrolment Rate (GER), the pupil-teacher ratio, expenditure per pupil, and school density, while demographic and socio-economic variables are in ST_{pt} and X_{pt}. We apply White-Huber standard errors to deal with potential heteroscedasticity.

The estimation of an EPF presents several challenges from the technical point of view, which our dataset allows to tackle. The most important concern omitted variables, as well as selection bias and potential endogeneity issues (Hanushek and Woessmann 2010). First, we

[16] We explore the potential non-linearity of inputs by including in a separate set of specifications squared terms as well as interaction terms of input variables at our disposal. However, according to specific tests on the significance of such non-linearities we decided not to include them in the main specification. Results are available upon request.

can address the omitted variable bias by including a rich and comprehensive array of controls. Secondly, thanks to the panel structure of our data, we can employ lagged inputs into the EPF regressions to limit potential endogeneity and reverse causation – although the latter cannot be completely ruled out. Thirdly, since we use provincial figures based on the whole population, the data that we use should not be prone to selection and self-selection bias at the individual and school level. By the same token, bias from unobservable differences in individual ability should not be an issue in our regressions, since we focus on the aggregate provincial-level measures (see Schwartz and Zabel 2013 for an in-depth overview).

After measuring the effectiveness in the production of literacy for each cross-section in five benchmark years (i.e. how inputs relate to literacy), we include the pre-unification literacy rate estimated by Ciccarelli and Weisdorf (2018) among the controls, to proxy for educational attainment in the first half of the 19th century (1831). Another model performs the same exercise by exploiting the panel structure of our dataset through different techniques, such as pooled OLS (POLS) and fixed-effect estimations. Finally, we extend our analysis by including alternative measures of pre-unitarian schooling and further relevant variables highlighted in the literature on the expansion of mass schooling.

4.2. Results

Cross section analysis

We estimate the EPF in five separate cross-section regressions spanning the entire period under examination. In Table 2, we regress the literacy rate of young people aged 15-19 on school inputs (which are entered with a lag of 10 years) in a basic specification throughout Columns 1 to 5, whereas Columns 6 to 10 include an additional set of covariates aimed to capture geography, demography, and economic and social features.

By doing so, we aim to provide a preliminary assessment of whether getting more public schooling was worth the financial effort, against the hypothesis that the development of literacy was mainly driven by demand-side and other contextual factors (e.g., economic, social, institutional, or demographic developments).

Table 2, Columns 1 to 5, shows that the literacy rate and the primary GER are strongly correlated, mainly at the 1-percent level of significance. The magnitude of the coefficient indicates that a 1-percentage-point increase in the enrolment rate in 1861 was associated with a 0.34-percentage-point change in the literacy rate of the same cohort ten years later – with

the estimated coefficient becoming larger throughout time. In 1911, the literacy return to schooling is equal to 62 literates for every 100 pupils enrolled ten years before. The pupil-teacher ratio and the density of schools are also positively correlated with literacy, especially in 1871, 1881, and 1901. The expenditure per pupil is characterized by a positive coefficient, which is significant at the 5-percent level in the first four benchmark years. However, it is worth noting that the latter three inputs contributed to literacy to a lesser extent than the GER. For example, the direct impact of expenditure was rather limited, although more resources into schooling likely affected literacy via inputs: our estimates suggest that every additional 1000 per-capita Lire spent on primary education (an immense increase) would improve the literacy rate of youngsters ten years later by an amount always below one percentage point – holding everything else constant. We thus observe that more resources into schooling mattered when schooling and human capital accumulation were very limited. Generally speaking, literacy benefitted from a better supply of schooling and higher enrolments.

When a more comprehensive set of covariates are included in Columns 6 to 10, the main results hold true, with the main exception for the GER, the statistical significance of which is chipped away in 1871 but remains strong in later years. The positive coefficient of the pupil-teacher ratio may suggest that, in late-19th century Italy, class size was not linked to literacy via the quality of schooling. As mentioned in Section 2, Westberg and Cappelli (2019) argue that, around 1881, the best performers in schooling and human capital among Italian provinces were those with a large class size. Based on this, and assuming that the quality of teachers was higher there where the pupil-teacher ratio was higher (a sensible assumption given the above), the coefficient may be indirectly capturing the quality of schooling – which is something that we cannot include in our analysis, obviously due to the lack of historical figures on the matter. An alternative – and possibly complementary – interpretation is that the beginning of mass schooling was characterized by economies of scale in the provision of education. All other factors being held constant, allocating the same teaching time to more children may have resulted in more of them getting literate, even when the quality of teaching does not change. To sum up, our estimates provide evidence that putting more resources into the school system and getting more schooling was important to improve literacy.

Next, in Table 3, we add literacy rates in the early-19th century among the regressors in the model with all the controls. Our results confirm our prior on the persistence and long-lasting effect of past educational policies: pre-unification literacy is positively correlated with our dependent variable in a significant way between 1871 and 1901. The effect is not negligible.

Keeping all else constant, a 10 percentage-point positive variation in pre-unification literacy is associated with an increase in the literacy rate of the youngsters by 3.9 and 4.8 percentage points in 1881 and 1901 respectively, to decrease to 2.7 percentage points in 1901. In 1911 this effect fades out, possibly due to the implementation of the reforms in the first decade of the 20th century, as described in Section 2. This issue is scrutinized more thoroughly in the next paragraph.

