Cliometrica
Journal of Historical Economics and Econometric History

Cliometrica provides a leading forum for the exchange of ideas and research in historical economics, covering all facets, all historical periods, and all parts of the world. The journal encourages the methodological debate, use of economic theory, model building, and reliance upon quantification to support models with historical data. Moreover, it stresses the use of standard historical knowledge to broaden understanding and suggest new avenues of research as well as the use of statistical theory and econometrics to combine models with data into a single consistent explanation. Periodically, specialized topics are addressed in special issues.

Officially cited as: *Cliometrica* — show all

Editor-in-Chief
Claude Diebolt

For authors

Submission guidelines

Language editing services

Ethics & disclosures

Open Access fees and funding

Contact the journal

Submit manuscript

About this journal

Abstracted and indexed in

ABS Academic Journal Quality Guide

ANVUR

Arts & Humanities Citation Index

Australian Business Deans Council (ABDC) Journal Quality List

BFI List

Baidu

CLOCKSS

CNKI

CNPIEC

Current Contents / Social & Behavioral Sciences

Current Contents/Arts and Humanities

Dimensions

EBSCO Business Source

EBSCO Discovery Service

ECONIS

EconLit

Google Scholar

Journal Citation Reports/Social Sciences Edition

Naver

OCLC WorldCat Discovery Service

Portico

ProQuest ABI/INFORM

ProQuest-ExLibris Primo

ProQuest-ExLibris Summon

Research Papers in Economics (RePEc)

SCImago

SCOPUS

Social Science Citation Index

TD Net Discovery Service

UGC-CARE List (India)

Wanfang

Copyright information

A "Silent Revolution": school reforms and Italy's educational gender gap in the Liberal Age (1861–1921)

Gabriele Cappelli[1] · Michelangelo Vasta[1]

Abstract

This paper explores the evolution of the human capital gender gap in Liberal Italy (1871–1921). First, we show that Italy lagged some 50 years behind more advanced countries like France, Prussia and the UK, and that the regional divide in gendered literacy was unparalleled in the rest of Europe. Next, we test whether the shift to primary-school centralization in 1911 (the Daneo-Credaro Reform) brought about a decisive improvement in female literacy. We rely on a brand new, cross-sectional micro (municipal)-dataset of literacy rates in 1911 and 1921, as well as their potential determinants around 1911. Such data, combined with propensity score matching to improve identification, show that primary-school centralization increased the average annual growth of female literacy by 0.78 percentage points. Thus, even though the Reform did not aim at girls specifically, it brought about the unintended consequences of more rapid human capital accumulation for women and—ceteris paribus—a reduced educational gender gap. We briefly discuss why this "Silent Revolution" likely had important implications for Italy's economic history.

1 Introduction

The theoretical literature considers human capital a crucial factor of economic growth. Higher skills affect economic performance through the improvement in labor productivity (Mankiw et al. 1992) and increasing innovative capacity brought about by the more educated labor force (Nelson and Phelps 1966; Lucas

✉ Gabriele Cappelli
gabriele.cappelli@unisi.it

Michelangelo Vasta
michelangelo.vasta@unisi.it

[1] Department of Economics and Statistics, University of Siena, Siena, Italy

1988; Romer 1990). The empirical literature has confirmed the existence of a nexus between human capital and economic growth by using cross-country growth regressions (Barro 1991; Lindahl and Krueger 2001; Barro and Lee 2015).[1] In recent years, unified growth theory has also connected economic performance to long-term human capital accumulation (Galor 2005, 2011). Within this stream of the literature, the schooling of women and the educational gender gap have become a central issue, because of the mutual relationship between the fertility decline and the demand for education (the quantity-quality trade off) that ultimately fosters long-term human capital accumulation (Cinnirella 2019; Diebolt and Perrin 2019).

Since the classic article by Amartya Sen (1990), who coined the term "missing women," the issue of gender inequality has received a growing attention by economists. On the one hand, economic development plays a crucial role in reducing gender inequality; on the other hand, empowering women accelerate the pace of economic growth through a virtuous circle linking female empowerment, human capital accumulation and technological progress (Diebolt and Perrin 2013)—even though, under specific conditions, gender inequality can also be associated with economic growth (Seguino 2000). Because of this, one of the most important dimensions of the gender gap is education. Indeed, large educational differences between men and women lower aggregate human capital, resulting in less investment in the education of children—possibly linked to higher fertility (Klasen 2002).

Within economics, the link between institutional change and educational gender inequality has been under researched. Indeed, school policy may foster human capital accumulation, so it becomes relevant to bring about equity between men and women (Duflo 2012). This result is consistent with research carried out on the USA (Clay et al. 2012), yet it remains an isolated attempt to investigate whether school reforms affected education and, more specifically, the education of women.

Within economic history, the educational gender gap has received very little attention, with few important exceptions (Becker and Woessmann 2008; Diebolt et al. 2017; Hippe and Perrin 2017; Jaoul-Grammare and Perrin 2017; van Zanden et al. 2019), even though Cipolla (1969) dealt with this issue in his seminal book on literacy in the West. Concerning Italy, the need for historical research on the educational gender gap is even more compelling: indeed, the issue seems to have been neglected by coeval observers, historians and economic historians, with some notable exceptions (Bertocchi and Bozzano 2016; Ciccarelli and Weisdorf 2019).

