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pre-unification school systems into  
Italy's Liberal Age (1861-1911)**

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## Abstract

This paper contributes to the literature on the determinants of the expansion of mass schooling and the long-term legacy of educational institutions. Based on a new provincial-level dataset for Italy in the period 1861-1911, we argue that different models of schooling provision adopted by the different pre-unification polities influenced primary-education organization across macro-regions up to WWI. As a result, school access and the capability to generate literacy given current rates of enrolment differed substantially, with the Northern regions aiming to increase schooling for all, while the Centre and the South implemented a more elitist model.

JEL Classification: E02, H75, I25, N33

Keywords: Mass schooling, Education, Literacy, economic history, Italy, legacy, institutions

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*“[...] the improvement and advances made so far concerning [public] schools, more than moral, are material; they satisfy the eye of the inexperienced visitor more than they provide effectively for the intellectual development of the pupils. [...]”*

From a Letter of the Ministry of Public Education (Emilio Broglio) to the Prefect and President of the Provincial School Board of Abruzzo Ulteriore II (Aquila). Florence, February 18<sup>th</sup>, 1868, as reported in the *Documenti sulla istruzione elementare nel Regno d'Italia* (Firenze: 1868), first part, p. 33 (our translation).

## **1. Introduction**

Human capital has been a crucial determinant of economic performance, at least since the mid-19<sup>th</sup> century (Allen 2011; Galor 2011; Goldin 2016).<sup>1</sup> The long-term growth of human skills has gone hand in hand with the rise of public schooling and mass education since the 1850s; yet, whether human capital improved throughout the 19<sup>th</sup> century as a result of milestone school acts fostering public education (Gomes and Machado 2020; Milner 2020; Montalbo 2021) or as a result of favourable economic and demographic trends (Cvrcek 2020), is still contended. Similarly, whether national school acts in the 19<sup>th</sup> century brought about more equity in access to education or simply reinforced existing social and spatial inequality in literacy and schooling keeps being a debated issue (Beltrán Tapia and Martínez-Galarraga 2018; Cappelli and Vasta 2020; 2021). The last decade has witnessed a growing stream of literature on the determinants of educational levels in the past. Contributions have focused on institutions (Palma and Reis 2021), religion (Squicciarini 2020), economic activity (Diebolt, Chapelain, and Menard 2019; Montalbo 2020), demography (Becker, Cinnirella, and Woessmann 2010), and the political economy of schooling (Cinnirella and Hornung 2016; Cvrcek and Zajicek 2019).

This line of research has gained momentum within the recent historiography on the economic development of Italy and its regional divide in the Liberal Age (1861 – 1911). Brian A'Hearn and Giovanni Vecchi (2017a) have argued that landownership concentration hampered investments in primary schooling across the regions of Italy,

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<sup>1</sup> It is worth noticing as Allen (2011) considers the implementation of a “mass education” system as one of the four pillars of his “standard model” of industrialization adopted by Western countries since mid-19<sup>th</sup> century.

while Emanuele Felice and Michelangelo Vasta (2015) have highlighted that slow human capital accumulation was mainly due to the country's decentralized education system, which limited expenditure for schooling in the poorest regions. Altogether, there has been a substantial effort to reconstruct new data on the evolution of mass schooling and literacy (Cappelli 2016) and educational gender inequality (Bertocchi and Bozzano 2016) in the Liberal Age.

The quantitative evidence on the evolution of schooling and human capital in the first half of the 19<sup>th</sup> century, the decade that preceded the unification of Italy, is even more limited, with the recent exception of the work by Carlo Ciccarelli and Jacob Weisdorf (2019). The authors estimate adult literacy from 1821 to 1911, showing that the human capital of men was relatively high in the North of Italy by the time of the country's unification, probably pushed by skill premia, early public-education reforms and the role played by military schools. Average male adult literacy stood at about 60 percent in the North-West, c. 40 percent in the Centre and North-East, and as low as c. 25 percent in the South – while female literacy was much lower everywhere. Importantly, males kept on achieving literacy into their 30s, while women seem to have achieved literacy in their 20s (Ciccarelli and Weisdorf 2019, 12).

The article by Ciccarelli and Weisdorf constitutes an important first attempt to explore the role played by pre-unification conditions in the development of Italy's regions in the Liberal Age. This is an under researched issue in quantitative Italian economic history: although this is acknowledged as a crucial aspect, the legacy of pre-unification states on Italian economic development has been explored by few pioneering contributions concerning state capacity (Dincecco, Federico, and Vindigni 2011), trade (Federico and Tena-Junguito 2014), and innovation (Nuvolari and Vasta 2019). Within this literature, a new contribution by Michele Postigliola and Mauro Rota focuses on human capital, arguing that Napoleonic educational reforms between 1801 and 1815 represented an important positive shock for Italy's pre-unification school systems (Postigliola and Rota 2021). According to their estimates, a longer political control by the French is associated with higher literacy at the time of unification. To explain this result, Postigliola and Rota argue that education reforms played a role, but other institutional changes brought about important modifications to individual and "collective preferences" concerning education. As the authors write, several reforms

introduced stronger incentives for households to acquire education. On the demand side, the dismantling of feudalism and increased access to land implied new incentives to be literate. Similarly, the reforms went hand in hand with growing bureaucracy and thus employment opportunities that required literacy. All of this, combined with specific educational reforms that increased school inputs, determined a new equilibrium in the market for education in the Northern regions of Italy.

Despite these recent contributions, some important gaps remain. Although their dataset is highly innovative and relevant, Ciccarelli and Weisdorf do not explicitly investigate the relationship among the provision of mass education, contextual factors and literacy. This is particularly important for women, since they acquired literacy mostly before their 20, and female literacy followed very different trends across areas of Italy following the unification of the country (Ciccarelli and Weisdorf 2019, 24 – 25). At the same time, Postigliola and Rota have studied human capital accumulation by focusing on literacy but not inputs into schooling, as their work explores a counterfactual Italy at the time of unification based on the influence of French institutions. According to their estimates, literacy rates in the South would have been up to 70 percent higher in 1861 if they had experienced the same duration of French dominance as the North. However, the authors only speculate as to how the French legacy affected educational developments during the decades following the unification of the country.

In this paper, we contribute to this literature by focusing on Italy in the long 19<sup>th</sup> century, exploring how pre-unification conditions (c. 1831) affected primary education and literacy in the 50 years that followed the birth of the Kingdom of Italy (1861-1911). To this aim, we build a new comprehensive panel dataset of primary-school and literacy variables for Italy's 69 provinces (1861-1911), including several controls concerning demographic, economic, political, and other aspects. First, we rely on Education Production Functions (EPFs) to analyse what factors contributed to increasing enrolment rates in primary education and improving school efficacy in transforming enrolments into basic human capital – by measuring the enrolment-literacy gap (GER-LIT Gap) for the same cohort of pupils. Second, we test whether (and if so, why) educational across unified Italy are linked to literacy in pre-unification states (pre-1861).

Our results show the existence of two distinct models of public-school investments and organization of educational institutions, in the framework of growing school expenditure during Italy's Liberal Age:<sup>2</sup> the average number of pupils per teacher was larger in the North of the country compared to the South, while the average expenditure per pupil was lower in the former. This means that, under decentralized primary schooling, provinces in the North-West and North-East aimed at expanding education for all, while local authorities in the South and the Centre followed a more elitist educational model.

According to our panel estimates, increasing class size by 1 standard deviation (9.3 pupils per teacher) is associated with an increase in the Gross Enrolment Rate (GER) equal, on average, to 14 percentage points. When school efficacy is concerned, we find that reducing class size by one standard deviation was associated with a reduction in the GER-LIT Gap equal to 6.7 percentage points. Improving expenditure per pupil, once enrolments are factored in, would also reduce the GER-LIT Gap: an increase equal to a standard deviation (c. 13 Lire per pupil) would reduce the gap by 2.5 percentage points. These coefficients are large, given that the standard deviations of the GER and the GER-LIT Gap are, respectively, 37.7 and 17.7 percentage points – thus school inputs explain a substantial share of the variation in enrolment rates and school efficacy, even when controlling for a wide range of contextual variables.

Furthermore, our results show that pre-unification conditions cast a long shadow on the enrolment rates and school efficacy across the regions of the new Kingdom of Italy. The provinces that were literate in the early 19<sup>th</sup> century were the ones that improved education for all ahead of other areas following unification: increasing 1831 literacy by one standard deviation (11.4 percentage points) was associated with additional 10.8 percentage points in the GER. This effect remained strong until 1901, while it faded out in the first decade of the 20<sup>th</sup> century, possibly due to growing state intervention offsetting regional inequality. The growth of the GER initially compromised school efficacy, with the latter improving substantially starting in the 1890s.

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<sup>2</sup> Total expenditure for education grew from c. 270,000 Lire (8.6 Lire per school-age child) in 1861 to c. 930,000 Lire (21.5 Lire per school-age child) in 1901. In 1911, due to substantial state intervention, expenditure reached c. 1,774,000 Lire (38.5 per school-age child).

The paper is organized as follows: in Section 2 we briefly describe the evolution of primary education, while Section 3 presents detailed information of data and sources, and Section 4 illustrates our empirical strategy. The following two sections present our main results: Section 5 deals with the determinants of human capital accumulation and discusses its efficacy, while Section 6 explores the long shadow of pre-unitary institutions on the school system of the Kingdom of Italy. Section 7 concludes.

## **2. Pre-unification schooling and Italy's primary-education system (1861 – 1911)**

At the time Italy was unified in 1861, none of the pre-unification polities had yet fully embarked on sustained industrialization and economic growth: a substantial share of its labor force was employed in agriculture, very limited railway and road infrastructure had been built, extensive poverty and land inequality characterized large areas (Fenoaltea 2011; Toniolo 2013; Felice 2015). Despite its limited economic development, the country was already characterized by regional economic inequality. Little regional disparities could be discerned in 1871 concerning GDP per capita, yet a large divide was already evident in many dimensions, such as natural endowment (A'Hearn and Venables 2013), market potential and literacy (Basile and Ciccarelli 2018), infrastructures (Ciccarelli and Groote 2017), inventive activity (Nuvolari and Vasta 2017), and real wages (Federico, Nuvolari, and Vasta 2019).

Likewise, the pace and timing of educational development largely varied across territories, e.g., concerning literacy rates (A'Hearn and Vecchi 2017) and the gender gap in primary schooling (Bertocchi and Bozzano 2016), by and large favoring the North over the South.

Figure 1 shows enrolment rates and adult literacy rates during pre-unification years (the left-hand-side figure shows the names of pre-unification states).<sup>3</sup> Large regional inequality was evident at the beginning of the 19<sup>th</sup> century and, as we will see, remained a central feature of Italy's literacy and schooling. While the former Kingdoms of Sardinia and of Lombardy-Venetia – with Lombardy ahead – exhibited enrolment and literacy rates not distant from those characterizing central-European countries (e.g. Prussia), the Center and the South lagged behind.

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<sup>3</sup> Literacy rates from Ciccarelli and Weisdorf (2019) refer to 1831. The authors provide 1821 estimates, but they are based on a much smaller sample compared to 1831 and later years. Enrolment rates for the pre-unification years refer to the period between 1821 and 1850, depending on the area concerned.