Table 2: Education Production Function: cross section estimates, 1871-1911

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	1871	1881	1891	1901	1911	1871	1881	1891	1901	1911
Estimation technique: OLS	Literacy Rate 15-19									
GER municipal sch.	0.343***	0.511***	0.573***	0.643***	0.623***	0.078	0.102*	0.229***	0.204***	0.244***
	(0.032)	(0.068)	(0.049)	(0.059)	(0.053)	(0.058)	(0.059)	(0.051)	(0.056)	(0.064)
Pupil-Teacher ratio (municipal)	0.005***	0.004***	0.002	0.004**	0.001	0.003***	0.002*	0.002**	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expenditure per pupil	0.004**	0.007**	0.003**	0.004***	0.001	0.001	0.006***	0.002***	0.001	0.001
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
School density	0.491***	0.369	0.238	0.175	0.127**	0.310**	0.656***	0.293*	0.133	0.091
	(0.143)	(0.231)	(0.178)	(0.113)	(0.049)	(0.154)	(0.223)	(0.173)	(0.166)	(0.177)
Geography	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Demography	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Economic and social controls	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Observations	69	69	69	69	69	69	69	69	69	69
Adjusted R-squared	0.823	0.863	0.886	0.887	0.904	0.970	0.970	0.979	0.977	0.972

Notes: OLS estimates are reported with White-Huber robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A constant is always included. All control variables when included are latitude, longitude, average temperature, average rainfalls, population density, dependency ratio, infant mortality rate, height, share of labour force in agriculture, rate of outward migration, industrial VA per capita, electoral franchise, parental literacy rate.

Table 3: Education Production Function and legacy of history: cross section estimates, 1871-1911

	(11)	(12)	(13)	(14)	(15)
	1871	1881	1891	1901	1911
Estimation technique: OLS	Literacy Rate 15-19				
GER municipal sch.	0.029	0.020	0.156***	0.164***	0.243***
	(0.054)	(0.043)	(0.050)	(0.053)	(0.060)
Pupil-Teacher ratio (municipal)	0.003***	0.002	0.003***	0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expenditure per pupil	0.000	0.005***	0.002***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
School density	0.314**	0.608***	0.331**	0.177	0.095
	(0.123)	(0.173)	(0.149)	(0.156)	(0.170)
Literacy rate 1831	0.389***	0.484***	0.301***	0.272***	0.012
	(0.107)	(0.144)	(0.081)	(0.091)	(0.103)
Geography	Yes	Yes	Yes	Yes	Yes
Demography	Yes	Yes	Yes	Yes	Yes
Economic and social controls	Yes	Yes	Yes	Yes	Yes
Observations	69	69	69	69	69
Adjusted R-squared	0.975	0.977	0.982	0.980	0.971

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A constant is always included. All control variables included are latitude, longitude, average temperature, average rainfalls, population density, dependency ratio, infant mortality rate, height, share of labour force in agriculture, rate of outward migration, industrial VA per capita, electoral franchise, parental literacy rate.

Panel estimates: dynamics and persistence

In Table 4, we estimate the EPF again by pooling our cross sections – i.e. by exploiting the panel structure of our data.[17] We first rely on a pooled OLS model (POLS), then we implement a FE panel-data model; in further specifications, we explore the determinants of schooling by including macro-regional dummies (instead of provincial FEs) to control for common shocks and other common features of the areas concerned, but allowing for time-invariant factors – like historical schooling – to be included in the regressions.

As the panel estimates show, the GER and the expenditure per pupil are consistently and positively correlated with educational outcomes at the 1-percent level of significance. The pupil-teacher ratio is positively correlated with literacy rates, while the result for school density is mixed. Overall, the cross-section results are consistent with panel-data estimates, meaning that school inputs can explain the variation of literacy across provinces, but also the change in literacy rates within provinces or macro-areas over time. All in all, the results confirm that school inputs mattered for the development of human capital in late-19th century Italy. Among the controls, which are not reported in Table 4, we find parental literacy rates to have been a strong determinant of the literacy of young people, the coefficients being statistically significant at the 1-percent level; our proxy for socio-economic well-being, height, is also positively correlated with literacy – which seems to stand as evidence backing up the so-called modernization hypothesis, namely the claim that as a society becomes wealthier and more industrialized, more emphasis is placed on education and human capital accumulation. Our result is also in line with the view that good nutrition and wellbeing may prompt better cognitive capabilities (Tollnek and Baten 2017); the share of people employed in agriculture is also strongly and negatively correlated with literacy, providing evidence that the opportunity cost of education was still pressing at that time; finally, electoral franchise, i.e. the share of males entitled to vote in local elections, is positively correlated with literacy, as expected, since the expansion of suffrage is commonly correlated with the expansion of education.[18]

The macro-regional dummies, included in Columns 3-5, show that provinces located in the Northwest of the country, the omitted reference category, were characterized by a positive premium on literacy rates with respect to the Centre and – even more – the South, a variation

[17] In POLS estimates in Table 4, standard errors are not clustered at the provincial level. However, applying clustering does not change the significance of our results. The latter estimates are available upon request.

[18] Results are unchanged when in Table 4, model 2, we introduce a lag of literacy in the previous grade, that is the literacy rate of the youngsters when were children aged 6-10.

which is not explained by any of the factors included in our EPF. Interestingly, the significance of these coefficients does not fade out completely, even when historical literacy (1831) is included in the analysis (columns 4 and 5). This calls for a further exploration of regional disparities in features that are normally unobservable, like school efficiency, and need to be estimated – as we do in the second part of the paper.

Consistently with Table 3, early-19th century literacy rate has a strong long-term effect on our education outcome. When we investigate this relationship throughout time (with the inclusion of interactions of 1831 literacy with the year dummies) we see again that the effect fades out only in 1911, the last period under scrutiny.