We contribute to this line of research in two ways. First, we reconstruct regional patterns of the human capital gender gap in Liberal Italy by relying on literacy data. Second, we test whether the Daneo-Credaro Reform of 1911, which represented a strong move toward centralized funding and management of primary schooling, had a substantial impact on the literacy of women. A peculiar feature of the Daneo-Credaro Reform of 1911 can be studied as a quasi-experiment: virtually, all country's municipalities shifted to centralized primary education from a previous system based on extensive local school autonomy; yet, the provincial and district capitals were excluded from this new administrative structure. Therefore, the educational

---

[1] The causality can also run from economic development to human capital accumulation (e.g., Bils and Klenow 2000; Diebolt and Jaoul-Grammare 2006).

performance of the municipalities that retained autonomy can be compared to that of the administrative units that shifted to centralization (Cappelli and Vasta 2020). Since the "treated" municipalities may be inherently different from the provincial and district capitals (control group), propensity score matching (henceforth PSM) is used to study the impact of the Reform as if it was a randomized experiment (Rosenbaum and Rubin 1983). Indeed, due to the lack of pre-1911 data at the municipal level, a Diff-in-Diff approach is not viable, as we explain below.

We put forward that the new organization of primary schooling—through more elective school boards and a new mechanism to redistribute resources to disadvantaged areas—and additional funding benefitted more women than men on the margin. This happened because the education of women was heavily neglected within Italy's primary-school system. Because of this, additional funding and improved management benefitted female literacy more than aggregate literacy.

Concerning the primary-school gender gap in Liberal Italy, we find it to have been strikingly large and long-lasting: the ratio of female to male literacy from marriage registers, i.e., the Gender Parity Index (GPI), was 85 percent in 1911, a value that many Western European regions had reached 40–60 years earlier. Furthermore, by 1911, the educational gender gap still differed substantially across regions of Italy, being larger in the South of the country. Second, our results show that primary-school centralization increased the average annual growth of female literacy by 0.78 percentage points over the period 1911–1921. Thus, one may consider the Daneo-Credaro Reform as a "Silent Revolution" concerning female education, even though we find that the improvement in women's literacy was seemingly brought about as an unintended consequence of the new organization of the primary-school system.[2]

The rest of the paper is organized as follows: Sect. 2 presents a literature review on human capital formation and the gender gap in Italy during the Liberal Age, while Sect. 3 illustrates the legislative framework and deals with the educational performance and the gender gap in a comparative and regional perspective. Section 4 explains the empirical strategy focusing on the data and methods, while Sect. 5 presents the results of the paper. Section 6 concludes.

2 Literature review: a Silent Revolution

Italy's economic growth in the long run is tightly linked to human capital accumulation. Vasta (1999) maintains that the remarkable delay in human capital accumulation has been a heavy toll on the country's capability to reach sustained growth in the long run and up to the present day (Di Martino and Vasta 2017). Indeed, the new stream of empirical quantitative studies in Italy's economic history has claimed that the aggregate stock of human capital is a main driver of industrial location (Basile and Ciccarelli 2018, Missiaia 2018), innovation (Nuvolari and Vasta 2017), industrial growth (Cappelli 2017a) and the growth of real wages (Federico et al. 2019).

---

[2] The expression "Silent Revolution" has already been used by Baudelot and Establet (2006) in the subtitle of their book, *Allez les filles!*.

Furthermore, schooling and education are crucial determinants of the long-term economic divergence between the North and the South of the country (Felice 2012; Felice and Vasta 2015).

Due to this line of research, Italy's primary-school system during the Liberal Age and its relationship with education and human capital accumulation have been debated extensively, being mainly focused on the country's comparative human capital disadvantage and the educational North–South divide. Within the literature, there is a general agreement on the problematic nature of Italy's decentralized primary-school system (Felice and Vasta 2015; Cappelli 2017b), which hampered human capital accumulation, innovation and technological progress (Nuvolari and Vasta 2015, 2017). As we explain in more detail below, the system established in 1859 set forth that funding and management of primary schooling was a burden on Italy's municipalities. New legislation on primary education in the first decade of the twentieth century—such as the Coppino or the Orlando Laws—produced a reduction in the literacy divide between North and South and prompted more rapid human capital formation; yet, amazingly, by 1911, average adult male literacy in the South was no higher than what it had been in Northern Italy in 1821 (Ciccarelli and Weisdorf 2019; Figure 7) and Italy lagged behind the educational performance of other countries.

Two main interpretations have been provided on the determinants of such educational trends. On the one hand, stressing the political-economy mechanism under decentralized education, A'Hearn and Vecchi (2017) have argued that municipalities where land inequality was large and—partly because of that—local electoral franchise limited, did not raise local taxation to fund primary schooling. On the other hand, Zamagni (1993) suggested that low literacy rates in the South and rural areas were due to the municipalities' limited fiscal capacity. Similarly, Vasta (1999) stressed that school decentralization was detrimental to education in the Southern regions of Italy, provided the heterogeneity within the country. Cappelli (2016a) has put both hypotheses to the test, arguing that fiscal capacity was more independent from land inequality and suffrage than what is claimed by A'Hearn and Vecchi (2017). According to him, local economic performance determined local resources to fund primary education, improving inputs into schooling and expenditure per child—even though the political-economy mechanism à la A'Hearn and Vecchi is recognized to have played some role. Indeed, an empirical analysis by Cappelli and Vasta (2020) demonstrates that the Daneo-Credaro Law (1911) was a crucial Reform, which brought about more extensive state funding and a more centralized management of primary schooling: according to the authors, such a change improved regional convergence in schooling and the pace of diffusion of primary education in the country.

Educational gender inequality is a crucial aspect of Italy's development, since the country was characterized by a very large and regionally uneven educational gender gap. Although some recent works on Italy's historical human capital have devoted some attention to this aspect (Bertocchi and Bozzano 2016; A'Hearn and Vecchi 2017, p. 186), a comprehensive study on the evolution of educational gender inequality and its determinants in the Liberal Age (1861–1921) is still missing. The most complete and accurate quantitative reconstruction on the evolution of the educational gender

gap is provided by Ciccarelli and Weisdorf (2019), who rely on the original methodology of backcasting to reconstruct adult literacy rates by gender and province from 1821 to 1911. Similarly, little has been written on the link between institutional change and gender educational inequality. According to Ciccarelli and Weisdorf (2019), the unification of the country—which meant the birth of a unified, national compulsory primary-school system—is associated with a first reduction in the educational gender gap, at least in the central and northern regions—similarly to what Cappelli and Vasta (2020) have found concerning the positive impact on literacy of the Daneo-Credaro Reform in 1911. Despite this, the link between school reforms and gender educational inequality has not been specifically investigated. Since the study by Cappelli and Vasta (2020) neglects the issue of the educational gender gap, we posit that this important Reform may have represented a Silent Revolution that affected the education of women even more than that of men—an aspect that has not been investigated so far.