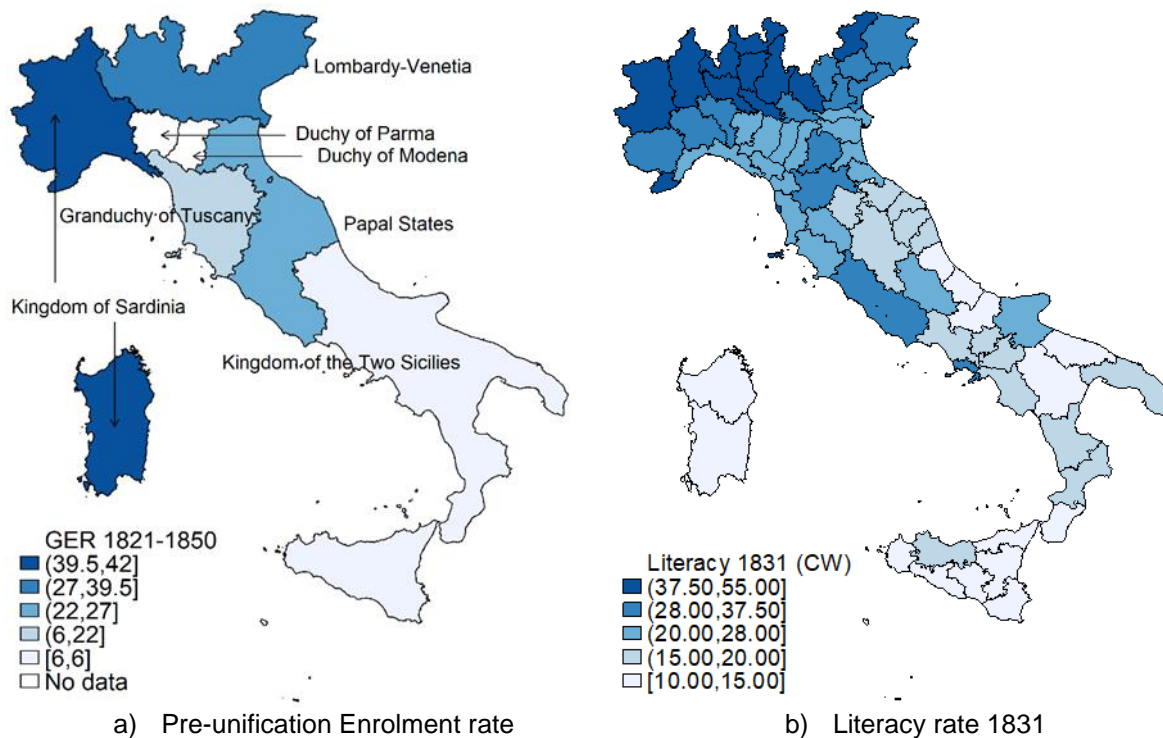
Indeed, Italy's different pre-unification states pursued varying public-education policies. Most reforms initiated in the 18<sup>th</sup> century marginally addressed primary education, focusing on universities and secondary schooling instead. However, by Italy's unification in 1861, the Kingdom of Sardinia had already established a primary school system heavily based on centralized norms and public funding by the municipalities (Ricuperati 2015). Since the mid-18<sup>th</sup> century, the Kingdom of the Two Sicilies had also sought to reform education in the context of the Enlightenment (Felice 2013): in the second half of the century, a new tax was imposed on monasteries' income to fund public schools; further attempts at reforming the school system were carried out in the early 19<sup>th</sup> century, but the chronic unavailability of primary-school teachers forced the authorities to keep relying on religious orders. In 1810, primary education was made compulsory, yet school fees kept being charged. Albeit slowly, primary education grew to some extent between 1760 and 1815; yet, with the restoration of the absolutist regime of the Bourbons, and the threats to their rule coming from liberal ideas that might have been spread by mass education, primary schooling was permanently relegated to the control of the clergy and private initiatives (Genovesi 1998). In the rest of the peninsula, the Duchies of Modena and Parma, the Granduchy of Tuscany and the Papal States had begun a process of reform to introduce public primary schooling to varying degrees (Ricuperati 2015).

Concerning schooling – and literacy – the Kingdom of Lombardy-Venetia was split: even though the two regions of Lombardy and Venetia were part of the same kingdom from 1815 to 1859, Lombardy had forged ahead of the rest of Italy and caught up with Piedmont, constituting a high-literacy cluster in North-Western Italy. First, this happened as a result of enlightened school reforms introduced in the Duchy of Milan under Austrian rule (1714 – 1797). Even though primary schools were initially organized and managed through private initiatives charging tuition fees, the latter were abolished with the introduction of cost-free public education in 1791 (Genovesi 1998). Secondly, Lombardy's initial educational development was reinforced by the Napoleonic occupation of the Duchy of Milan and a few provinces further East – which was called the Cisalpine Republic (1797 – 1815). Male and female public schools were opened in every district of the Republic (Genovesi 1998, 29). Such trends were not reversed by the restoration of Austrian rule and the foundation of the Kingdom of Lombardy-Venetia in 1815: primary education was compulsory for children aged between 6 and 12 years, even though each municipal school was under the

supervision of the local priest. Despite this development, the region of Venetia had long relied on religious education and, following the annexation to the Kingdom of Italy in 1866, the problem of agrarian elites hampering investments in public schools slowed the development of mass education into the Liberal Age – at least initially.

The effort to harmonize Italy’s education system took place since the very beginning of the unification process (which started during the 1860s and was completed by 1871), when the Kingdom of Italy implemented its first national school act.<sup>4</sup> Figure 2 displays youngsters’ literacy rates in 1871 and 1911 obtained from population censuses.<sup>5</sup> The regional pattern of literacy rates strongly echoes the spatial distribution of early schooling and human capital in the pre-unification states shown in Figure 1.

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



Notes: Literacy rates in 1831 refer to adult population aged 30-40. Sources: data on enrolment rates are taken from Giovanni Vigo (1971). Literacy rates in 1831 are taken from Ciccarelli and Weisdorf (2019).

<sup>4</sup> 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.

<sup>5</sup> Adult literacy rates (15+) are slightly different in levels, but show the same variation across provinces.

A clear picture of the state of the education system in recently-unified Italy was depicted by Gerolamo Buonazia (1868):

*“The conditions of popular education in the different provinces of the Kingdom are characterized by different ways and outcomes of teaching, as well as school traditions conforming to the degree of culture and industriousness of each [pre-unitarian] country; [...] new methods live side by side with old ones, like secular and religious institutes. There are many ancient and recent reasons explaining this battling of disordered forces, and the waiting for an ordering power that can alleviate the discordant claims, bringing harmony and making them cooperate in for the same purpose.”<sup>6</sup>*

The first comprehensive set of norms were contained in the Casati Law, passed by the Kingdom of Sardinia in 1859 and later extended to the newly annexed areas of the unified country. As far as primary education was concerned, the central government set all the formal norms regulating the primary schools. The Law stated that primary education 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 enforcing attendance was a responsibility born by the municipalities.<sup>7</sup> No redistributive mechanism was set up to correct the large regional inequality concerning fiscal capacity and educational investments. This issue was addressed through the Coppino Reform (1877), which introduced (weak) sanctions for missing enrolment and brought compulsory education to three years (up from two), introducing very limited subsidies – which had to be demanded by each municipality. This set of norms had little effect on human capital accumulation. Due to this, state intervention became more substantial at the turn of the 20<sup>th</sup> century, when the Nasi (1903) and Orlando (1904) Laws improved the salaries of primary-school teachers and strengthened their legal position vis-à-vis the city councils – which up to that point could discretionarily

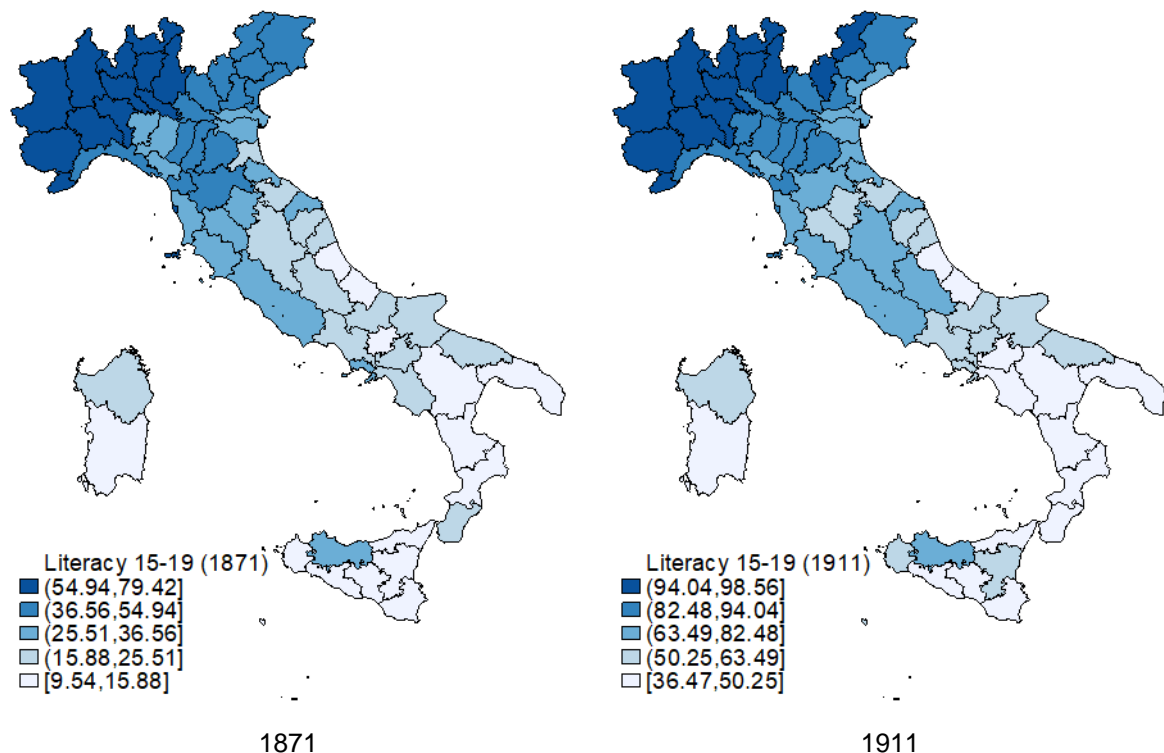
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<sup>6</sup> Quotation translated by the authors. Many state inquiries into the conditions of primary schooling were conducted during the Liberal Age, since national education was a priority of Italy's governments (*Ministero della Pubblica Istruzione 1872*).

<sup>7</sup> 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 concerning funding and management, although the norms and curricula were set forth by the central administration.

lay-off them. The actual step towards centralization was taken in 1911, through the Daneo-Credaro Reform: with it, the state fully funded current expenditure on primary education, supported investments for school buildings, and managed directly the organisation of primary schooling through provincial school boards. Recent research shows that this Reform brought about a positive increase in the pace of human capital accumulation, as measured by municipal-level literacy rates (Cappelli and Vasta 2020).

Figure 2: Literacy rates (age 15-19) in 1871 and 1911



Notes: Literacy rates (age 15-19) in 1871 and 1911 refer to population aged 15-19. Sources: census data.

### 3. Data and sources

To study how school inputs contributed to literacy in Liberal Italy, and how this relationship was linked to pre-unification conditions, we must first measure inputs into schooling and educational outcomes. Although collecting provincial data for the period that we study is normally very challenging, Italy's historical statistics provide detailed figures on schooling and literacy – as well as other contextual variables. We built a new panel dataset on literacy rates and school inputs at the provincial level (roughly today's NUTS-3) and at ten-year intervals between 1861 and 1911 (mostly

corresponding to census years). A detailed description of each variable in our dataset, as well as the related sources consulted to elaborate it, is included in the Data Appendix (Table DA1). We briefly discuss the dataset below. We start from the main education and schooling indices, then describe the geographic, demographic, and socio-economic controls, concluding with the presentation of the early-19<sup>th</sup>-century variables that we use to explore the legacy of pre-unification states on human capital accumulation in Liberal Italy.

### *Education and schooling variables*

We rely on the literacy rate of youngsters (aged 15 to 19)<sup>8</sup> and enrolment figures in primary schooling (aged 5 to 9) to obtain our outcome variables: the first dependent variable is the Gross Enrolment Rate (GER), defined as the number of pupils enrolled in primary schooling (regardless of age) as a share of the population of primary-school age. Although the GER is mostly considered an input into schooling within educational studies, we remain agnostic on this aspect and carry out a two-step analysis. First, we investigate what factors were associated with higher GERs across Italy's provinces to assess what factors were associated with the (quantitative) expansion of mass schooling. It is important to note that GER figures are not likely to be biased over time. The cross-province distribution of enrolment rates that we calculate is very consistent over the period that we study (1861-1911).

The second dependent variable is defined as "school efficacy" and is the percentage-point gap between enrolment and literacy rates for the same cohort. Literacy rates are calculated based on the population censuses, separately for boys and girls.<sup>9</sup> To obtain "school efficacy" in every benchmark year we subtract the literacy rate 15 – 19 from the first lag of the Gross Enrolment Rate (GER). For example, for 1881, we subtract the literacy rate of those aged 15 -19 from the GER of those aged 5 – 9 in 1871, thus

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<sup>8</sup> We focus on literacy for two main reasons. First, it has been extensively used as an index of human capital (Nuvolari and Vasta 2017; Basile and Ciccarelli 2018; Federico, Nuvolari, and Vasta 2019). Secondly, upper-tail human capital indices for Italy's provinces during the Liberal Age are still unavailable. However, one may note that literacy rates (15-19) across provinces correlate strongly with a comprehensive human-capital index calculated by Ciccarelli and Stefano Fachin (2017).