Table 4: Education Production Function: panel estimates, 1871-1911

	(1)	(2)	(3)	(4)	(5)
			Literacy rate 15-19		
Estimation technique:	POLS	FE	POLS	POLS	POLS
GER municipal sch. (lag 10)	0.214***	0.129***	0.136***	0.113***	0.131***
	(0.019)	(0.024)	(0.019)	(0.019)	(0.018)
Pupil-Teacher ratio (lag 10)	0.002***	0.001***	0.003***	0.003***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Expenditure per pupil (lag 10)	0.001***	0.000	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
School density (lag 10)	0.054	0.074	-0.022	0.010	-0.028
	(0.045)	(0.048)	(0.041)	(0.040)	(0.041)
Northeast			-0.047***	-0.035***	-0.041***
			(0.009)	(0.009)	(0.009)
Centre			-0.090***	-0.073***	-0.081***
			(0.011)	(0.010)	(0.010)
South			-0.116***	-0.097***	-0.102***
			(0.019)	(0.019)	(0.018)
Literacy rate 1831				0.211***	
				(0.041)	
LR1831*year1881					0.210***
					(0.039)
LR1831*year1891					0.161***
					(0.037)
LR1831*year1901					0.222***
					(0.048)
LR1831*year1911					0.017
					(0.054)
Geography	yes	no	yes	yes	yes
Demography	yes	yes	yes	yes	yes
Economic and social controls	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes
Macro-regions	no	no	yes	yes	yes
Province FE	no	yes	no	no	no
Observations	345	345	345	345	345
Provinces		69			
Adjusted R-squared	0.978	0.973	0.945	0.983	0.984

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A constant is always included. The omitted macro-region dummy is Northwest. All control variables are latitude, longitude, average temperature, average rainfalls, population density, dependency ratio, infant mortality rate, height, share of labour force in agriculture, rate of outward migration, industrial VA per capita, electoral franchise, parental literacy rate.

Finally, starting from model 3 in Table 4 as a benchmark, we run further regressions as robustness checks. In the first three columns of Table 5, we drop early-19th century literacy and include three pre-unification measures of school inputs taken from Vigo (1971): the GER, the pupil-teacher ratio and the supply of teachers (number of teachers over the total population of the province). This is the first time that these variables are employed in

econometric analysis and, due to data availability, when they are included the total number of observations declines. All the three new variables show a strong correlation with the dependent variable at the 5-percent of significance, validating our argument.

Finally, as highlighted by Cinnirella and Hornung (2016), as well as Beltrán-Tapia and Martinez-Galarraga (2018), education may be delayed by landed elites: we therefore include an index of land inequality from Cappelli (2017b). As expected, model 4 shows that restricted access to land is negatively and strongly correlated with the literacy rate yet leaving our previous results on inputs qualitatively unchanged.

Table 5: Education Production Function: panel estimates, further controls, 1871-1911

	(1)	(2)	(3)	(4)
Estimation technique: POLS		Literacy rate 15-19		
GER municipal sch. (lag 10)	0.129***	0.156***	0.151***	0.140***
	(0.024)	(0.024)	(0.024)	(0.019)
Pupil-Teacher ratio (lag 10)	0.003***	0.003***	0.003***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Expenditure per pupil (lag 10)	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
School density (lag 10)	-0.178*	-0.140	-0.127	-0.028
	(0.093)	(0.092)	(0.091)	(0.042)
Pre-unification GER	0.001***			
	(0.000)			
Pre-unification pupil-teacher ratio		0.001**		
		(0.000)		
Pre-unification supply of teachers			0.001**	
			(0.001)	
Index of land inequality				-0.018**
				(0.007)
Geography	yes	yes	yes	yes
Demography	yes	yes	yes	yes
Economic and social controls	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes
Macro-regions	yes	yes	yes	yes
Observations	250	250	260	345
Adjusted R-squared	0.983	0.982	0.982	0.982

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A constant is always included. All control variables included are latitude, longitude, average temperature, average rainfalls, population density, dependency ratio, infant mortality rate, height, share of labour force in agriculture, rate of outward migration, electoral franchise, parental literacy rate.

5. Measuring efficiency: Data Envelopment Analysis (DEA) and determinants

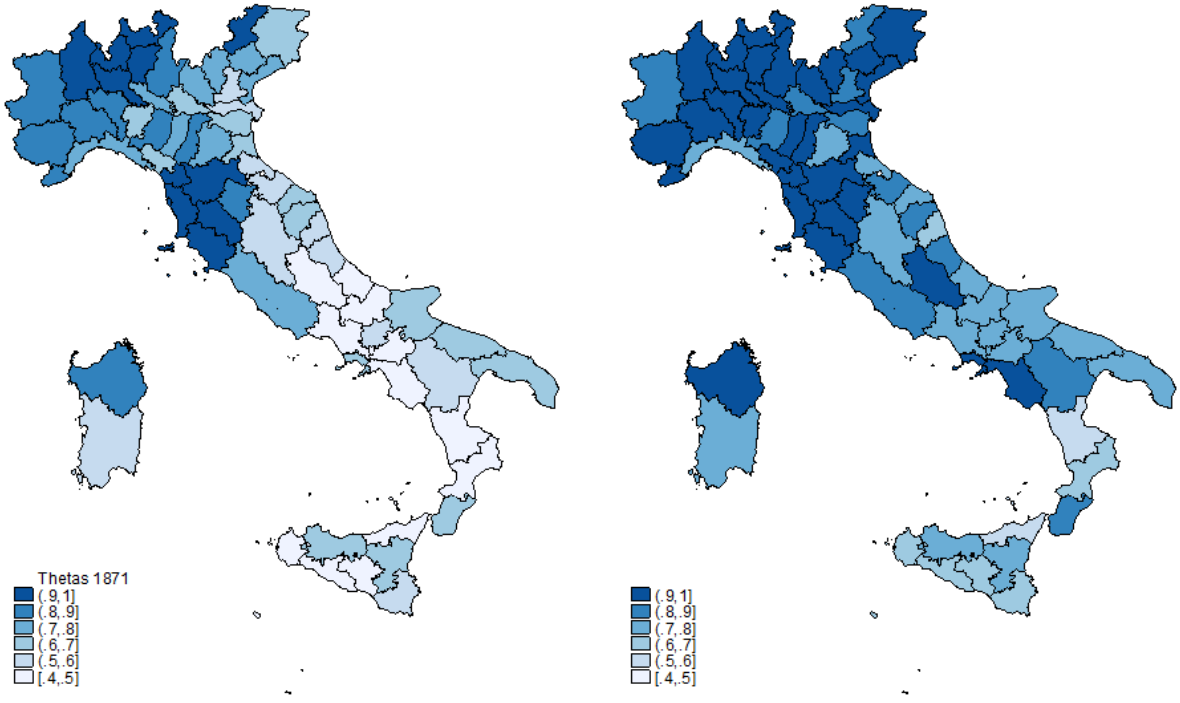
As often emphasized by studies in the field of education economics (Hanushek 1986), the relationship between resources and educational outcomes is not straightforward, since it depends on the efficiency of the education system. Therefore, although exploring the relationship between school inputs and educational outcomes in an EPF framework is crucial to understand the factors behind the diffusion of mass education, some of the variation across school outcomes remains unexplained by socio-economic and other environmental factors.