In 1869, Giulia Molino Colombini, a writer and pedagogist famous for her *Sulla educazione della donna* (On the education of the woman, first published in 1851), claimed that "to women who were going to work for their whole life, education was useless" (cited in Soldani 1993). Such coeval view is confirmed by the norms contained in one of the first decrees aimed at consolidating the country's unified national school system, passed in 1860 (*Regio decreto 15 settembre 1860*, no. 4336, art. 25). The decree proposed that more teachers should be hired, but that they would teach male and female pupils in the same school (*scuola mista*). Boys would be given priority. According to Soldani (1993), for every 75 min of classes received by male pupils, only 45 were gotten by female students—and some of that time was destined to learn "housewives' occupations" (*lavori donneschi*) and needlework. Based on this, our hypothesis on the potential impact of primary-school centralization stems from the historical evidence (albeit limited) on the policy-maker's preference for male education. We posit that the education of female students was left with the short end of the stick, and that the Daneo-Credaro Reform increased the pace of female literacy growth by improving access to primary schooling for the most marginalized within the education system.

3 Education and the gender gap (1861–1921)

This section sketches the evolution of Italy's primary-school system in the Liberal Age (1861–1921) by focusing on both the legislation and the educational performance in a comparative and regional perspective, paying specific attention to gender disparities.

3.1 Primary-school laws

The Kingdom of Italy established a national education system during the process that led to the unification of the country. Concerning primary education, the Kingdom of Sardinia's Law no. 3725/1859, known as the Casati Law, decentralized the funding and management of primary schooling at the municipal level, while providing national rules on the curricula and salary of teachers (Vigo 1971; Cives 1990). The Casati Law stated that education had to be offered free of charge,

"proportionally to the municipalities' spending capacity and according to their people's need." Primary education lasted only for 2 years, from six to eight and, if a municipality had a population larger than 4000 inhabitants or a secondary school, education was compulsory for another 2 years. The Law no. 3961/1877 (Coppino Reform) raised the years of compulsory (first-grade) primary schooling from two to three, and established sanctions aimed at reducing parental misconduct and poor enforcement of compulsory attendance. Despite these efforts on paper, state intervention to improve attendance remained weak throughout the nineteenth century. In the early years of the twentieth century, two new laws were passed: the Law no. 45/1903 (Nasi Law) established the right for female teachers to have the same wage of their male colleagues, while the Law no. 407/1904 (Orlando Law) raised the age of compulsory education up to 12, introducing the first increase in teachers' salary since 1886 (Cives 1990). Some norms concerning schooling were also included in the Law no. 383/1906 (Special Law for the Southern Regions of Italy); yet, a significant step toward a radical change of the education system was taken with the Law no. 487/1911 known as Daneo-Credaro Law, which represented a clear shift toward centralized primary education. The type of centralization introduced by the Reform was twofold. On the one hand, it affected the function and importance of the *Consiglio Scolastico Provinciale* (provincial school boards, henceforth CSP)—which had previously played a mere advisory role: the CSP was redesigned to manage resources allocated to primary education and to hire teachers. On the other hand, the system was centralized financially far more than it had ever been, as the state was fully committed to pay teachers' salary. State funding for primary schooling as a share of the country's GDP more than doubled within 1 year: according to Coccia and Della Torre (2007, Figure 5), it grew from 0.12% in 1911 to 0.25% in 1912.

The reading of the articles and norms contained in the primary-school legislation introduced throughout the second half of the nineteenth century and up to 1911 does not pick up any information on the education of women, nor does it highlight any will to tackle the issue of the primary-school gender gap by policy makers and legislators. The issue is also very much neglected by the most-known accounts of Liberal Italy's primary schooling: no specific chapter on the education gender gap is included in books discussing the matter, like Cives (1990), De Fort (1996) or Galfré (2017). Even the detailed inquiries on the state of Italy's primary schooling before World War I, published at regular intervals between 1865 and 1912, *never* address the education of women as major issue within the school system (Ministero della Pubblica Istruzione 1872, 1897, 1910).

In fact, the data collected by Italy's government throughout the Liberal Age certainly depict a dismal picture about the educational gender gap: a first result of our work is, indeed, the finding that women's education was completely neglected in Liberal Italy, despite its magnitude. The lack of specific norms concerning the education of women in the *Regio Decreto* 4 ottobre 1848, no. 818 (Boncompagni Law)—the first legislation set forth by the Kingdom of Sardinia on compulsory schooling that inspired the same legislation in unified Italy—was not amended by the Casati Law. Rather paradoxically, some have seen this point as something potentially impeding the discrimination of women in primary schooling (Manacorda 1989). However, our data show that the legislation was interpreted in the most

Table 1 Comparative literacy rates, 1860–1950 *Source*: see the dataset reporting the Historical Index of Human Development (https://espacioinvestiga.org/home-hihd/?lang=en) and Prados de la Escosura (2015)

Country	1860	1880	1900	1913	1950
USA	80.3	83.0	88.4	91.8	96.8
Japan	25.0	41.1	53.1	74.8	97.9
France	62.7	72.8	83.5	88.1	96.5
Germany	86.0	92.0	96.3	97.0	98.5
Italy	25.3	38.4	50.1	60.7	85.6
Spain	25.7	31.4	41.3	42.2	82.4
Sweden	91.2	93.6	96.0	97.6	98.5
UK	69.4	82.7	94.1	96.4	98.5

Literacy figures refer to adult (15+) literacy. The repository defines a literate person as one "who can, with understanding, both read and write a short simple statement on his everyday life." Even if the exact definition of literacy may vary to a little extent across sources and countries, the general picture is not likely to change due to this

conservative way—ignoring the issue of female education and de facto hampering it.