<sup>9</sup> 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 household members. Considering that the 1891 Census was not conducted due to budgetary reasons, literacy rates (and all census variables discussed below) for 1891 are interpolated based on 1881 and 1901 values.

referring to the same cohort and measuring the success rate in producing literacy given previous enrolments.

Among school inputs, we first compute the average class size, i.e. the number of pupils enrolled divided by the number of available teachers. Nowadays, a small class size captures high-quality education, and large class sizes are not desirable; yet, in the past, large classes were necessary to rapidly expand education in the attempt to improve literacy rates.<sup>10</sup>

We also calculate the density of primary schools as the number of schools per squared km in each province. We elaborate a similar index concerning the density of Evening and Sunday schools, since they were complementary institutes that might have mattered for the development of youngsters' literacy.<sup>11</sup>

State inquiries into primary (public and private) and mass education provide information on the number of pupils enrolled in primary schools, the number of teachers, the number of primary schools, and the number of evening and Sunday schools for youngsters and adults (see the Data Appendix for further details).<sup>12</sup> Apart from Evening and Sunday schools, we collected information separately for females and males.<sup>13</sup> Including private institutes is important: their share over total primary-school enrolments was quite large in 1861, albeit declining – from c. 15 to about 5 percent at the beginning of the 20<sup>th</sup> century. Importantly, the relevance of private schooling as opposed to public education varied substantially across regions (Lupo 2006; Vigo 2017).

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<sup>10</sup> As early as the 1830s, Giuseppe Sacchi (1834) discussed the index of class size referring to primary schooling conditions in the provinces of Lombardy. The coeval observer explicitly argued that the average ratio between pupils and school teachers was not to be understood as a measure of school quality. Instead, it should have been interpreted as a measure of teachers' industriousness – implicitly suggesting the existence of economies of scale. Sacchi notes that class size was typically larger in urban contexts and large cities, whereas it was smaller in more remote places.

<sup>11</sup> We do not include military schools in our analysis: first, data on military schools are not available at the provincial level and for the whole period; second, and more importantly, although this type of school has been deemed to be important for the literacy of adults (Mastrangelo 2017), it targets (male) conscripts aged 20, while our analysis hinges on the impact of school inputs on the literacy of males and females aged 15 to 19. What is more, although the impact of such schools on discharged male conscripts was large during the 1860s, it declined substantially by the end of the 1880s – probably implying a negligible effect on the whole population (Coccia and Della Torre 2007, 37).

<sup>12</sup> In the statistics that we use, a school is defined as a classroom where a group – or different groups – of children are taught by one or more teachers. The sources indicate that the definition did not change in the period 1861 – 1911 (*Istituto Centrale di Statistica* 1931). The statistics on education only reported data based on a different definition of school for the years 1883/4 – 1886/7: we did not obtain any information from these.

<sup>13</sup> When primary schools are concerned, they are divided into male schools, female schools, and mixed ones (where both sexes could enrol).

Finally, we add expenditure per pupil as an input into primary schooling. This index is calculated by dividing total municipal expenditure by the number of pupils enrolled in (public) primary schooling and it is reported in current Lire. Data on primary-school expenditure are available only for public primary schooling. We collected the figures from the municipalities' budgets (*Bilanci comunali*), published by the Ministry of Agriculture, Industry and Trade (*Ministero di Agricoltura, Industria e Commercio*). In principle, once we include all relevant school inputs, no relationship between expenditure per pupil and the capability to produce literacy given enrolments should be found. However, expenditure was not only destined to teachers' salaries and school buildings: in 1895, according to the municipalities' budgets, c. 30 percent of total (including current and capital) expenditure concerned didactic materials, heating, cleaning, and maintenance, i.e. the quality of schooling (as argued for today's OECD countries by Barrett et al. 2019). Given the poor state of Italy's primary schools, these features might have had an important residual positive effect on the efficacy of the school system in achieving high literacy, beyond other major school inputs, as witnessed by primary-education inspectors across the country.

#### *Geographic, demographic, and socio-economic variables*

We complement our data including a broad set of control variables, organized 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 (the sum of children aged 6 to 10 and people older than 65 as a share of total inhabitants) to capture potential differences in the age structure of the population. We rely on census figures to obtain these variables. We also collect and compute infant mortality rates to capture hygienic conditions and health within each province, which might have affected both access to schooling and cognitive abilities once in schools, thus influencing literacy rates. Infant mortality rates are calculated from vital statistics, and are defined as deaths in the age group 0-5 divided by live births.<sup>14</sup>

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<sup>14</sup> Deaths in 1901 and 1911 are interpolated due to availability of regional data only (no provincial figures available). For live births, each annual figure is centred around the census year but is an average of the annual values of the previous 10 years (e.g. 1863 – 1870 for 1871). Fewer values are used when the data is not available. For deaths, the moving average includes three years around the census year.

An important aspect linked to schooling and literacy is the rate of outward migration – calculated as emigrants as a share of total residents – since it may have brought about brain drain (or gain) (Spitzer and Zimran 2018). Indeed, c. 30 percent of emigrants were aged between 15 and 20, according to Matteo Gomellini and Cormac Ó Gráda (2013). Figures on emigrants are obtained from the Yearbook of Italian Migration, *Annuario della emigrazione italiana dal 1876 al 1925* (Commissariato Generale dell'Emigrazione 1926) and from Leone Carpi (1874) for the years 1869 – 1873. The sources concerning Italy's outward migration might be biased to some extent, since they report passages recorded through passports. Naturally, this may underestimate actual migration abroad, thus not accounting for the actual impact of migration on the formation of literacy. Due to this potential bias, as well as the fact that internal migration flows are unknown, we add a further index that should capture the impact of both types of migration in each province: for each year, we compare the number of youngsters (aged 15-19) in year  $t$  with the number of children (aged 5-9) ten years before (same cohort). Had there been no migration at all, one should observe an index roughly equal to one. If more people emigrated than those who had arrived, the ratio will be smaller than one – and larger than one if a net positive influx of migrants had taken place. The ratio can be easily computed through population censuses. Since the 1911 census was conducted in the summer, a further advantage of including this migration index is the fact that we can control for potential bias in the 1911 literacy rate, if e.g., some people selected into temporary (seasonal) summer migration in a way that is consistently linked to their human capital, thus potentially affecting the actual value of the ratio between young literates and the population group aged 15 to 19.

Socio-economic variables include the urbanization rate, defined as the share of the provincial population living in cities with more than 30,000 inhabitants (Nuvolari and Vasta 2017); the height of conscripts (males aged 20) organized by birth cohorts, obtained from A'Hearn and Vecchi (2017b) as a proxy for economic well-being – which should correlate positively with literacy rates;<sup>15</sup> industrial Value Added per capita, obtained through the ratio between industrial value added figures (Ciccarelli and

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<sup>15</sup> Adult height is commonly employed in economic history as a proxy for wealth and living standards around the time of birth, because it provides important information on the stock of nutritional investment and hygienic as well as health conditions. If conscripts aged 20 from a specific province were measured, say, in 1881, their (average) height relative to that observed in other places can be interpreted as the result of prevailing conditions in that province (compared to others) in 1861. See Joerg Baten and Matthias Blum (2014).



Fenoaltea 2013) and population data from the censuses (the presence of industries might prompt a more rapid rise of literacy); the share of the labour force employed in agriculture (Missiaia 2014) to proxy for the opportunity cost of educating children;<sup>16</sup> electoral franchise, represented by the share of adult males (21+) entitled to vote in local (e.g. municipal) elections, since the democratization of local decision-making might have led to more education via pressure on municipal councils, which were in charge of funding and managing primary schooling (Cappelli 2016; A'Hearn and Vecchi 2017a). We also perform other robustness checks by including more controls (discussed below).

### *Early 19<sup>th</sup> century variables*

We exploit data on early-19<sup>th</sup>-century literacy rates (1831) as estimated by Ciccarelli and Weisdorf (2019). Data are based on the back-casting methodology, a procedure in which literacy rates recorded in 1881 and 1911 are projected backwards to estimate literacy rates before unification.<sup>17</sup> To complement this part of the analysis we also include the pre-unification GER and class size.

### *Descriptive Statistics*

Our final dataset covers 69 Italian provinces (at 1871 boundaries) for five benchmark years (1871, 1881, 1891, 1901, and 1911), spanning the initial fifty years of the unified Kingdom of Italy. These figures are uncommonly rich for a 19<sup>th</sup>-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 in the first decade of the 20<sup>th</sup> century. Selected descriptive statistics are reported in Table 1 (see Tables A1-a and A1-b in the Appendix for the full list).

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<sup>16</sup> Missiaia (2014) provides the first attempt at harmonizing this index over different censuses, yet the panel obtained still reflects limited adjustment with respect to the sources. The growth in the agricultural share from 1881 to 1901 is particularly cumbersome. To check if potential measurement bias can affect our results, we drop the 1901 value – associated with a peak in the agricultural share within our period – and use instead a value interpolated between 1881 and 1911. The results remain virtually the same.

<sup>17</sup> 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 fully acquired when older than 30 years.

Table 1 – Summary statistics.

Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>1871 - 1911</i>	<i>1871</i>		<i>1881</i>		<i>1891</i>		<i>1901</i>		<i>1911</i>	
Literacy rate 15-20	34.4	19.4	42.8	22.2	51.5	22.5	60.2	23.1	72.1	20.0
Density of Evening and Sunday schools	65.5	57.8	73.9	66.1	28.8	27.4	22.3	24.4	49.0	53.0
<i>Lag 1 (1861 - 1911)</i>	<i>1861</i>		<i>1871</i>		<i>1881</i>		<i>1891</i>		<i>1901</i>	
GER (total)	53.3	37.5	65.4	36.6	87.7	35.5	91.5	33.2	94.8	30.7
Class size (total)	32.1	7.9	36.5	8.6	39.7	8.8	40.5	7.8	42.0	7.4
Expenditure per pupil (public)	23.8	13.3	26.0	13.4	20.7	7.4	24.0	8.0	24.9	6.5
Primary-school density (total)	148.4	139.1	158.2	143.6	231.8	257.1	254.5	270.9	270.4	271.1

Notes: All school inputs, except for the density of evening and Sunday schools, are lagged by 10 years. This means that, for example, the GER 1871 refers to pupils aged 6-10 enrolled in 1861 who are aged 15-19 in 1871.

Relying on the cohort structure of our dataset, we already uncover an important piece of evidence by comparing the primary GER of the age group 6-10 with the literacy rates of the same cohort ten years later – i.e. the age group 15-19. The figures show that, on average, out of 53 pupils enrolled in primary schooling in Italy in 1861, only 34 had become literate by 1871. The same figures in 1911 were 95 and 72 percent, respectively. This discrepancy is partly due to the lack of data on repeaters and attendance rates being normally lower than enrolment rates,<sup>18</sup> and grows when adding private enrolments to public ones.