For this reason, exploring school efficiency – i.e. the degree of capability in transforming inputs into achievements – constitutes another piece of evidence that is worth considering.

To measure efficiency, we rely on Data Envelopment Analysis (DEA), which is a non-parametric linear programming technique elaborated by M. J. Farrell (1957) and then by A. Charnes et al. (1978). DEA captures the relative efficiency of a set of homogenous Decision-Making Units (in our case, provinces) and determines the efficiency in converting inputs into outputs. In a decentralized primary-education system like Italy's one in the late 19th century, it is reasonable to assume that the provinces are homogeneous DMUs.

DEA analysis assumes the existence of a convex production frontier. This frontier is basically constructed using linear programming methods, the term "envelopment" being used because the frontier envelops the set of observations. This methodology allows the calculation of technical efficiency measures that can be either input or output oriented.

Figure 6: School efficiency for youngsters (age group 15-19): DEA efficiency scores.



1871 1911

Notes: the outcome is literacy rates for the age group 15-19. The school inputs employed in the calculations are GER, pupil-teacher ratio, expenditures per pupil, and school density, all taken with a lag of 10 years. Source: see text. Efficiency is measured by the Thetas, i.e. efficiency scores, ranging from 0 to 1 (1 being efficient).The darker the shade, the higher the efficiency score.

Estimates of school efficiency are reported in Figure 6 in 1871 and 1911.[19] A value of 1 represents provinces on the estimated efficiency frontier, while sub-efficient units are within the 0-1 range.

We choose the output-oriented estimates because we are interested in how much literacy is likely to grow given the quantity of inputs observed[20] and assume Constant Returns to Scale (CRS). However, we check our results by alternatively assuming Variable Returns to Scale (VRS) as well and find that the ranking of the provinces in terms of school efficiency remains virtually the same: Figure A.1 in the Appendix visually explores the high correlation between our CRS and VRS estimates. We explain this result with the fact that, assuming a common S-shaped model for the diffusion of education in developing countries (Bloom 2006), most Italian provinces – the literacy rate of which ranged between 10 and 65 percent – were likely to be characterized by the same constant relationship between inputs and outputs, i.e. literacy changing by the same proportion as inputs into schooling grew over time. This was the case across Italy's provinces in the late 19th century because none of them had literacy rates close to zero or to 100 percent, hence the majority of them was not affected by increasing or decreasing returns to scale.

In Table 6, we present the main characteristics of the most efficient and least efficient provinces. In 1871, among the former, we find the provinces of Belluno in the Northeast, Como and Sondrio in the Northwest, Florence, Livorno, Lucca, and Grosseto in the Centre, all placed on the efficiency frontier (theta=1). They are followed by a group of provinces mostly located in the North of the country, i.e. Bergamo, Milan, and Novara. The average score of these provinces is 0.94, very close to the estimated efficiency frontier. The least efficient provinces are instead mostly located in the Centre and South of the country, mainly in the territories previously belonging to the pre-unification Kingdom of the Two Sicilies: Avellino, Benevento, Salerno (in Campania), Teramo, Chieti and Aquila (in the Abruzzi), as well as many others located in Calabria and Sicily. Some exceptions to this regional pattern are Padova, Pesaro Urbino, and Ascoli Piceno, which are located in the Centre-North. The average score among the least efficient provinces is 0.48. As far as other features of these two groups are concerned, one may notice that they differ in many more respects: the most efficient provinces feature higher population densities and outmigration rates, more rapid

[19] Provincial estimates for all benchmark years are not provided but available upon request.
[20] We apply the DEA command in Stata as elaborated by Yong-Bae Ji and Choonjoo Lee (2010).

industrialization, as well as more solid endowment of parental human capital and historical (pre-unification) literacy.