3.2 Human capital accumulation: a comparative perspective

Two distinct features characterized Italy's human capital endowment after the unification of the country: the comparative backwardness and the remarkable regional divide. To discuss evidence on the former, we rely on the most common measure of human capital in a historical perspective, literacy, which is available for a sample of peer economies. Table 1 displays how Italy fared compared to other European countries, plus the USA and Japan.[3] The human capital gap was extremely large in 1860, yet Italy (with Spain) failed to catch up quickly with the first comers within the sample. By 1913, Japan had leaped forward, converging rapidly toward 80 percent literacy and approaching the other high-income countries. Italy, with about 60 percent literacy, lagged behind the most advanced economies with a gap of 30 percentage points, being followed by Spain.

The educational gender gap, as expressed by the literacy Gender Parity Index (GPI), is a striking feature of Italy's Liberal Age. The literacy GPI (the ratio of female to male literacy) based on marriage registers that we retrieved for 1911 was equal to 85 percent: the same marriage-register literacy GPI had been reached by England in c. 1850 (Clark 2007, Fig. 9.3, p. 179) and by France in c. 1870; census-based data suggest that Prussia's literacy GPI was about 95 percent by 1870 (Becker et al. 2014).[4] This result is consistent with the data presented and discussed

---

[3] We wish to thank Leandro Prados de la Escosura for sharing his data with us.

[4] A comparison of the literacy GPI from marriage registers and census data for Italy suggests that the two sources lead to virtually equal results. The Prussian aggregate female and male population younger than 10 years old (not reported in the online dataset for 1871) has been estimated by assuming that the

Table 2 Gender Parity Index (literacy) in France and Italy. *Sources*: for France, data were kindly provided by Faustine Perrin (see Diebolt and Perrin 2013); for Italy, own elaborations from *Ministero dell'Istruzione* (1890)

Year(s)	France		
	Grooms (% literate)	Brides (% literate)	GPI (literacy)
Average 1884–1886	86.40	78.10	0.90
1887	87.90	81.00	0.92
Year(s)	Italy		
	Grooms (% literate)	Brides (% literate)	GPI (literacy)
Average 1884–1886	55.85	34.76	0.62
1887	57.17	37.18	0.65

In both countries, data refer to the capability of grooms and brides to sign marriage registers (writing)

by Hippe and Perrin (2017, Fig. 2), who show that the literacy GPI was particularly low in Italy's South around 1900: only a few regions in the Iberian Peninsula show similar values, i.e., below 40 percent.

Table 2 provides a more direct and detailed snapshot of the literacy gender gap in Italy and France during the 1880s. France exhibited very little gender gap in 1887 (92 percent), while in Italy there were 65 literate females for every 100 literate men—the same ratio being 40 percent, on average, in the South of the country. Italy would reach the 1887 French value of the Gender Parity Index in the at the beginning of the 1920s, i.e., c. 40 years later, while the South of Italy would not approach gender equality in literacy until World War II.

3.3 Human capital accumulation: a regional perspective

The national development of human capital is strongly linked to the issue of the educational regional divide, a pressing one since the rise of mass education policies in pre-unification states (Ciccarelli and Weisdorf 2019). Figure 1 shows the spread of literacy in unified Italy's 69 provinces in 1871 and 1911 (central and right-hand-side maps), while comparing it to pre-unification estimates (left-hand-side map). The most important and remarkable feature that comes up clearly from the maps is the long-lasting persistence of regional inequality. The pre-unification map matches almost perfectly the post-unification (1871) one—the exception being the Kingdom of Sardinia, where the most backward Sardinia is mingled with the high-literacy Piedmont and Liguria, and the Kingdom of Lombardy-Venetia, where Lombardy was much ahead of Veneto. In the South, in 1871, literacy rates were still around 10–15 percent, with the exception of the provinces of former capitals, Naples and

---

Footnote 4 (continued)