Figure 3 shows the ratio between the entire school-age population and primary-school teachers (panel a), as well as expenditure divided again by the whole school-age population (panel b). This pattern indicates that the supply of schooling compared to the school-aged population was considerably higher in the North than in the South. For example, on average, each one of the teachers in the provinces of Piedmont covered, potentially, no more than 46 school-age children; the same ratio grew along

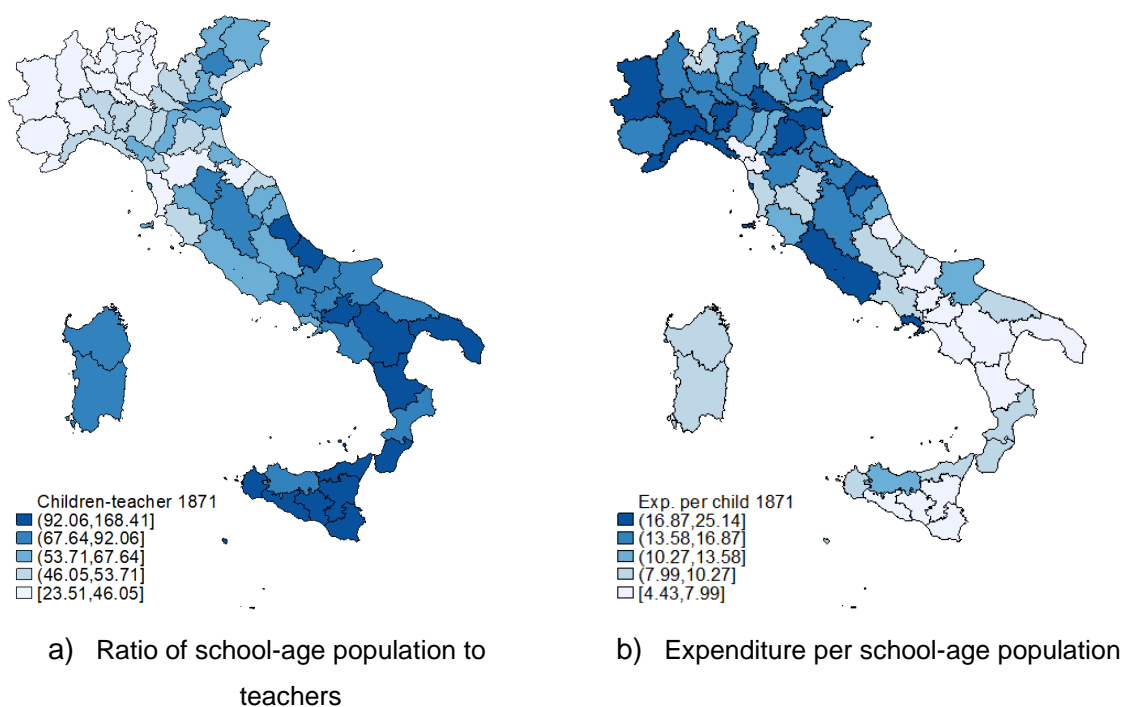
<sup>18</sup> This discrepancy is partly due the GER being an imperfect measure of school-age enrolments and actual attendance. Unfortunately, Net Enrolment Rates (NERs) cannot be calculated due to missing data on repeaters. Figures on attendance at the provincial level are not consistently available for the Liberal Age. At the national level, from the mid-1870s to the mid-1890s, attendance rates were always about 20 percentage points lower than enrolment rates (A'Hearn and Vecchi 2017a, 197), which is a gap consistent with our provincial data. The GER can be larger than 100 percent due to a high incidence of early or late enrolments with respect to the school age being considered, in our case the age group 6-10. The GER in private institutes declined from c. 7 percent in 1871 to less than 5 percent in 1911.

a North-South gradient, to reach peaks of 170 school-age children per teacher in Calabria and Sicily.

Yet, in Figure 4, a remarkable result emerges: the South supplied a larger number of teachers, and invested more resources, compared to the number of enrolled pupils, than the North. Indeed, while the average class size (pupils per teacher) was as low as 23 in the South in 1871, the same ratio was larger than 45 in all provinces of Piedmont.

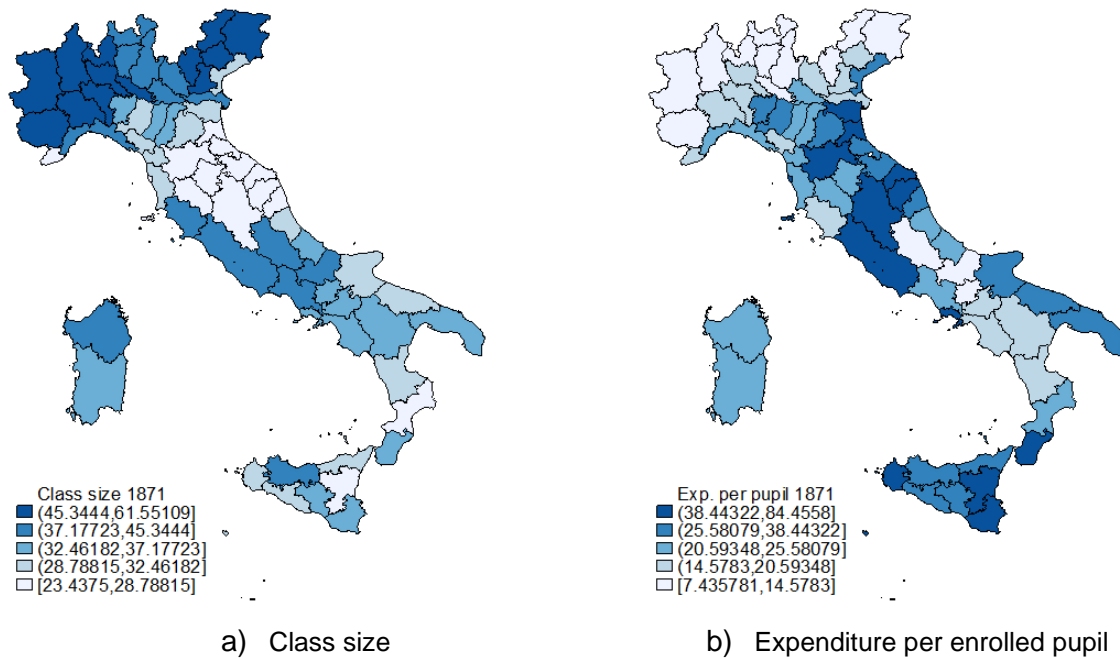
These patterns suggest the existence of at least two distinct models of providing schooling across the country: in the Northern provinces, the authorities sought to provide mass education. Instead, in the South, fewer people had access to schooling, yet they were allocated more educational resources. This is somewhat mediated by demand-side variables – something that we consider below, where we set out to explore whether the two allegedly different models of providing mass education in pre-unification Italy cast a long shadow into the Liberal Age.

Figure 3: Supply of public schooling: child-teacher ratio and expenditure per child, 1871.



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

Figure 4: Territorial distribution of school inputs: class size and expenditure per pupil, 1871.



Notes: Class size is measured by the number of pupils enrolled in primary schools per teacher (including private education), while expenditure per pupil is calculated as the amount of municipal (public) expenditure on education per pupil enrolled in (public) primary schools. Sources: see text.

#### 4. Empirical strategy

Our empirical strategy first focuses on estimating a linear model where the dependent variable is the GER and the regressors are lagged inputs into schooling – class size, expenditure per pupil and primary-school density over the territory – to explore the factors associated with the expansion of enrolments, i.e. mass schooling. Our models control for the geographic, demographic, and socioeconomic factors presented in the previous sections.

Secondly, we estimate a similar model to explore whether and to what extent inputs into schooling correlate with school efficacy – the capability to produce literacy given enrolment rates – while controlling for social, economic, demographic, and political factors.

We also expand our benchmark specifications concerning both enrolment rates and school efficacy by including pre-unification literacy rates estimated by Ciccarelli and Weisdorf (2019) to proxy for educational attainment in the first half of the 19<sup>th</sup> century (1831). We aim at identifying whether a historical legacy stemming from pre-unification

regional states might have affected the development of literacy beyond local school inputs and contextual factors.

The models that we employ draw from the literature on Education Production Functions (EPFs), which are an established methodology to explore the effectiveness of schooling in generating learning outcomes, even though most contributions rely on modern data. For example, the seminal article David Card and Alan Krueger (1992) has underlined the positive role of school quality on economic returns to education in the US. It is worth noting that, recently, Hanushek and Ludger Woessmann (2020) 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.

By contrast, there is little research investigating the relationship between school inputs and educational 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 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 school efficacy by exploring the factors that improved the production of literacy given existing rates of primary-school enrolment.

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

$$Q_{pt} = f_{pt}(SC_{pt}, X_{pt}, SE_{pt}) + \varepsilon_{pt} \quad (1)$$

which produces the output  $Q_{pt}$  by combining educational inputs ( $SC_{pt}$ ), province-specific environmental characteristics ( $X_{pt}$ ), and socio-economic variables ( $SE_{pt}$ ).

We assume a linear specification, as follows:<sup>19</sup>

$$Q_{pt} = \beta_0 + \beta_1 SC_{pt} + \beta_2 X_{pt} + \beta_3 SE_{pt} + \varepsilon_{pt} \quad (2)$$

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<sup>19</sup> We explore the potential non-linearity of inputs by including their squared terms. However, according to the tests that we conducted on the significance of such non-linearities, we decided not to include them: their inclusion does not change our main results but make the reading of the regression output more confusing. Estimates are available upon request.

In a first version of our model,  $Q_{pt}$  is represented by the GER. All school inputs,  $SC_{pt}$ , included in the regression analysis are measured in the same year, since current conditions affect enrolment decisions immediately. In a second version, we focus on school efficacy ( $Q_{pt}$ ) is, which is the GER-LIT Gap (percentage points) where the GER is measured in the previous benchmark year – so that school efficacy concerns the same cohort, as it should. Clearly, since we are focusing on the literacy of the cohort that was in primary schooling ten years earlier, we measure all other school inputs as first lags.

Educational inputs ( $SC_{pt}$ ) include class size, expenditure per pupil, primary school density, and the density of Evening and Sunday schools, while demographic and socio-economic variables are in  $SE_{pt}$  and  $X_{pt}$ . In our core estimates, we focus on public-school inputs, since private schooling was rather marginal in Italy during the Liberal Age.<sup>20</sup>

The estimation of an EPF presents several challenges from a technical point of view, but our dataset allows us to tackle such issues. The most important ones concern omitted variable bias, as well as selection bias and potential endogeneity (Hanushek and Woessmann 2020). We address these issues as follows. First, we consider the omitted variable bias by including a rich and comprehensive vector of controls. Second, 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. Third, 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 (Schwartz and Zabel 2013).

We start estimating our two models through repeated cross sections, while controlling for an extensive set of correlates; then, we estimate the same model through different panel-data regressions, such as pooled OLS (POLS) and specifications where we include time dummies (capturing a trend in the outcome variable common to all provinces) as well as different types of dummies (provincial and regional) to capture

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<sup>20</sup> We dedicate a sub-section to a model which does include both public and private schooling inputs (Table 4).

time-invariant differences across provinces and regions (fixed effects).<sup>21</sup> Finally, as we briefly outlined above, we further expand our specification by including pre-unification literacy rates estimated by Ciccarelli and Weisdorf (2019). This is a crucial test to identify whether a pre-unification legacy stemming from different models of providing mass schooling can be discerned, even when controlling for the local provision of education by Italy's municipalities in the Liberal Age, and independently of contextual factors influencing the demand for schooling.

## **5. Determinants of schooling and school efficacy**

In Table 2, we present cross-section regressions, always including all control variables, with the GER as the dependent variable (cols. 1-5) and then focusing on school efficacy (the GER-LIT Gap) in Columns 6 to 10.

First, we find that a large average class size (enrolled pupils per teacher) was associated with high enrolment rates (cols. 1-5). Increasing the class size by 10 units (roughly a standard deviation) was associated with a premium on the GER ranging from 12 to 17 percentage points, therefore substantial economies of scale were pursued in the attempt to expand basic schooling. Similarly, the density of schools over the territory was an important aspect correlated with the expansion of enrolments: increasing the number of primary schools per 1,000 squared kms by 239 units (a standard deviation) was associated with an increase in the GER ranging from 24 to 55 percentage points.<sup>22</sup> The same holds true for the density of Evening and Sunday schools, albeit to a lesser extent, as increasing its value by one standard deviation (50 schools per 1,000 squared kms) would increase enrolment rates by a premium ranging from 3 to 13 percentage points. Instead, expenditure per pupil was not correlated with enrolment rates. Among the controls that are statistically significant, electoral franchise was positively correlated with the expansion of primary-school enrolment rates (A'Hearn and Vecchi 2017a). Instead, outward migration and the dependency ratio were negatively correlated with enrolments. Similarly, population density and the average temperature show a negative sign – possibly indicating that the growth of enrolment rates happened in rural and places in the North more than elsewhere during the late 19<sup>th</sup> century.

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<sup>21</sup> In the cross-section analysis, we apply White-Huber standard errors to deal with potential heteroscedasticity, while in the panel regressions we always rely on standard errors clustered at the provincial level.

<sup>22</sup> 1,000 squared kms is roughly the size of a small Italian province.