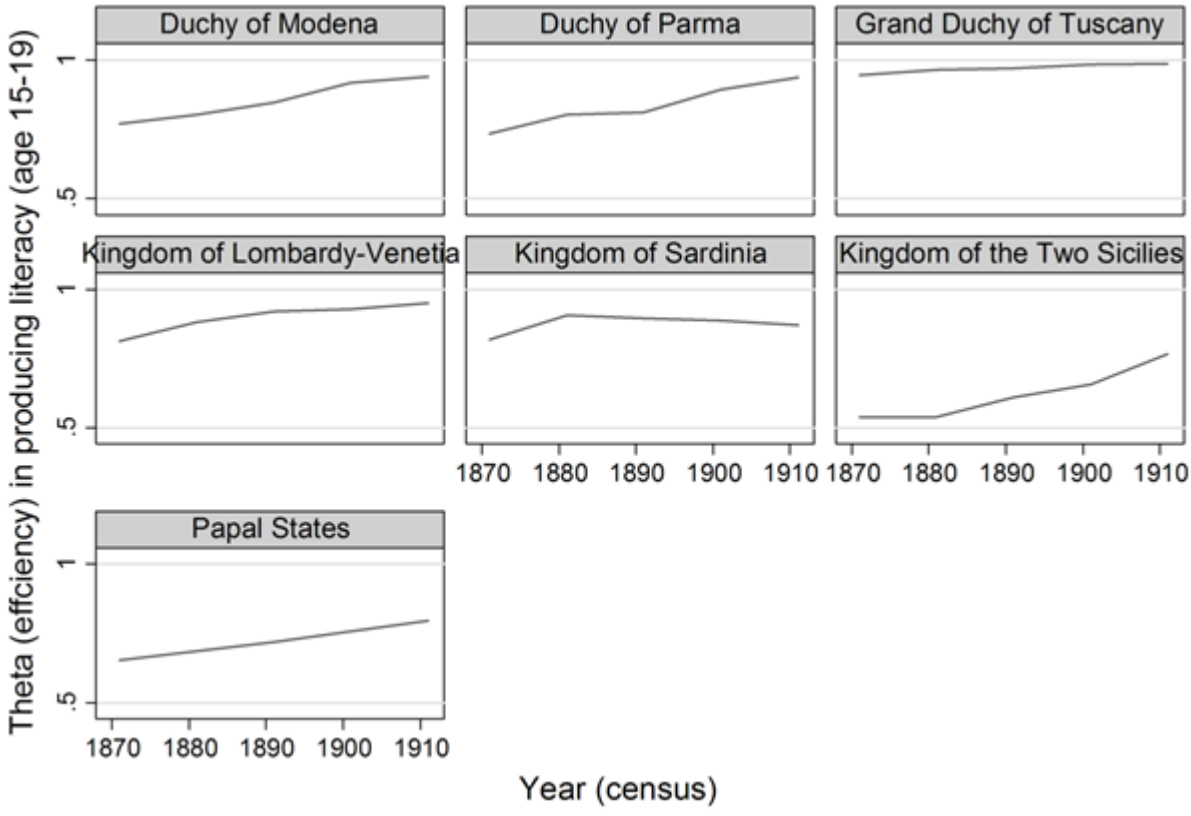
Table 6: Characteristics of the most and least efficient provinces in 1871 and 1911.

	n=17 (least efficient)				n=17 (most efficient)			
Variable	Mean	SD	Min	Max	Mean	SD	Min	Max
				1871				
Theta (efficiency) LR 15-19	**0.48**	**0.04**	**0.40**	**0.55**	**0.94**	**0.07**	**0.84**	**1.00**
Latitude	40.64	2.31	37.18	45.24	44.27	1.48	40.43	46.11
Longitude	13.98	1.26	11.53	16.35	9.61	1.37	7.33	12.13
Pop. density	93.3	32.99	56.22	186.53	127.9	99.26	21.85	366.42
Dependency ratio	0.08	0.01	0.07	0.09	0.09	0.01	0.08	0.1
Infant mortality rate	0.41	0.08	0.31	0.55	0.35	0.03	0.31	0.42
Height	161.26	1.41	159.6	165.7	163.49	1.41	159.8	165.3
Share of LF in agriculture	56.53	11.04	37.77	72.28	56.42	15.43	11.2	83.45
Rate of outward migration	2.02	2.08	0.06	6.6	10.1	15.04	0.19	64.69
Industrial VA per capita	39.46	10.77	25.95	62.16	57.24	19.75	27.26	91.14
Electoral franchise	0.13	0.03	0.09	0.19	0.26	0.1	0.14	0.4
Parental Literacy rate	24.93	7.99	15.67	42.76	62.62	13.61	31.7	82.55
Literacy rate 1831	0.17	0.05	0.11	0.32	0.38	0.12	0.12	0.55
				1911				
Theta (efficiency) LR 15-19	**0.68**	**0.06**	**0.56**	**0.75**	**1.00**	**0.00**	**0.99**	**1.00**
Latitude	39.89	2.41	37.04	44.3	44.05	1.59	40.21	46.11
Longitude	14.03	2.56	8.55	18.11	10.68	1.71	8.01	14.15
Pop. density	127.89	50.56	38.92	255.84	207.58	278.35	33.5	1228.29
Dependency ratio	0.08	0	0.08	0.09	0.08	0.01	0.07	0.1
Infant mortality rate	0.28	0.04	0.21	0.35	0.24	0.04	0.18	0.33
Height	163.36	1.67	160.6	167.3	166.15	1.41	163.5	168.2
Share of LF in agriculture	59.31	11.56	30.57	77.11	54.64	18.01	10.65	77.76
Rate of outward migration	18.9	8.14	3.98	29.43	18.39	12.98	3.59	48.62
Industrial VA per capita	84.22	43.97	48.03	234.79	126.16	60.34	47.27	271.03
Electoral franchise	0.34	0.09	0.22	0.48	0.5	0.17	0.27	0.78
Parental Literacy rate	58.95	14.3	46	92.93	86.57	10.67	68.04	98.61
Literacy rate 1831	0.17	0.06	0.1	0.35	0.33	0.11	0.18	0.55

Notes: Efficiency measured by the Thetas, i.e. efficiency scores (ranging from 0 to 1; 1 being efficient).