proportion of females to males below 10 was the same of that characterizing the whole population. The female and male number of people has been obtained by subtracting the number of children below 10 from the total population.
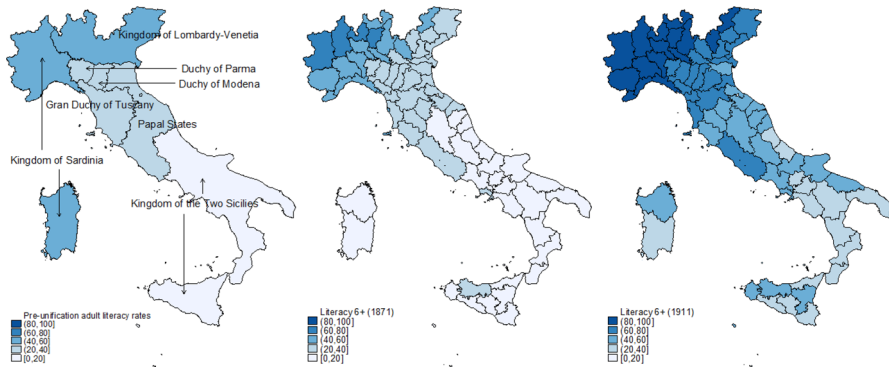
Fig. 1 Literacy rates prior to unification, post-unification (1871) and in 1911. *Notes*: data for 1871 and 1911 refer to the population 6+, while pre-unification literacy rates are reported for adults. The pre-unification Kingdom of Sardinia excludes the Savoy region, since the latter is not included in post-unification Italy, and thus in the maps provided by Sistat, http://sistat.istat.it/sistat/. *Sources*: pre-unification literacy rates are compiled from Ciccarelli and Weisdorf (2019, Table 1). Post-unification figures come from population censuses
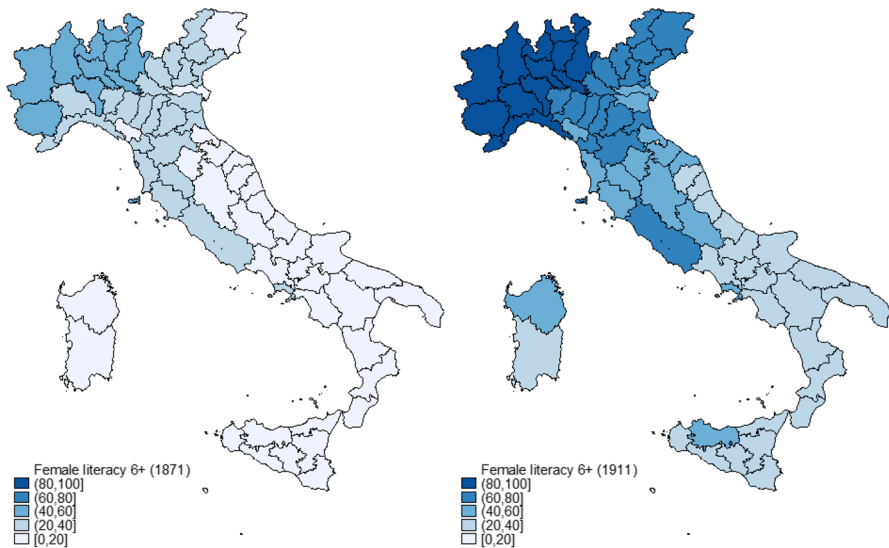

Fig. 2 Female literacy rates in 1871 and 1911. *Sources*: population censuses

Palermo. By 1911, while the Northwestern "triangle" of Piedmont, Lombardy and Liguria was approaching full literacy, the regional inequality highlighting three distinct macro-regions was still evident.

Naturally, the issue of the regional divide pertains to the educational gender gap, too. Figure 2 shows the provincial distribution of female literacy rates (age 6+) in 1871 and 1911. Nowhere in 1871 in Italy did female literacy surpass 60 percent. In
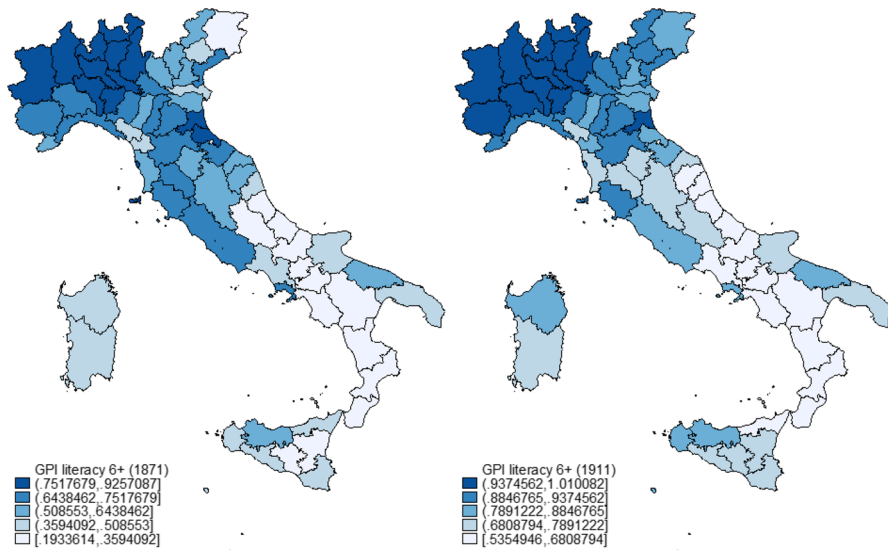
Fig. 3 Gender Parity Index (Literacy) in 1871 and 1911. Notes: the class ranges are based on quintiles; thus, each class contains 20% of Italy's provinces. *Sources*: population censuses

most of the country's central and north-eastern provinces, indeed, the literacy rates of women remained well below 40 percent. In the South, women's literacy ranged from 3.7 in the province of Cosenza to 16 percent in the province of Palermo—excluding the province of Napoli, the former capital of the Kingdom of the Two Sicilies, where female literacy was anyways as low as 22 percent. While the situation had improved everywhere by 1911, the relative difference between the North and the South in terms of female literacy remained large.

Unsurprisingly then, the GPI of literacy remained very different across areas in the country during the Liberal Age. Figure 3 shows the distribution of the GPI in Italy in 1871 and 1911. Although there was a general improvement, the relative inequality between provinces did not change.[5] The North–South divide is still well visible in 1911. Moreover, in the latter year, an increase in the gap between the North and Central provinces is evident.

If one combines the regional and comparative perspective, Italy's position within Europe at the beginning of the twentieth century is unequivocally negative. Hippe and Perrin (2017, p. 173, Figure 2) show that Italy was the country with the largest regional (NUTS-2) inequality in the literacy GPI within Europe, and the definition of which includes southeastern Europe and European Russia. Italy's literacy GPI regional values range from less than 0.20 in Basilicata to parity in the Northwest. In what is arguably the most similar country to Italy in Hippe and Perrin's sample, that is Spain, the literacy GPI regional values were all within the 0.40–0.80 range.