Focusing on school efficacy (the GER-LIT Gap), one notices that a reduction in class size equal to a standard deviation (9.3 pupils per teacher) is associated with a reduction in the gap between enrolment rates and literacy roughly equal to 6 to 8 percentage points (cols. 6-10). Once pupils were enrolled, reducing the class size was necessary to improve literacy. The density of primary schools is associated with a larger divide between enrolment and literacy rates: an increase of one standard deviation in the density of schools would increase the GER-LIT Gap by c. 25 percentage points. This suggests that a growing network of schools over the territory was important for a larger number of boys and girls to enrol into primary education, yet the growing quantity of schooling might have compromised its quality – a known issue among policymakers aiming at universal primary education in low-development countries in the last thirty years (Glewwe 2013). Evening and Sunday schooling, similarly, were not linked to educational performance given enrolment rates. Among the controls, population density is associated with a reduction of the GER-LIT Gap in every benchmark year, whereas all other controls – except from temperature and heights – have seldom coefficients that are statistically significant.

To sum up, expanding the quantity of schooling required economies of scale given limited resources. However, for increasing educational outputs, improving the quality of schooling was crucial, which could be pursued by reducing the class size.



Table 2: cross-section regressions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable:			GER					GER-LIT Gap		
Year	1871	1881	1891	1901	1911	1871	1881	1891	1901	1911
Class size (total)	1.175*** (0.266)	1.530*** (0.220)	1.600*** (0.279)	1.674*** (0.301)	1.185*** (0.293)	0.643** (0.242)	0.652*** (0.231)	0.835*** (0.164)	0.786*** (0.210)	0.679*** (0.209)
Expenditure per pupil (public)	-0.094 (0.172)	-0.066 (0.258)	0.071 (0.205)	0.300 (0.270)	0.055 (0.117)	-0.164 (0.136)	-0.450*** (0.146)	-0.323 (0.195)	0.018 (0.149)	0.217 (0.245)
Primary-school density (total)	0.117** (0.047)	0.099** (0.039)	0.231*** (0.035)	0.188*** (0.033)	0.123** (0.052)	0.104*** (0.028)	0.111*** (0.036)	0.089*** (0.023)	0.093*** (0.023)	0.097*** (0.030)
Density of Evening and Sunday schools	0.047 (0.042)	0.064* (0.036)	0.257*** (0.050)	0.139** (0.052)	-0.022 (0.020)	-0.010 (0.047)	-0.006 (0.044)	0.087 (0.056)	0.173*** (0.037)	-0.022 (0.018)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	69	69	69	69	69	69	69	69	69	69
Adjusted R-squared	0.934	0.947	0.941	0.936	0.817	0.794	0.797	0.834	0.787	0.759

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Note: in Columns 6 to 10, all school inputs excluding the density of Evening and Sunday schools are lagged by one period (10 years). The controls include latitude, longitude, average temperature, average rainfall, population density, the urbanization rate, the dependency ratio, infant mortality rate, height, the share of labour force employed in agriculture, industrial VA per capita, the outward migration rate, the share of males 25+ allowed to vote in local elections, and the migration proxy based on population ratios.

In Table 3, we exploit the panel structure of our data and estimate variants of our previous specifications. In model 1 and 2 we regress, respectively, the GER and the GER-LIT Gap (school efficacy) on all school inputs and controls. In model 3, we include macro-regional dummies instead of provincial FE to show that most of the variation in the GER-LIT Gap that is estimated to be due to time-invariant provincial features is actually linked to features that are common within macro-regions. This last model will be later used to focus on the long-term relationship between educational levels in pre-unification areas and the quantity and quality of education in the Liberal Age (1861 – 1911). Since early 19<sup>th</sup> Century variables are available as sectional data, it is crucial to employ a model with macro-regional dummies instead of provincial FE. The evidence from panel estimates confirms previous results.<sup>23</sup> High enrolment rates were achieved by relying on economies of scale (large class sizes) and a more widespread network of primary schools, while expenditure per pupil did not matter once other inputs were factored in (col. 1). Consistently with the cross-section estimates, we show that reducing class sizes would produce more literacy given enrolment rates; additionally, in the panel model shown, more expenditure per pupil improves school efficacy (col. 2).<sup>24</sup>

The estimated coefficients are very stable when provincial FE are substituted with macro-regional dummies (col. 3), allowing to estimate the effect of historical variables on education in the Liberal Age. Like previously, population density and heights are systematically associated with improved literacy given enrolment rates, whereas an increase in the migration proxy is associated with a growing GER-LIT Gap: since the receiving provinces were the ones characterized by large cities, it is plausible that more internal migration went hand in hand with fewer literate people as a share of the population aged 15 to 20.

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<sup>23</sup> Since the relationship between the two dependent variables and the regressors might be influenced by the fact that literacy is capped at 100 percent and the GER is not – the latter can reach more than 160 percent given pupils enrolled beyond school age – we also ran the same regressions excluding GERs larger than 100 percent. All results remain virtually the same, but expenditure per pupil becomes statistically significant in all benchmark years except from 1911. Similarly, excluding literacy rates above 90 percent does not change the results (see Table A2 in the Appendix).

<sup>24</sup> The fact that expenditure per pupil was not significant in the cross-section results suggests that it is correlated with factors that do not change / change very slowly over time (now captured by FE).

Table 3: panel-data regressions.

Panel Variables	(1) FE GER	(2) FE GER-LIT Gap	(3) POLS GER-LIT Gap
Class size (total)	1.516*** (0.217)	0.707*** (0.126)	0.607*** (0.112)
Expenditure per pupil (public)	-0.084 (0.122)	-0.196** (0.078)	-0.217*** (0.067)
Primary-school density (total)	0.068*** (0.025)	0.052*** (0.013)	0.055*** (0.020)
Density of Evening and Sunday schools	0.005 (0.015)	0.010 (0.017)	0.025 (0.015)
Northeast			-8.974*** (2.446)
Center			-12.255*** (2.829)
South			-16.254*** (3.890)
Islands			-16.570*** (6.084)
Control variables	Y	Y	Y
Province FE (69)	Y	Y	N
Year dummies	Y	Y	Y
Macro-region FE (4)	N	N	Y
Observations	345	345	345
Adjusted R-squared	0.826	0.635	0.787

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Notes: the benchmark macro-region in Column 3 is the North-West. GER-LIT Gap stands for school efficacy. The controls include population density, the urbanization rate, the dependency ratio, infant mortality rate, height, the share of labour force employed in agriculture, industrial VA per capita, the outward migration rate, the share of males 25+ allowed to vote in local elections, and the migration proxy based on population ratios.

In Table A3 in the Appendix, we undertake a number of robustness checks to check whether our baseline panel models in Table 3 are biased by other potential omitted variables, including parental literacy, real wages, high-to-low value added in industry, patents per million inhabitants, and land inequality c. 1871. All results hold. Among the variables that are statistically significant, we find a more prominent importance of high-value added firms in industry to have been associated with enrolment rates, but not with school efficacy. Patents per million inhabitants, instead, are associated with both more enrolments and a higher school efficacy.

Although private primary schooling played a minor role in Italy's education system – and a declining one towards the eve of the 20<sup>th</sup> century – private education might have still mattered for some population groups, like wealthy families, religious communities, and through the potential preference of wealthy families for private schooling to educate their daughters. Moreover, in some provinces, low public investment in education could be associated with high private enrolment rates. In Table 4, we compare public and private GERs with public-school and private-school inputs in a panel model with provincial FE and time dummies (cols. 1-2).<sup>25</sup> As expected, two distinct patterns emerge: higher public-school enrolment rates were associated with a larger class size and a denser network of schools over the territory. By contrast, economies of scale were not pursued by private institutes – the class size was not a significant correlate of enrolment rates. Likewise, a higher number of private schools per squared km is positively associated with private GERs, but the coefficient is much smaller than that of public-school density. The two coefficients of school inputs into private education tell a plausible story. Contrary to what happened in public schools, private education essentially targeted few groups of selected students.

Column 3 tests the same model with the GER-LIT Gap as the dependent variable. Given the nature of this index (both public and private-schooling GERs contribute to literacy and are included in the dependent variable) we consider the different types of education (private vs public) by computing (i) the ratio of private-education teachers over total teachers and (ii) the ratio of private schools over total schools and include them as regressors (lag 1). The two coefficients are not statistically significant, suggesting that the share of private over total schooling did not affect the capability to produce literacy given enrolment rates – a result that is perhaps to be expected, given that private education played a relatively minor role in Liberal Italy (the national average of private over total enrolments was 6.6 percent in 1871 and 4.3 percent in 1911).

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<sup>25</sup> Unfortunately, we can only measure Evening and Sunday schools concerning public education like in the case of expenditure per pupil.

Table 4 – panel-data regressions, considering public and private education, as well as females and males, separately.

Variables	(1) GER (public)	(2) GER (private)	(3) GER-LIT Gap	(4) GER (F)	(5) GER (M)	(6) GER-LIT Gap (F)	(7) GER-LIT Gap (M)
Class size (public)	1.648*** (0.173)						
Primary-school density (public)	0.173*** (0.030)						
Class size (private)		0.040 (0.030)					
Primary-school density (private)		0.039*** (0.010)					
Class size (total)			0.922*** (0.125)				
Primary-school density (total)			0.047*** (0.013)				
Private teachers % total			24.850 (21.666)				
Private schools % total			-4.266 (22.606)				
Class size (female)				0.670** (0.304)		0.271** (0.120)	
Primary-school density (female)				0.076*** (0.027)		0.077*** (0.019)	
Class size (male)					0.273*** (0.047)		0.228*** (0.061)
Primary-school density (male)					0.038* (0.020)		0.086*** (0.019)
Expenditure per pupil (public)	-0.092 (0.114)	0.031 (0.023)	-0.189*** (0.069)	-0.410*** (0.133)	-0.599*** (0.137)	-0.239*** (0.085)	-0.367*** (0.077)
Density of Evening and Sunday schools	-0.010 (0.016)	0.007* (0.004)	0.009 (0.017)	-0.003 (0.023)	0.024 (0.018)	0.010 (0.021)	0.016 (0.020)
Control variables	Y	Y	Y	Y	Y	Y	Y
Year dummies	Y	Y	Y	Y	Y	Y	Y
Province FE (69)	69	69	69	69	69	69	69
Observations	345	344	345	276	276	345	345
Adjusted R-squared	0.864	0.516	0.651	0.796	0.808	0.533	0.574

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Notes: all models are based on a FE panel-data regression with time dummies. The controls include population density, the urbanization rate, the dependency ratio, infant mortality rate, height, the share of labour force employed in agriculture, industrial VA per capita, the outward migration rate, the share of males 25+ allowed to vote in local elections, and the migration proxy based on population ratios.

We also present results that are split by gender, to investigate whether increasing school inputs was associated with a different change in enrolment rates and school efficacy for boys and girls (cols. 4-7). We suggest that growing enrolment rates for girls were associated with growing class sizes, and this correlation was more prominent than in the case of boys (cols. 4-5). An increase equal to 10 female pupils per female teacher was associated with an increase in female enrolment rates of about 7 percentage points, whereas the same increase in male schools would be equal to a premium on enrolment rates of about 3 percentage points. A similar difference is found concerning the school-density coefficient. Both results are expected given that female schooling was less common at that time, thus the same increase in school inputs might have improved access to schooling to a larger extent for females than males (Bloom 2006). Again, the coefficient of expenditure per pupil is negative, confirming that the provinces that witnessed the largest increase in enrolment rates were the ones that spread available resources on a larger number of enrolled pupils.