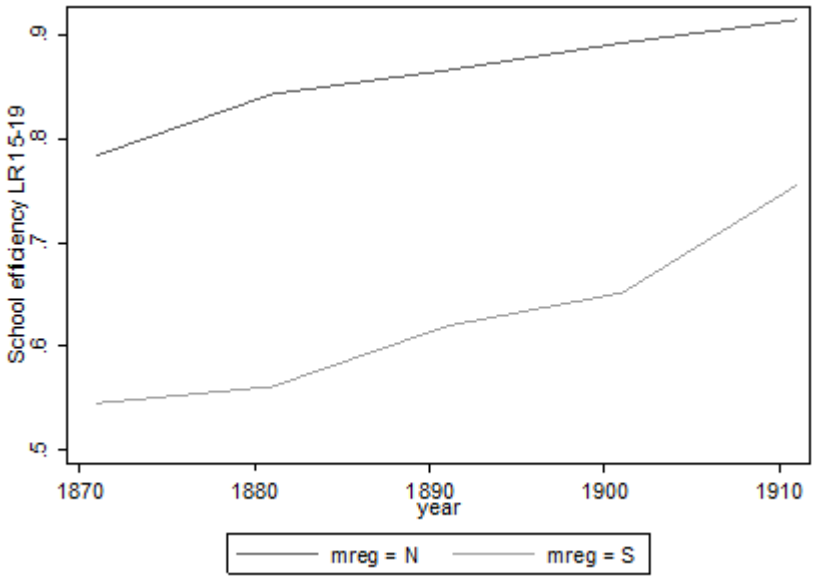
The DEA estimates suggest that the North was clearly ahead of other regions within the country in 1871, yet the advantage did tend to fade out in the long run. It is worth noting that, as Figures 8 and 9 also show, more rapid convergence did not occur until the first decade of the 20th century. This means that early (weak) education reforms that amended formal rules but did not affect the management and the level of school autonomy in the system – like the Coppino Law of 1877 – had little impact on Italy's education. Instead, convergence in efficiency accelerated remarkably when the state stepped in into matters related to primary schooling, in the early-20th century (it did so quite mildly during the first decade of the 20th century, and more decidedly with the Daneo-Credaro Reform of 1911). The pattern of persistence that we find may be linked to the long shadow that pre-unification school systems cast on post-unification Italy. We put forward the hypothesis that the North of the country – where public compulsory schooling had been established well before 1861 – had a cognitive and organizational advantage in the development of education under a decentralized primary-school system, whereas the South – where public schooling had long been absent before unification – experienced a deficit in that sense.

Figure 8: Unweighted average of DEA efficiency for ancient pre-unitarian states and polities.



Source: see text

Figure 9 – Unweighted average of DEA efficiency for the North and the South of Italy,



Note: mreg = N is the efficiency trend of the North, while mreg = S represents that of the South. Source: see text.

After measuring efficiency for each province through to the DEA methodology, we now explore the determinants of school efficiency through a methodology devised by Simar and Wilson (2007),[21] which connects the environmental (non-discretionary) variables to the DEA scores to give further insights into the drivers of school efficiency in Liberal Italy.[22] Again, we include early-19th-century literacy rates from pre-unification. We also include all variables taken into account in the most complete specification when estimating the EPFs, i.e. geography (latitude, longitude, temperature, and rainfall), demography (population density, the proxy for the child-dependency ratio, and the infant mortality rate), and socio-economic controls (height, industrial VA per capita, the share of LF in agriculture, the outward migration rate, and parental literacy). Since efficiency can be thought of as a residual measure with respect to these features – as the EPFs previously estimated suggest –, we do not expect to find a strong correlation between them and school efficiency.

[21] Simar and Wilson (2007) estimate the role of non-discretionary inputs on efficiency scores using a truncated regression with bootstrapped robust standard errors.
[22] Antonio Afonso and Miguel Aubyn (2006) apply the same approach for the measurement of efficiency in contemporary secondary education across Europe. We are not aware of any study that employs this technique in historical perspective.

Table 7 shows that school efficiency was systematically affected by historical legacies before 1901, but with a declining intensity over time. Instead, the correlation between post-school efficiency and parental literacy is significant up to 1901, i.e. right before the primary-school system was first changed by state intervention, not only with more funding but also with a stronger protection of the rights of the teachers – a first institutional reform (the Nasi Law) that somehow paved the way for increased centralization starting in 1911. The more persistent effect of parental human capital may be due to the fact that this variable pertains to people who had already completed some schooling, thus being not directly affected by the changes in the education system itself.

Table 7: Determinants of school efficiency, 1871 – 1911, age group 15-19.

	(1)	(2)	(3)	(4)	(5)
Dependent variable: efficiency (Thetas)	Efficiency in producing literacy (age group 15-19)				
	1871	1881	1891	1901	1911
Height	-0.007	0.0008	-0.0037	-0.0072	-0.009
	(0.017)	(0.016)	(0.012)	(0.010)	(0.019)
Share of LF in agriculture	-0.001	-0.0003	-0.0005	-0.0004	-0.003
	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)
Rate of outward migration	-0.001	0.008***	0.0014	-0.0015	-0.004*
	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)
Industrial VA per capita	-0.001	-0.001	-0.001	-0.002**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Electoral franchise	-0.445	-0.4918	0.0381	0.0387	0.03
	(0.474)	(0.398)	(0.203)	(0.198)	(0.213)
Parental literacy rate	0.006**	0.006**	0.004**	0.005***	0.0004
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Literacy rate 1831	0.689**	0.636**	0.472**	0.138	-0.015
	(0.326)	(0.289)	(0.189)	(0.215)	(0.309)
Geography	yes	yes	yes	yes	yes
Demography	yes	yes	yes	yes	yes
Sigma	0.089***	0.083***	0.061***	0.061***	0.086***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.010)
Observations	69	69	69	69	69

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Geographic controls include latitude, longitude, average temperature, average rainfalls. Demographic controls include population density, dependency ratio, infant mortality rate.