---

[5] Note that the maps are based on quintiles, meaning that each class contains 20% of the country's 69 provinces. This is done to highlight the persistence of regional disparity in the GPI even if some convergence, in 40 years, occurred.
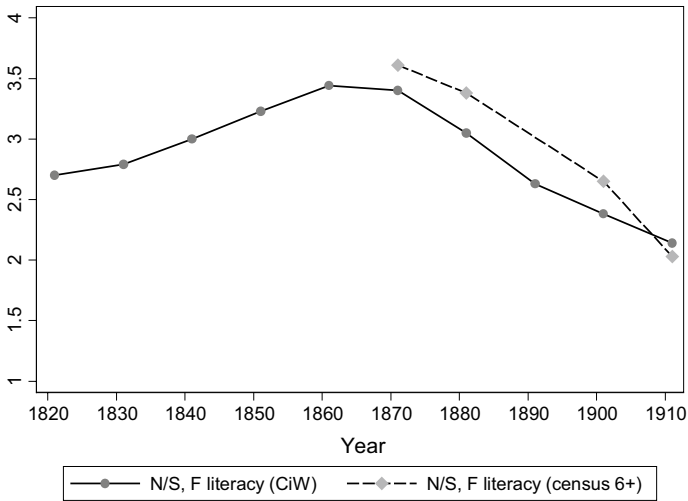
Fig. 4 North–South ratio for female literacy rates, 1821–1911. Notes: the series for 1821–1911 (solid line) refers to the female population aged 30–40. The series for 1871–1911 (dashed line) refers to the female population aged 6+. Concerning the former, we calculate the North and South values of female literacy by weighting each regional value for its female population in 1881. Concerning the latter, we weighted each regional value with the female population aged 6+, separately for each census year. *Sources*: the 1821–1911 series is based on data provided by Ciccarelli and Weisdorf (2019). The series for 1871–1911 is based on census data

Figure 4 takes a more diachronic perspective, displaying the evolution of the North and Centre-South divide in female literacy from 1821 to 1911, at 10-year intervals. The solid line is based on data published by Ciccarelli and Weisdorf (2019) concerning the literacy rate of women aged 30–40, while the dashed line represents our own series on the literacy rate of females aged 6 + (from census figures). In the early nineteenth century, for every ten literate women in the South, 2.5 women could read and write in the North. This gap had widened by the time the country was unified under the Kingdom of Italy in 1861—up to almost 3.5 to one. This was mainly due to the rise of male literacy in the North driven by early proto-industrial activity and early public-school legislation, while female literacy remained stagnant. Since then, no matter what series one considers, there has been a decline in the regional divide, which in 1911 was still large: the ratio was two to one, not much lower than it had been in 1821. The more rapid decline in the 6+ series may reflect the fact that initial reforms of primary schooling (which likely affected girls aged 6–14) were introduced in the first decade of the twentieth century. Indeed, Table 3 shows that, in absolute terms, the first decade of the twentieth century brought about the largest annual absolute gain in female literacy rates in the South.

The fact that the North–South gap in female literacy and the gender equality had not improved much over the late nineteenth century—and that the Italian GPI in literacy in 1911 was still behind the one of France in the mid-1880s—prompts the question of whether the Daneo-Credaro Reform fostered literacy by affecting the education of women substantially. We want to stress that, in the following, the focus

Table 3 Absolute gains in female literacy (percentage points, annually) in different periods

Period	Annual gain (percentage points)
1871–1881	0.32
1881–1901	0.49
1901–1911	1.30

will be on the aggregate impact of the Reform, i.e., whether the shift to centralized administration and funding proved beneficial to the literacy of women. Although the main approach that we use to investigate the relationship between policy and the gender gap does not explicitly address the issue of regional inequality, part of what we discuss below is linked to this specific question. Finally, we want to stress that no research has been done on this matter concerning the post-1911 period. The next section, thus, presents the new data and methodology that we use to explore the aforementioned questions.

4 Empirical strategy

The history of the Italian primary-school system provides an excellent identification strategy to improve the understanding of the impact of centralized schooling on the educational gender gap. Our quasi-experiment draws on a peculiar feature of the Daneo-Credaro Reform of 1911: while most of the country's municipalities (*comuni*) were forced to shift to centralized primary education, the provincial and district capitals were excluded ex-ante from the state-regulated administrative structure. This allows us to compare the educational performance of the *comuni* that retained autonomy with those that shifted to centralization. Given the absence of pre-1911 historical municipal data, propensity score matching (PSM) is the best methodological tool to explore the impact of the shift to centralization on the growth of female literacy rates in the period 1911–1921 (a DiD approach with municipal data is not viable).

4.1 Data

Systematic quantitative analyses of the economy of the early twentieth century have rarely been conducted at the municipal level. In this paper, we rely on a new version of a micro-dataset on economic, social and institutional variables for a 10-percent stratified sample that is fully representative of the whole population of Italian municipalities: the dataset was compiled by Cappelli and Vasta (2020) and it has been expanded by collecting new data on female education. We include all the *comuni* that—following the Daneo-Credaro Law (art. 14)—were granted autonomy in education policy, i.e., the provincial and district capitals (272 observations). We include all of them given their small number compared to the total number of other

Italian municipalities (8000+). Concerning the treatment group, we draw 802 observations by calculating, for each province, the number of municipalities and their cumulative population, excluding district and provincial capitals. Then, we calculate the share of these provincial figures in the national total (excluding capitals). We use this figure on provincial population as a share of the national total to understand how many observations (municipalities) we need to draw from each province. To form the final representative sample, we generate random numbers without replacement.[6]

Our outcome variable is the average annual growth of female literacy (population 6+) in 1911–1921, while all other variables are measured at the beginning of the period, which is drawn from the 1911 and 1921 population censuses. At the municipal level, data on literacy are not available by age. For this reason, it is impossible to assess the impact of school centralization on the human capital of people within different age groups. Even though we cannot reconstruct pre-1911 literacy trends at the municipal level, we include the 1911 female literacy in the probit regression used to estimate the propensity scores for our PSM model. This means that only municipalities with a very similar level of literacy—hence, the same level of development and scope for future human capital accumulation—will be compared to assess the impact of the Daneo-Credaro Reform, limiting potential bias due to different pretreatment trends. Finally, it is worth noting that other measures of schooling (enrolments, teachers) are not available at the municipal level *after* 1911, and hence, they cannot be used as post-treatment dependent variables.