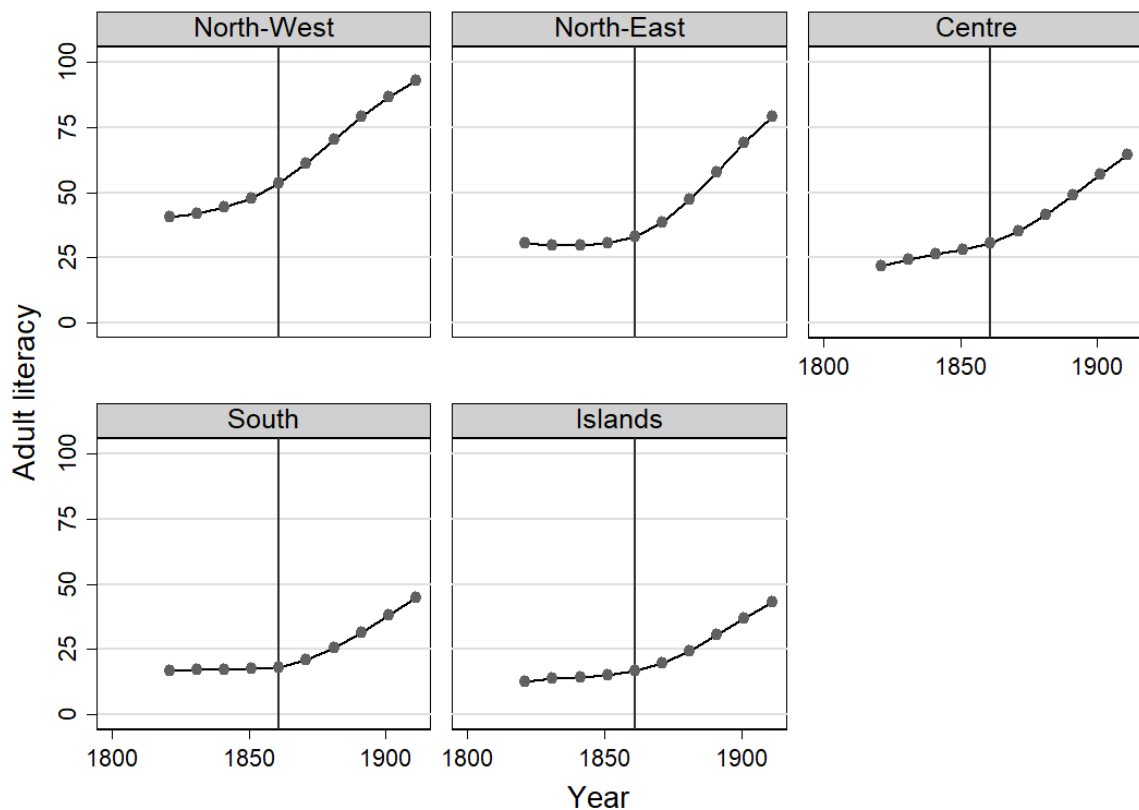
Furthermore, we highlight that, concerning class size and school density, no major divide can be discerned in the way that they affected school efficacy between females and males (cols. 6-7). However, the coefficient of expenditure per pupil is quite different. Both coefficients are negative, as expected – given that, once school inputs and enrolment rates are factored in, increasing expenditure was associated to an increase in the quality of education, as we argued before. Yet, the coefficient is larger for boys than girls. A one-standard-deviation increase in expenditure per pupil (c. 13 Lire per pupil) was associated with a reduction in the GER-LIT Gap equal to 3 percentage points for females, and almost 5 percentage points for males. This is indicative to a bias in resources allocation favouring boys over girls in primary education.

## **6. A legacy of pre-unification education?**

So far, our study, stretching from the pre-unification period to the early 20<sup>th</sup> century, has highlighted the central role played by local school inputs in expanding enrolments and, at a later stage, improving literacy during Italy's Liberal Age (1861-1911). This is suggestive of persistent differences stemming from the legacy of pre-unification education policies, which differed substantially before the unification of Italy. Figure 5 highlights the early divide in literacy by relying on the Ciccarelli-Weisdorf dataset on adult literacy, the vertical line marking the unification of Italy. While literacy had

reached c. 40 percent in the Northwest (The Kingdom of Sardinia plus Lombardy) and it was more than 30 percent in the Northeast (including Venetia and the Duchies of Modena and Parma) in 1831, it stood at about 20 percent in the Center (Grand Duchy of Tuscany and Papal States) and ranged between 15 and 20 percent in the South and Islands (the former Kingdom of the Two Sicilies, excluding Sardinia). Following the unification of Italy in 1861, literacy in the Northwest and Northeast grew remarkably fast while the Center followed closely. Instead, the diffusion of literacy remained slow in the South and Islands.

Figure 5: Adult literacy in Italy's macro-regions, from 1831 to 1911.



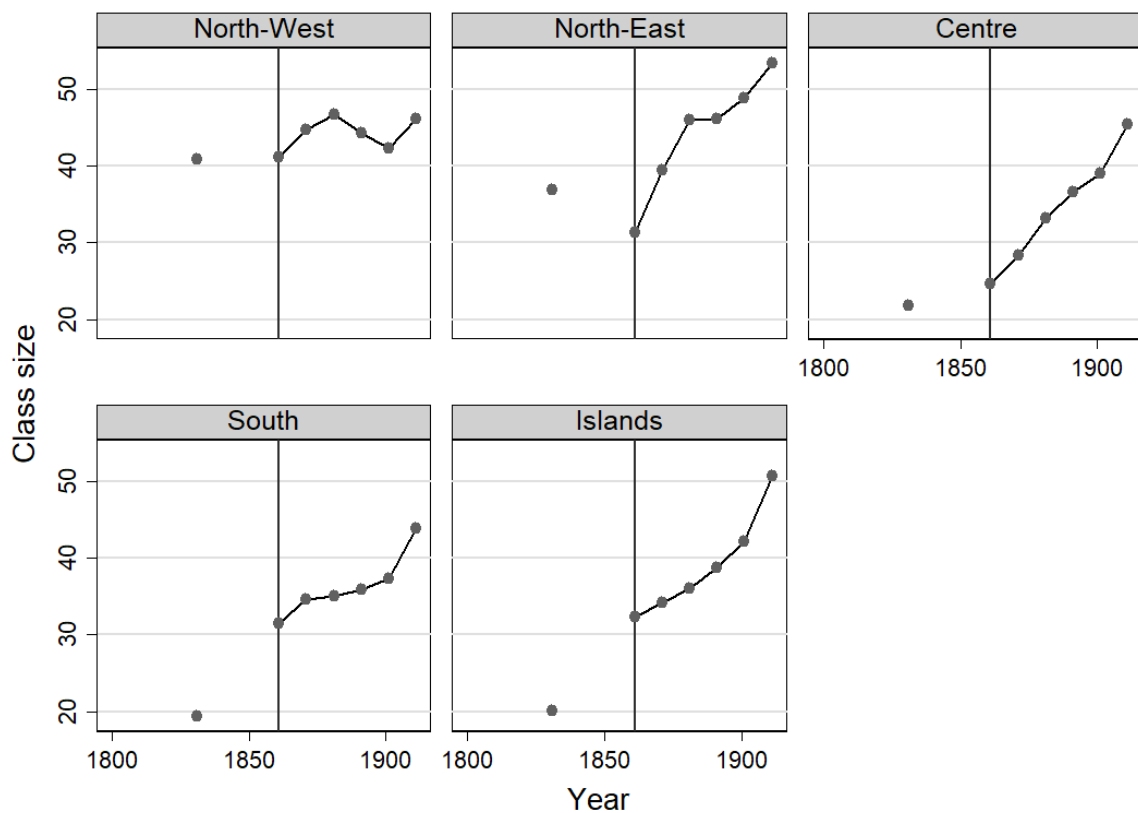
Sources: see text. Note: we rely on Ciccarelli and Weisdorf (2019)'s literacy. The vertical line marks the unification of Italy in 1861.

The variation in literacy post-1861 seems to be linked to significant pre-existing differences across macro-regions in providing schooling, which can be fully appreciated by looking at macro-regional averages concerning two school inputs:

class size in public schooling (enrolled pupils per available teacher) and public-schooling expenditure per pupil.<sup>26</sup>

Class size indicates remarkable disparities in the way that primary education was provided in the pre-unification era: in Figure 6, both the Northwest and – to a lesser extent – the Northeast exhibit a *large* average class size, whereas the Center as well as the South and Islands show a *small* class size.

Figure 6: Class size among Italy's macro-regions, from the pre-unification era to the early 20<sup>th</sup> century.



Sources: see text.

These patterns are consistent with the hypothesis that the North had already paved the way towards a model of public mass schooling – relying on economies of scale in primary education in an attempt to reach most of the population.<sup>27</sup> Instead, the Center

<sup>26</sup> The evidence based on the density of primary schools is consistent with our argument – not shown for the sake of brevity.

<sup>27</sup> Economies of scale in education that affect average costs across areas are common. Tayler Bowles and Ryan Bosworth (2002) study 17 Wyoming school districts in the 1990s, finding that a 10-percent increase in school size decreased the cost per student by 2 percent.



and the South of the country had not yet abandoned a more elitist view of education based on private institutions, near-zero public education, and a focus on educational grades higher than the primary: as a result, fewer primary-school pupils were taught by more teachers. In the long run, the two areas converged towards a similar class size, the one based on the provision of schooling for all and mass education – under the same national school act – but this process took more than 50 years, holding back convergence in literacy rates across the country.

Figure 7 on educational expenditure per enrolled pupil highlights the same divide. Unfortunately, harmonized data for the pre-unification period are not available, thus these results must be taken with a pinch of salt. At the beginning of the existence of the Kingdom of Italy, Piedmont and Liguria (in the Kingdom of Sardinia) and Lombardy (within the Kingdom of Lombardy-Venetia) spent 12 Lire per enrolled pupil; all other macro-regions spent more. Again, over time, one can identify a convergence towards two distinct models: the Center and the Northeast catch-up with the low expenditure per enrolled pupil that characterized the Northwest, sign of the effort to provide mass education (even though the Center does not fully converge and expenditure per pupil remains higher than in the Northwest and Northeast). Instead, the South and Islands are characterized by a higher expenditure per pupil enrolled compared to the Northwest, in any benchmark year during the Liberal Age.

Figure 7: Expenditure per pupil across Italy's macro-regions, 1861 to 1911.

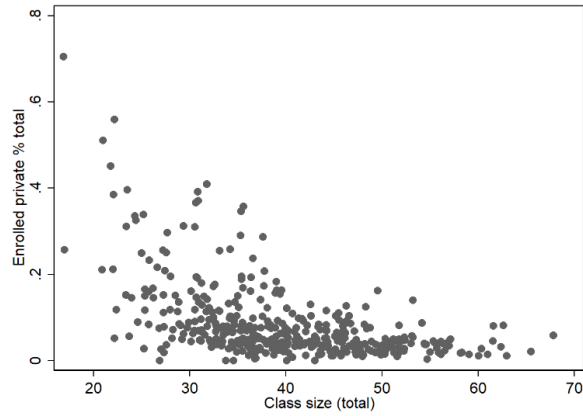


Sources: see text.

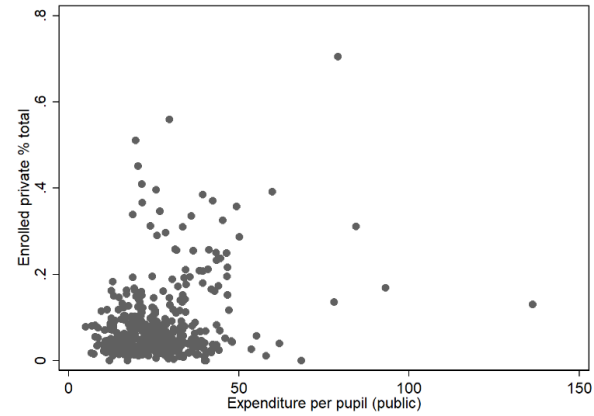
The intuition that class size and expenditure per pupil can be used as a proxy of preferences or models in the provision of primary schooling is backed up by the clear relationship between the importance of private education and class size or expenditure per pupil. As Figure 8 below shows, a larger share of enrolments in private over total education is associated with a smaller class size (panel a) and a larger expenditure per pupil (panel b). Figure 9 interestingly shows that early movers that adopted a more inclusive model of educational provision reduced considerably gender inequality in literacy, and much more rapidly than the Centre and the South. The percentage-point gap was reduced to virtually zero in the North-West, and to about five in the North-East. Instead, in the Centre and in the Islands, the average gap decreased slightly, yet remaining larger than 10 percentage points, while in the South the gap remained stable and above 20 percentage points.

We further explore this legacy with a series of regressions with year dummies and macro-regional FE instead of provincial FE – which would otherwise capture any time-invariant effect that varies merely across provinces. It is worth noting though, that in Table 3 the FE model with provincial dummies and the POLS specification with macro-regional effects were perfectly consistent. We expect to find a link between pre-unification education and post-unification literacy within each macro-region. Since we control for a large set of contextual variables, this would imply that pre-unification states (and provinces within them) that had adopted an early system of mass education tended to be characterized by higher enrolment rates and, possibly, school efficacy.