6. Conclusions

Italy represents an ideal case study of the relationship between historical institutions and reforms in the long run. Thanks to a new dataset, we explore to what extent school inputs mattered for the growth of literacy – controlling for demand-side and other environmental factors. First, we find that school was worth getting, as more expenditure per pupil, a higher enrolment rate and school density are generally correlated with higher human capital. This means that, under Italy's decentralized education system, local school inputs and resource endowments strongly affected outcomes, pointing out the persistence of regional disparities stemming from pre-unification states. Indeed, we also show that this pattern is partly due to historical legacies, because literacy correlates significantly with pre-unification measures of schooling attainment and literacy. Despite much debate on the issue, this is the first evidence that explicitly relates local conditions and inputs into schooling to the spread of literacy at the local level, and our findings back up claims that the decentralized schooling system set forth by the Casati Law in 1859 did not fit well much of the regions in the new Kingdom of Italy due to limited fiscal capacity and electoral franchise and, as a consequence, limited school inputs (Vasta 1999; Felice and Vasta 2015; Cappelli 2017a).

Since some of the variation in literacy rates across regions of the country is not explained by the variables considered in the EPF framework (even when including macro-regional dummies and pre-unification education), we estimate school efficiency at the provincial level by using Data Envelopment Analysis. The estimated school-efficiency scores show that regional efficiency-related disparities were large, and that they did not decline up to the eve of the 20th century. This is an important result, as one may put forward that early education reforms that tried to make the education system more effective failed, insofar as they did not affect the decentralized management of schooling – providing only subsidies with no change in the institutions regulating schooling at the central and local level up to the first decade of the 20th century (De Fort 1996).

We argue that school efficiency, too, was largely a historical legacy of pre-unification states. The strong, positive correlation between early-19th century literacy and human capital five to eight decades later confirms that large pre-unification regional inequality cast a long shadow. Only when the state started to limit the choices of the municipalities and their school autonomy, for example by limiting their discretionary power concerning hiring and layoff of teachers and by transferring some of the administrative responsibility to the central

authorities, did the regions of Italy start to converge in terms of school efficiency; the fact that the correlation between local school inputs and literacy becomes weaker in the first decade of the 20th century is suggestive of such a change.

Our results related to the broader literature on institutional persistence, change and economic development broadly defined. As shown by other studies, human capital accumulation is a long-term process prone to historical legacies (Chaudhary and Garg 2015; Bertocchi and Bozzano 2016); yet, public choices and changes – whether exogenous or driven by policy – can affect a country's development path (Cogneau and Moradi 2014). This study shows that important institutional features, like the decentralized nature of the education system, together with specific school reforms, can have important implications for long-term human capital accumulation and, in turn, for economic performance.

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8. Appendix

A.1 Variable definitions and Sources		
Variable	Description	Main source
Literacy Rate 15-19	Youngsters aged 15-19 able to read (at least) over total youngsters of the same age.	National censuses
Gross enrolment rate (GER)	Pupils enrolled in primary school/population of primary school age (6–10)	Inquiries on primary education and national censuses
Pupil-Teacher ratio	Number of children (males and females) in primary school age divided by the total number of primary school teachers.	Inquiries on primary education and national censuses
Educational expenditure per pupil	Total municipal expenditure on education per pupil enrolled. Total expenditure includes teachers' salaries, maintenance, the construction of new buildings and other, minor items. Figure are in Lire, at current prices.	Municipalities' balance sheets (*Bilanci Comunali*)
School density	Number of municipal schools per squared km	Inquiries on primary education
Latitude	Latitude of the main city of the province in decimal degrees	Passim
Longitude	Longitude of the main city of the province in decimal degrees.	Passim
Temperature	Provincial averages obtained from yearly data concerning the period 2000-2009, in Celsius degrees.	Passim
Rainfalls	Provincial averages obtained from yearly data concerning the period 2000-2009, in mm.	
Population density	Number of residents divided by the territory of each province (squared kilometres).	National censuses
Child-dependency ratio	Children in primary school age (6–10) divided by the total number of residents.	National censuses
Infant mortality rate	the number of dead children aged 0-5 over the total number of live births in the same year. Data for 1891 refer to 1890. Data for 1901 and 1911 are estimated by interpolation with data on 1921 from regional figures.	National censuses and annual issues of vital statistics, *Movimento della popolazione*
Height	Average height at age 20 of military conscripts	A'Hearn and Vecchi (2017b)

Share of labour force in agriculture	Number of people employed in agriculture divided by total labour force.	Missiaia (2014)
Rate of outward migration	Emigrants as a share of total residents	Yearbook on Italian Migration, *Annuario della emigrazione italiana dal 1876 al 1925*, and Carpi (1874)
Industrial VA per capita	Industrial value added (constant prices 1911)/total population (residents)	Our elaboration on Ciccarelli and Fenoaltea (2013)
Electoral franchise	Ratio between the total number of local electors and total males older than 21. Local electors are those entitled to vote in provincial and municipal elections	Cappelli (2016)
Parental literacy rate	percentage of spouses who were able to sign wedding acts (smoothed on three years and centred at the years of the censuses to avoid potential short-run measurement distortions)	Marriage registries reported in vital statistics
Literacy rate 1831	Literacy rate of adult aged 30-40 in 1831	Ciccarelli and Weisdorf (2018)
Pre-unitary schooling measures	GER, pupil-teacher ratio, and supply of teachers (number of teachers over total population)	Vigo (1971); Genovesi (1998)
Index of Land Inequality	The share of large landowners on the total number of landowners.	Cappelli (2017b)

Further methodological notes

Rate of outward migration: Emigration rates are smoothed by considering a ten-year average centred on the year concerned. For example, for 1911, we relied on an average pertaining to 1906-1915. For 1871, we relied on the period 1869-1873, as pre-1876 data are only available for those years. Data are from Carpi (1874).