The treatment is identified by the Reform dummy, i.e., a variable that takes a value of 1 if a municipality shifted to centralized primary education. To capture the impact of the Reform, we track whether—and when—each of the municipalities in our sample shifted to centralized primary education. We use the information contained in the *Gazzetta Ufficiale* (Official Gazette of Italy) to reconstruct the pattern of diffusion and implementation of the Reform, which was executed through dozens of Royal Decrees. All the *comuni* in our sample that were bound to change by the new norms—together with c. 100 district and provincial capitals that were supposed to retain school autonomy—moved to the centralized school system in 1914–1915.[7] Based on the pattern observed, we code the Reform dummy variable, assigning a value of 1 if the shift happened in those 2 years. We choose this time span because our first aim is to explore the impact of the Daneo-Credaro Reform in the 1911–1921 period. For this reason, in our analysis, we do not consider moves to centralized schooling that occurred after 1916.[8]

---

[6] For further details on this procedure and sampling results, see Cappelli and Vasta (2020, section III).

[7] The Law stated that the municipalities that were bound to shift to centralization could apply to retain school autonomy within 3 years after the Reform was passed. To obtain this exception, they had to comply with severe constraints, one of which was to have an illiteracy rate less than 25 percent, according to the 1911 census. This does not affect our identification strategy since we consider the 1911 literacy rates in our models. The district and provincial capitals could also apply to shift to centralization. Although there is no precise constraint to limit this shift, we can overcome the potential problem of self-selection using the PSM.

[8] A handful of municipalities regained autonomy between 1916 and 1917. Therefore, in these cases, the Reform dummy is equal to 0, given the short amount of time available to implement the Reform.

Our dataset also includes data on various aspects of Italy's municipalities. As previously explained, we include the initial level of literacy among the covariates because we expect municipalities with lower education to experience a faster accumulation of human capital over time. The literacy data come from the 1911 population census. We include female literacy to control for the fact that more literate municipalities will be characterized, ceteris paribus, by a more limited scope for literacy expansion over time. The male literacy rate is also included as a control: preferences about female versus male education may vary among municipalities depending on cultural, historical, socioeconomic and demographic factors. Although many of the latter are added to our model, we include male literacy for the sake of robustness. We draw on the Corradini Inquiry[9] to collect detailed data on inputs into schooling across Italy's municipalities in 1907–1908. The Inquiry provided several reports by inspectors who witnessed the state of schools across Italy's provinces and detailed data on municipal expenditures, teachers, schoolhouses, didactic material, performance and state subsidies. We rely on the Inquiry to construct several indices of schooling, like compulsory primary schools and elective primary schools per 1000 inhabitants, the ratio between state and total expenditure on primary education, the share of educational expenditure on the municipality's total budget and municipal per capita expenditure on primary education. We include these school-related variables because educational inputs will affect the output (literacy rates). Other important variables that can affect the development of primary schooling are included to capture supply and demand-side determinants of education. We code the altitude above the sea level for each municipality to proxy for geographic features that might have hampered access to schools (ruggedness). We also include access to sea (dummy equal to 1 if seaside within a 5-km radius) and the linear distance (in km) from the nearest university. The former should be positively related to schooling since closeness to sea should favor trade and economic activity; the latter is included because higher education might increase the demand for primary schooling. The share of local electors on total population[10] is constructed from electoral statistics published in 1897, which is the closest available publication to 1911 reporting municipal data.[11] This variable reflects the growing importance attached to political voice and accountability (Engerman and Sokoloff 2002; Mansuri and Rao 2013): more restricted elites likely hamper the spread of basic public education. We capture the demand for skills by drawing on the 1911 industrial census, which was published in 1913,[12] so that we can estimate the number of industrial workers per 1000 inhabitants and the number of industrial-engine horsepower (HP) per 1000 inhabitants. We posit that larger and more mechanized industries increase the demand for education. We include population density and military deaths due to the Great War as a share of the total population as further controls. The former might favor economies of scale linked to the organization of schooling, while the

---

[9] This major inquiry of the time contains data for the 1907–1908 school year and represents an outstanding source of information on the state of Italy's primary schools before WWI.

[10] These were municipal and provincial elections.

[11] Ministero di Agricoltura, Industria e Commercio (1897).

[12] Ministero di Agricoltura, Industria e Commercio (1913).

Table 4 Summary statistics

Variable	N	Mean	SD	Min	Max
Average annual growth female literacy 1911–1921	1073	3.37	4.82	− 0.75	60.00
Female literacy 1911	1074	55.53	24.94	3.00	100.00
Male literacy 1911	1074	66.16	20.00	19.00	100.00
Reform	1074	0.83	0.37	0.00	1.00
Electors (local)/pop.	1071	0.09	0.07	0.01	1.06[a]
Compulsory schools × 1000 inh.	1074	1.70	0.77	0.00	12.05
Elective schools × 1000 inh.	1074	0.20	0.90	0.00	22.56
Education budget: state % total	1074	0.19	0.12	0.00	1.73
Education total % municipal budget	1074	0.21	0.11	0.02	0.90
Municipal exp. education p.c. (Lire)	1074	3.08	2.61	0.39	27.97
Altitude MSL	1074	288.71	267.32	0.00	1725.00
HP × 1000 inh.	1074	42.10	384.72	0.00	12,268.83
Ind. workers × 1000 inh.	1074	50.10	72.88	0.00	1166.55[b]
Population density 1911	1074	3.18	12.75	0.02	344.00
Access to sea < 5 km	1074	0.19	0.39	0.00	1.00
Lin. dist. from nearest university (km)	1074	66.66	56.83	0.00	334.00
Provincial fertility rate	1074	50.57	7.89	31.90	68.18
WWI deaths × 1000 inh.	1074	15.50	5.65	0.00	49.45