Figure 8: Private education, class size and expenditure per pupil, full sample (all years).



a) Class size and private education



b) Expenditure per pupil and private education

Figure 9: Gender inequality in literacy: male literacy minus female literacy, 1831 – 1911.

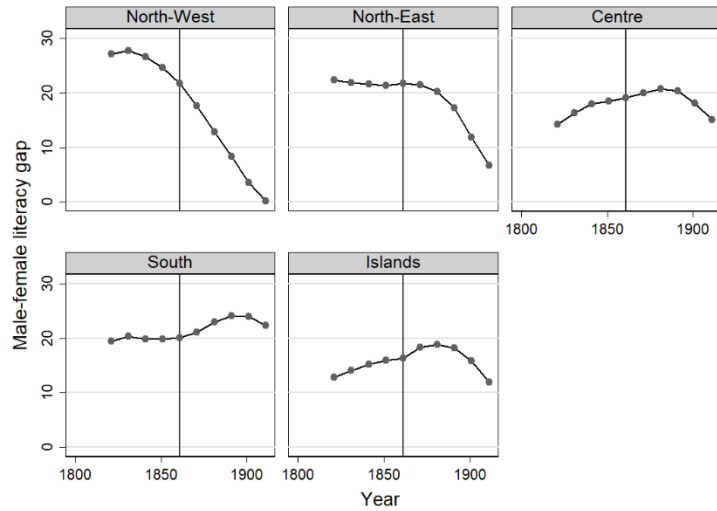


Table 5 shows a positive and significant correlation between enrolment rates and pre-unification (1831) literacy (col. 1). In Column 2, we interact pre-unification (1831) literacy with the year dummies to explore whether this alleged pre-unification educational legacy persisted over time: in every year considered, the coefficient of the legacy of pre-unification literacy is given by the sum of the 1831 coefficient and the interaction between the latter and the dummy for the concerned year (the excluded year is 1871). For example, in 1881, the marginal effect of pre-unification (1831) literacy is  $0.948 + (-0.270) = 0.678$ . Therefore, we find pre-unification literacy to have been relevant until the early 20<sup>th</sup> century: in 1911, the coefficient of 1831 literacy interacted becomes virtually zero. This is plausible, since the period 1901 – 1911 marks the first era of substantial state intervention in matters related with primary schooling (the aforementioned Nasi and Orlando Laws). In Columns 3 and 4, we explore whether this legacy was different for boys and girls. The legacy appears to have been more persistent for girls, which resonates with the more prominent effort by local authorities to provide schooling to boys. As Ciccarelli and Weisdorf (2019, Fig. 6) have shown, female adult literacy caught up relatively quickly with male literacy in the Northwest after unification. The same, though to a lesser extent, happened in the Centre and Northeast. However, in the South, a substantial gender gap in education remained. This result is fully consistent with our estimates in Column 3: while Central and Southern regions closed the gap in male enrolment rates following unification, the gap in female enrolment rates persisted into the 20<sup>th</sup> century.

Finally, we focus on the GER-LIT Gap and highlight that more literate provinces before unification tended to expand enrolment rates more rapidly, which was associated with a lower school efficacy (a larger GER-LIT Gap) (col. 5-6). This is consistent with the existence of two distinct models of providing schooling: an inclusive one aimed at fostering education for all in the North-West and North-East, and a more elitist one elsewhere, particularly in the South. Yet, over time (interaction terms), the net coefficient of 1831 literacy gets smaller, as the areas that expanded enrolments early on were the ones improving the GER-LIT Gap starting in the 1890s (The North and Centre), whereas the South and Islands reduced their GER-LIT Gap substantially in the first decade of the 20<sup>th</sup> century.<sup>28</sup>

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<sup>28</sup> The 1911 interaction is not statistically significant, as the aggregate result is dependent on diverse and mixed regional patterns: while school efficacy improved to a large extent in the Northwest and Northeast, enrolment

Our new data stand as evidence that early educational reforms and contextual conditions led to a long-term divergence in schooling and human capital accumulation that was only partly mitigated by the centralizing reforms of the 20<sup>th</sup> century. This finding resonates with the results offered by Postigliola and Rota (2021), who emphasize the importance of the legacy of French reforms, which improved the quality of schooling and changed “collective preferences” towards more education. However, our results constitute the first piece of quantitative evidence allowing us to qualify this argument. We confirm that there existed different equilibria of educational provision across Italian macro-regions, even if the French reforms did not translate into quality of schooling during the Liberal Age. We find that the areas most affected by the French legacy first increased enrolment rates by aiming at economies of scale and, only at a later stage, sought to improve the efficacy of schooling in generating literacy. In 1861, the gap between GER and literacy rates for the same cohort was particularly large in the North-West, the area most affected by French reforms – while it was relatively small elsewhere. The gap increased in all macro-areas following unification and, only at the end of the 1880s, it started to shrink as primary schooling became more effective (Figure 10).

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rates expanded rapidly in the Centre. We tested for the different relationship between 1831 literacy and school efficacy over the post-unification years separately for boys and girls, and we found no significant differences.

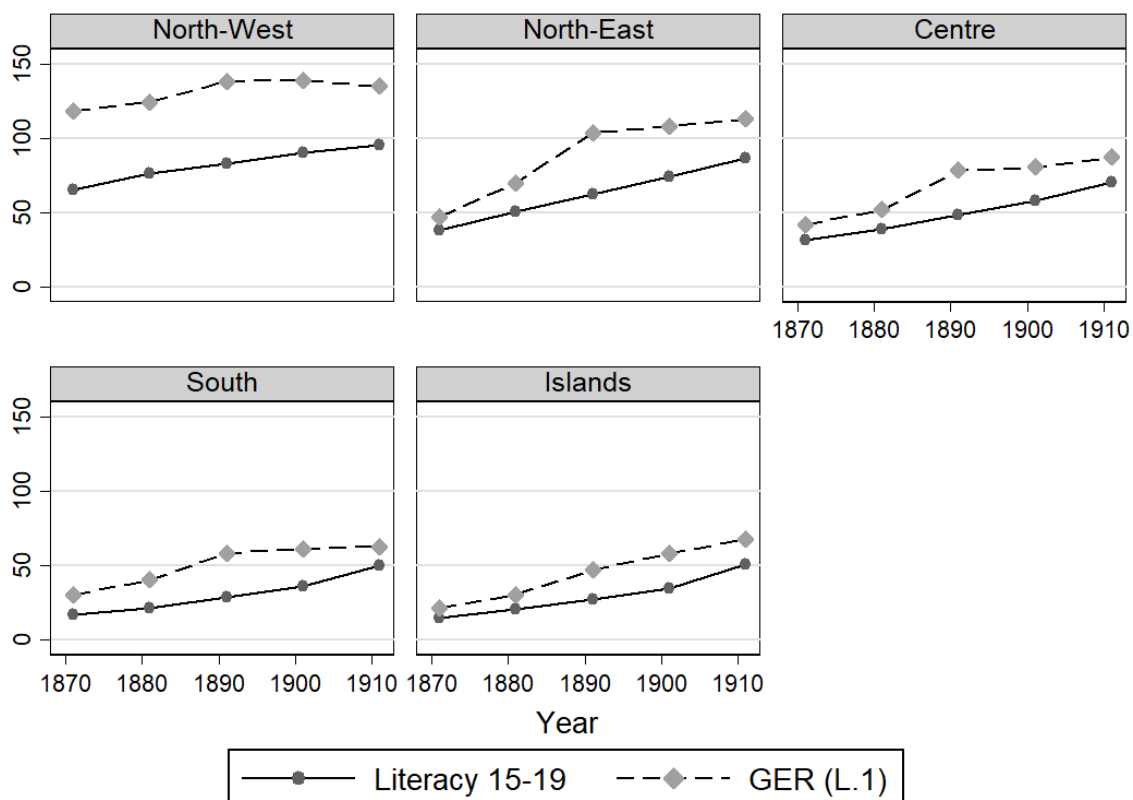
Table 5 – Panel-data regressions: a pre-unification legacy?

Panel Variables	(1) POLS GER	(2) POLS GER	(3) POLS GER (F)	(4) POLS GER (M)	(5) POLS GER-LIT Gap	(6) POLS GER-LIT Gap
Class size	1.351*** (0.135)	1.254*** (0.131)	1125*** (0.209)	0.117** (0.056)	0.561*** (0.111)	0.584*** (0.115)
Expenditure per pupil	-0.005 (0.080)	0.055 (0.088)	-0.169 (0.124)	-0.303*** (0.132)	-0.228*** (0.057)	-0.238*** (0.054)
Primary-school density	0.082*** (0.025)	0.078*** (0.025)	0.093** (0.040)	0.090** (0.036)	0.049*** (0.018)	0.050*** (0.017)
Density of evening and Sunday schools	0.028** (0.013)	0.002 (0.012)	0.011 (0.027)	0.028 (0.024)	0.009 (0.016)	0.007 (0.017)
Literacy CW 1831	0.596*** (0.148)	0.948*** (0.154)	1.213*** (0.225)	1.056*** (0.147)	0.418*** (0.107)	0.607*** (0.174)
Literacy CW 1831*1881		-0.270* (0.139)	-0.257 (0.208)	-0.256** (0.118)		-0.237* (0.136)
Literacy CW 1831*1891		-0.416*** (0.121)	-0.389* (0.214)	-0.522*** (0.112)		-0.319* (0.170)
Literacy CW 1831*1901		-0.597*** (0.140)	-0.479* (0.254)	-0.751*** (0.133)		-0.444** (0.187)
Literacy CW 1831*1911		-0.994*** (0.207)				-0.140 (0.234)
Control variables	Y	Y	Y	Y	Y	Y
Year dummies	Y	Y	Y	Y	Y	Y
Macro-region FE (4)	Y	Y	Y	Y	Y	Y
Observations	345	345	276	276	345	345
Adjusted R-squared	0.935	0.941	0.925	0.938	0.797	0.804

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Class size, primary-school density, and 1831 literacy refer to females and males only in Columns 3 and 4, respectively. In all other specification they refer to the total population. In columns 3 and 4, the number of observations drops to 276 due to schooling data divided by gender being unavailable for 1911. For a full list of controls, see Table 4.

Figure 10 – The GER-LIT Gap in all macro-regions, 1871 – 1911.



Notes: the value of the GER is lag 1 (-10 years).

## 7. Conclusions

Italy represents an ideal case-study to explore the relationship between institutions, reforms and local levels of education in the long run. Thanks to a newly collected dataset, we investigate to what extent school inputs mattered for both the mass expansion of schooling rates and the school efficacy in the Liberal Age, in a context of growing educational expenditure. By relying on provincial Education Production Functions, we find that two distinct models (equilibria) emerged concerning the provision of primary schooling. The Northern regions of the country relied on economies of scale (large class size and low expenditure per pupil) to increase the quantity of schooling, even if this came at the cost of limited effectiveness, at least until the late-19<sup>th</sup> century. Instead, the Centre and the South implemented a more elitist educational model, based on small class sizes and a large expenditure per pupil – yet



resulting in a smaller number of students enrolled compared to the school-age population. We also find that economies of scale were more relevant to increase female than male enrolment rates. Consistently, the improvement in school efficacy (the reduction of the GER-LIT Gap), which happened in the entire country starting in the 1890s, was driven by the reduction in class sizes and increasing expenditure per pupil, even when controlling for contextual factors associated with the demand for education.

Furthermore, we study the persistent effect of pre-unification human capital accumulation on enrolment rates and literacy in the Liberal Age, thus contributing to a recent, yet limited, body of research aimed at unveiling the origins of Italy's economic development and its regional economic divide. We find that post-unification literacy rates correlate significantly with pre-unification ones. The North was characterised by collective preferences for inclusive education, as witnessed by high literacy rates in the early 19<sup>th</sup> century and a very limited reliance on private schooling at the time of unification. Instead, limited early literacy and the reliance on private education in the Centre and South suggest the persistence of preferences towards a more restricted access to education – which further hampered the transition to mass schooling and, later, mass literacy.