Pre-unification schooling variables: the GER, the pupil-to-teacher ratio, and the supply of teachers (here as the number of teachers over total population) are available at the province level but for a reduced number of provinces, because of missing observations. Data are mainly taken from Vigo (1971) and relate to various years over the pre-unification period ranging from 1824 to 1858. More specifically: 1850 for the Kingdom of Sardinia, 1830 for Lombardy, 1824 for Venetia, 1841 for the Granduchy of Tuscany, 1835-36 for the Continental Kingdom of Two Sicilies, 1858 for the Papal States, 1835 for the Duchy of Lucca and 1833 for the Duchy of Parma. For the variable supply of teachers, we calculate the values referring to Lucca and Parma from Genovesi (1998).

A.2 Descriptive statistics (full).

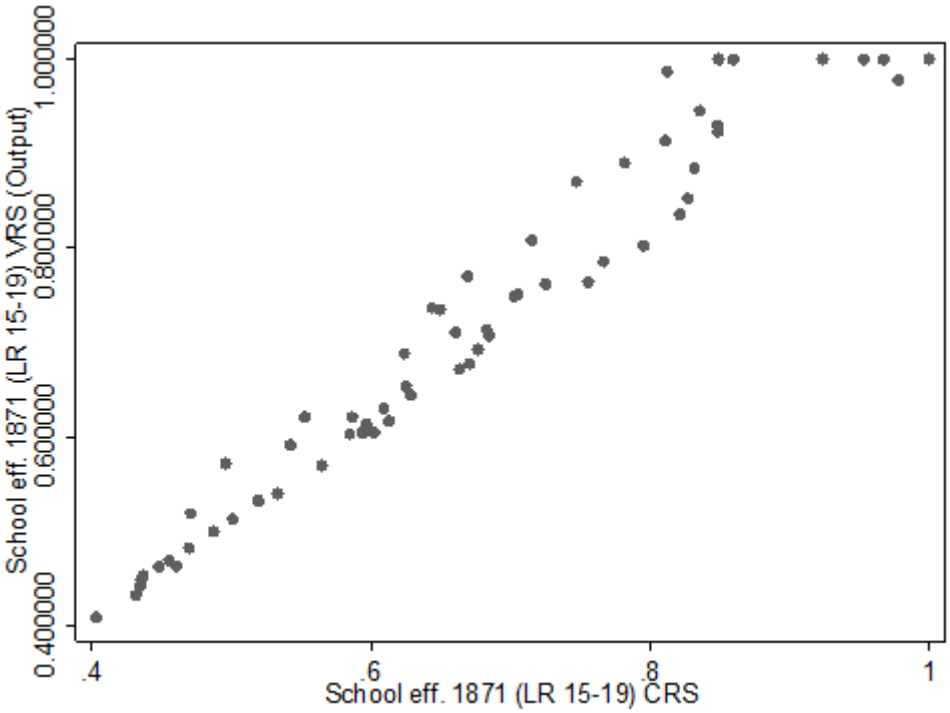
Table A1-a: Descriptive Statistics, 1871-1911

	1871		1881		1891		1901		1911	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Literacy Rate 6-10	0.183	0.109	0.292	0.162	0.399	0.189	0.507	0.218	0.565	0.168
Literacy Rate 15-19	0.343	0.195	0.428	0.222	0.514	0.224	0.601	0.231	0.719	0.202
GER 6-10	0.626	0.360	0.810	0.348	0.840	0.313	0.934	0.288	1.087	0.254
Pupil-teacher ratio	41.710	9.436	44.308	9.834	45.068	9.090	47.841	7.955	51.591	8.126
Expenditure per pupil	18.333	6.977	30.019	11.238	32.446	10.038	38.555	13.379	44.986	22.086
Municipal schools (sq. Km)	0.141	0.103	0.177	0.131	0.2013	0.1526	0.238	0.189	0.282	0.237
Population Density	118.406	107.11	126.666	115.674	134.88	124.348	143.089	133.260	157.076	154.35
Dependency ratio	0.085	0.006	0.081	0.005	0.083	0.005	0.087	0.006	0.083	0.007
Infant mortality rate	0.391	0.065	0.332	0.055	0.341	0.057	0.271	0.049	0.253	0.046
Height	162.782	1.817	163.406	1.867	163.67	1.899	163.980	1.998	165.040	2.026
Share of LF in agriculture	54.916	12.627	53.295	12.729	57.87	12.462	62.444	13.322	58.452	13.350
Rate of outward migration	5.243	9.664	4.379	7.660	8.19	12.2150	14.114	14.430	17.909	10.706
Industrial VA p.c.	48.880	15.570	55.725	19.277	64.966	26.138	74.208	33.565	103.268	51.491
Electoral franchise	0.178	0.084	0.205	0.085	0.293	0.117	0.367	0.133	0.433	0.140
Parental literacy rate	40.949	18.413	52.832	19.275	58.836	19.820	67.108	18.963	75.564	16.859

Table A1-b: Time-invariant variables

	N	Mean	St.Dev.
Literacy rate 1831	69	0.262	0.115
Pre-unification GER	50	25.1	19.219
Pre-unification pupil-teacher ratio	50	29.329	12.656
Pre-unification supply of teachers	52	10.485	6.366
Latitude	69	42.692	2.622
Longitude	69	11.971	2.471
Av Temperature	69	13.7	2.502
Av Rainfalls	69	774.652	109.24
Index of land inequality	69	0.348	0.308

Figure A.1: CRS (X axis) versus VRS (y axis) efficiency scores,1871



Source: see text