Our results on the existence a dual system of educational development across Italy' regions are linked to the literature highlighting different paths to modernization in the North and the South (Felice and Vasta 2015), as well as the existence of two long-lasting distinct institutional contexts (“access orders” à la North-Wallis-Weingast) (Di Martino, Felice, and Vasta 2020). Our evidence also builds on the results by Ciccarelli and Weisdorf (2019), who argue that skill premia and military schools were important forces improving adult literacy, particularly for males. We provide a complementary explanation for the rise of female (and overall) literacy. Not coincidentally, the more inclusive model of educational provision in the North was the one allowing women to become literate more rapidly than in other regions.

A legacy does not mean destiny, though: we show that the link between pre-unification education and literacy faded out over time, and that convergence between the North and the South started in the first decade of the 20<sup>th</sup> century with limited (but increasing) state intervention, which culminated with the centralization of the school system in 1911 thanks to the Daneo-Credaro Reform (Cappelli and Vasta 2020). By focusing on

the Liberal Age, the present paper is one of the first attempts to investigate how far back in time Italy's regional divide originated and what role pre-unification conditions played in affecting post-unification social and economic attainments. Further research should improve our quantitative knowledge of the expansion of primary education and other social, institutional and economic aspects in pre-unification years, to allow for a better understanding of Italy's long-term development.

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## Data Appendix

Table DA1: 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. For 1891 figures are linear interpolations from 1881 and 1901.	National censuses (various years).
Gross Enrolment Rate, or Rate (GER)	All pupils enrolled in primary schools regardless of age and including repeaters, as a share of primary-school-age children (6–10). Computed for public and private education, female and male.	Inquiries on primary education for pupils enrolled, and national censuses for school-age children (various years).
School efficacy (GER-LIT Gap)	The difference between the GER and literacy for the same cohort, measured in percentage points. Literacy refers to the year $t$ , while the GER concerns $t - 1$ (the same cohort).	See above.
Class size	Number of children (males and females) in primary school age divided by the total number of primary-school teachers. Computed for public and private education, female and male.	Inquiries on primary education for teachers, and national censuses for school-age children (various years). The inquiries are Ministero della Pubblica Istruzione (1865), Ministero della Pubblica Istruzione (1872), Ministero di Agricoltura, Industria e Commercio – Direzione della Statistica Generale del Regno (1881), and Ministero della Pubblica Istruzione (1910). When inquiries were not available, we relied on year-specific statistics regularly published on primary schooling, e.g. for 1891 and 1901.
School expenditure per pupil	Total municipal expenditure for education per pupil enrolled. Total expenditure includes teachers' salaries, maintenance, the construction of new buildings and other, minor items. Figures are in Lire, at current prices (average inflation was around zero during the Gold-Standard era). Figures were only available concerning public education.	Municipal budgets (various years) and inquiries on primary education.
Primary-school density	Number of municipal primary schools divided by the territory of each province (squared kilometres). Computed for public	Inquiries on primary education and national censuses.

	and private education, female, and male (plus mixed schools once introduced).	
Density Evening and Sunday schools	Number of evening and Sunday schools divided by the territory of each province (squared kilometres).	Inquiries on primary education and national censuses.
Latitude	Latitude of the main city of the province in decimal degrees	<i>Passim.</i>
Longitude	Longitude of the main city of the province in decimal degrees.	<i>Passim.</i>
Temperature	Provincial averages obtained from yearly data concerning the period 2000-2009, in Celsius degrees.	<i>Passim.</i>
Rainfall	Provincial averages obtained from yearly data concerning the period 2000-2009, in mm.	<i>Passim.</i>
Urbanization rate	Population living in cities with more than 30,000 inhabitants as a share of total residents	Nuvolari and Vasta (2017).
Population density	Number of residents divided by the territory of each province (squared kilometres).	National censuses.
Dependency ratio	Children (0–10) plus people 65+ 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.
Height	Average height at age 20 of military conscripts.	A'Hearn and Vecchi (2017).
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 population (residents).	Yearbook on Italian Migration, <i>Annuario della emigrazione italiana dal 1876 al 1925</i> (Commissariato Generale dell'Emigrazione 1926), and Carpi (1874) for the 1871 figures.
Migration index (cohort)	The ratio between the number of youngsters (aged 15-19) and the number of children (aged 5-9) ten years before (same cohort).	National censuses (various years).
Industrial VA per capita	Industrial value added (constant prices 1911) divided by the total population (residents).	Own elaboration on Ciccarelli and Fenoaltea (2013).



Electoral franchise	Ratio between the number of local electors and total males older than 21. Local electors are those entitled to vote in provincial and municipal elections.	Cappelli (2016), elaborated from electoral statistics (various years).
Parental literacy rate	Share 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. Computed for grooms and brides separately. The age of spouses averaged 25 – 30 years old.	Marriage registries reported in vital statistics (various years).
Real wages	Real wages are computed as welfare ratios (WRs), that is, the annual earnings of an unskilled worker divided by the cost of a subsistence basket for a family.	Federico, Nuvolari and Vasta (2019).
High VA / low VA industries	The ratio between industrial value added produced by high capital intensive (in terms of horse-power per worker - HP/L) sectors and the one produced within low capital intensive ones	Our elaboration on Basile and Ciccarelli (2018). Data were kindly provided by the authors.
Patents	Number of patents per million inhabitants	Nuvolari and Vasta (2017).
Index of land inequality	The share of large landowners on the total number of landowners.	Cappelli (2017).
Literacy rate 1831	Literacy rate of adults aged 30-40 in 1831.	Ciccarelli and Weisdorf (2019).
Pre-unitary schooling measures	The GER and class size.	Vigo (1971) and Genovesi (1998).

### 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 and class size 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.

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## Appendix

Table A1-a: Descriptive Statistics, 1871-1911

Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>1871 - 1911</i>	<i>1871</i>		<i>1881</i>		<i>1891</i>		<i>1901</i>		<i>1911</i>	
Literacy rate 15-20	34.4	19.4	42.8	22.2	51.5	22.5	60.2	23.1	72.1	20.0
<i>Lag 1: 1861 - 1901</i>	<i>1861</i>		<i>1871</i>		<i>1881</i>		<i>1891</i>		<i>1901</i>	
GER (total)	53.3	37.5	65.4	36.6	87.7	35.5	91.5	33.2	94.8	30.7
Class size (total)	32.1	7.9	36.5	8.6	39.7	8.8	40.5	7.8	42.0	7.4
Expenditure per pupil (public)	23.8	13.3	26.0	13.4	20.7	7.4	24.0	8.0	24.9	6.5
Primary-school density (total)	148.4	139.1	158.2	143.6	231.8	257.1	254.5	270.9	270.4	271.1
GER (private)	7.1	8.4	6.6	5.6	7.0	6.5	6.2	5.5	5.6	4.4
Class size (private)	18.0	6.6	19.4	6.3	20.7	4.3	19.6	3.5	19.0	4.8
Primary-school density (private)	41.5	85.6	34.7	65.0	52.3	144.5	48.9	136.2	45.8	108.6
<i>Controls (1871 - 1911)</i>	<i>1871</i>		<i>1881</i>		<i>1891</i>		<i>1901</i>		<i>1911</i>	
Density of Evening and Sunday schools	65.5	57.8	73.9	66.1	28.8	27.4	22.3	24.4	49.0	53.0
Population density	118.4	107.0	126.7	115.7	134.9	124.4	143.0	133.3	157.1	154.3
Urbanization rate (30,000+)	13.7	16.0	14.4	16.2	15.5	16.5	17.2	17.1	17.9	17.1
Dependency ratio	29.4	1.3	27.3	1.2	28.7	1.2	29.8	1.5	29.2	1.8
Infant mortality rate	41.8	6.0	38.5	6.0	34.6	5.3	30.0	4.6	25.7	5.0
Height	162.8	1.9	163.5	1.9	163.7	1.9	164.0	2.0	165.1	2.0
Share of LF in agriculture	54.9	12.6	53.3	12.7	57.9	12.5	62.4	13.3	58.5	13.4
Industrial VA p.c.	48.9	15.6	55.7	19.3	65.0	26.1	74.2	33.6	103.3	51.5
Outward migration rate	5.2	9.7	4.4	7.7	8.2	12.2	14.1	14.4	17.9	10.7
Share of males 25+ entitled to vote locally	17.7	8.3	22.5	8.9	29.2	11.7	36.7	13.3	43.3	14.0
Migration proxy (pop. ratio)	88.2	5.0	89.9	4.9	88.0	4.5	86.1	4.7	89.1	8.7

Table A1-b: Descriptive Statistics, time-invariant variables

Variable	N	Mean	SD	Min	Max
Literacy 1831	69	26.2	11.5	10	55
Pre-Unification GER	50	25.1	19.2	2.38	91.3
Pre-Unification class size	50	29.3	12.7	7.31	56.3
Latitude	69	42.7	2.62	37	46.1
Longitude	69	12	2.47	7.33	18.1
Average temperature	69	13.7	2.5	6.1	18.3
Average rainfall	69	775	109	465	1103

Table A2: Education Production Function: GER capped at 100 percent, and literacy capped at 90 percent; panel estimates, 1871-1911

Panel Variables	(1) FE GER-LIT Gap (GER<100)	(2) FE GER-LIT Gap (LIT<90)
Class size (total)	0.452*** (0.166)	0.691*** (0.142)
Expenditure per pupil (public)	-0.169** (0.076)	-0.179** (0.084)
Primary-school density (total)	0.045*** (0.012)	0.053*** (0.012)
Density of Evening and Sunday schools	-0.005 (0.025)	0.023 (0.021)
Control variables	Y	Y
Province FE (69)	Y	Y
Year dummies	Y	Y
Macro-region FE (4)	N	N
Observations	212	313
Adjusted R-squared	0.718	0.671

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table A3: Education Production Function: alternative correlates, panel estimates, 1871-1911

Model	(1) FE GER (total)	(2) FE GER (total)	(3) FE GER (total)	(4) FE GER (total)	(5) POLS GER (total)	(6) FE GER-LIT Gap	(7) FE GER-LIT Gap	(8) FE GER-LIT Gap	(9) FE GER-LIT Gap	(10) POLS GER-LIT Gap
Class size (total)	1.394*** (0.198)	1.519*** (0.219)	1.506*** (0.217)	1.503*** (0.219)	1.458*** (0.146)	0.678*** (0.142)	0.706*** (0.126)	0.699*** (0.125)	0.718*** (0.123)	0.595*** (0.109)
Expenditure per pupil (public)	-0.091 (0.120)	-0.086 (0.121)	-0.097 (0.124)	-0.132 (0.113)	0.031 (0.091)	-0.201** (0.078)	-0.195** (0.079)	-0.193** (0.079)	-0.204*** (0.073)	-0.209*** (0.068)
Primary-school density (total)	0.062*** (0.021)	0.067*** (0.025)	0.068*** (0.024)	0.070** (0.027)	0.089*** (0.027)	0.052*** (0.013)	0.052*** (0.013)	0.051*** (0.012)	0.053*** (0.013)	0.056*** (0.020)
Density of Evening and Sunday schools	0.011 (0.017)	0.007 (0.015)	-0.001 (0.015)	0.010 (0.016)	0.047*** (0.012)	0.012 (0.016)	0.010 (0.017)	0.008 (0.017)	0.014 (0.017)	0.024 (0.015)
Male parental literacy	0.933*** (0.185)					-0.062 (0.182)				
Female parental literacy	-0.087 (0.121)					0.092 (0.137)				
Real wages (FNV basket)		3.154 (3.789)					0.513 (2.899)			
High-to-low value added (industry)			7.429* (4.059)					1.908 (3.380)		
Patents per million inhabitants				0.103* (0.057)					0.062* (0.035)	
Land inequality 1871					-0.022 (0.037)					0.023 (0.029)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province FE (69)	Y	Y	Y	Y	N	Y	Y	Y	Y	N
Macro-regional FE (5)	N	N	N	N	Y	N	N	N	N	Y
Observations	345	345	345	345	345	345	345	345	345	345
Adjusted R-squared	0.848	0.826	0.829	0.831	0.929	0.634	0.634	0.634	0.640	0.787

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Notes: all models are with FE and year dummies, except from Columns 5 and 10, where we only include macro-regional FE (5 macro-regions) to allow the inclusion of a variable for land inequality in c. 1871 (time invariant). All geographic controls (latitude, longitude, average temperature and rainfall) are included in the POLS specifications. Sources: see Table DA1 above.