[a]The maximum ratio between local electors and total residents is larger than one. This value, which is the only observation overshooting the ratio, refers to the very small municipality of Torrazza (province of Porto Maurizio, in the region of Liguria), where the population declined substantially between the late nineteenth century (when we measure electors) and 1911, when we measure total residents

[b]This value pertains to the municipality of Torre di Santa Maria (province of Sondrio, in Lombardy), where large construction works to build infrastructures were taking place. According to the source we consulted, this resulted in a very large influx of workers into a relatively small municipality—thus implying an index larger than one. We are left with 1073 observations for the growth of literacy in 1911–1921 because, due to changes in municipal borders after 1921, literacy data for the municipality of Precotto (province of Milan, in the region of Lombardy) cannot be collected. The same problem applies to data on local electors, which were published in 1905, just before three of the municipalities in our dataset were created due to changes in municipal borders; this results in 1071 observations

latter relates to the growing importance of female labor (which often made up for the lack of male workers) during the War. Finally, it is worth noting that estimates of fertility rates—or a proxy for them—are not available at the municipal level. Due to the expected strong relationship between this aspect and education (Galor 2005), we nevertheless assign the average provincial fertility rate, provided by Bozzano (2019) to each municipality within said province. The fertility rate is defined as the ratio between the number of children aged 0–5 and the number of women aged 15–49.[13] Table 4 reports the summary statistics for all variables included in our dataset.

---

[13] We have also run our model by substituting fertility for the crude birth rate (births per 1000 people) and the results remain virtually the same.

4.2 Methodology

We rely on the PSM to model the selection into treatment first and, only thereafter, the impact of school centralization on literacy growth.[14] In the case of early twentieth-century Italy, we know that the 1911 Daneo-Credaro Reform required all Italian municipalities, except those from district and provincial capitals, to move toward centralization. In principle, assuming that these two groups exhibited parallel female literacy trends pre-1911, one could investigate the impact of the Reform by using a Diff-in-Diff econometric model. However, the absence of any municipal educational data before 1911 does not allow us to rely on this methodology. Most importantly, we face a problem linked to the bias concerning the selection into treatment: the Reform did generate a treatment and a control group, but the assignment into treatment itself depended on the level of literacy and economic development of the country's municipalities, as shown by official reports and parliamentary debates on the issue. District and provincial capitals were left with school autonomy because they were expected to fare better than the others.

PSM, though relatively unknown within economic history, is a methodological approach that allows the exploration of our research question despite these constraints. Indeed, for each municipality and based on the variables that we observe, PSM estimates the probability of being assigned to treatment (the propensity score); second, municipalities with virtually equal propensity scores, yet belonging to the two different groups (treated vs. control), are matched to directly compare units that are basically equal but differ just concerning the exposure to the Daneo-Credaro Reform. Finally, based on the different values of female literacy growth between the two groups, we assess whether the impact of school centralization was significant and positive, as we put forward.

Different steps must be followed to implement PSM. We first estimate the propensity scores via a probit model. Second, once the propensity scores are estimated, a visual inspection can reveal whether there is common support by plotting the frequency of observations over the range of scores for the two groups separately (treated vs. untreated observations). Common support means that there should be units belonging to the two different groups with equal propensity scores, so that the comparison can be made. For the sake of matching, we impose the condition of common support via the matching algorithm. The third step is the attempt to find the best match in the control group for each of the treated observations. We use the radius algorithm for matching, since it allows each unit in the treatment group to be matched to several units in the control group insofar as their propensity scores are within a certain caliper (distance) from the propensity score of the treated unit. Since we have a large treatment group and a relatively small control group (mostly comprising district and provincial capitals), this is a sensible approach. It must be noted that using a strict caliper is likely to reduce the bias (difference) between the two groups. However, the reduced number of observations in the control group used to match treated units might increase the variance and hence reduce the statistical significance of the results. The conventional approach, at least in research that relies extensively on PSM, is to use a caliper equal to 0.20 (Austin 2011; Wang et al. 2013). We decide to use the radius matching with

---

[14] We report the OLS results in "Appendix": they are fully consistent with those shown here, based on PSM.

Table 5 Probit "core" model to estimate propensity scores

Y = Reform dummy (mfx)	(1)
Female literacy 1911	−0.0019***
	(0.000)
Compulsory schools × 1000 inh.	0.0394**
	(0.018)
Elective schools × 1000 inh.	0.1887***
	(0.040)
Education budget: state % total	0.9165***
	(0.140)
Education total % municipal budget	0.6556***
	(0.107)
Municipal exp. education p.c. (lire)	−0.0162***
	(0.004)
Observations	1074

Standard errors in parentheses

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

a caliper equaling 0.05, which imposes a high degree of similarity for the matching to happen. We provide robustness checks using the nearest-neighborhood and Kernel matching. The former allows each unit in the treatment group to be matched with more than one unit in the control group if needed, like the radius matching, while the latter uses an average of all observations in the control group to construct the counterfactual. The results presented below remain virtually the same.

Our core probit model for estimating the propensity scores is based on variables concerning female literacy as well as education and primary schooling, which were directly observed by the policy makers and hence primarily influenced the criteria for assignment into the centralized system introduced by the Daneo-Credaro Reform (D'Ascenzo 2006). The rationality behind this choice is that policymakers assumed that the district capitals were the best performers in terms of schooling, and they chose to exclude all of them from the post-1911 education system. Furthermore, other variables capturing inputs into schooling and educational outcomes should capture well the chance to be in the treatment condition, and, in addition, they should identify the latter less exactly—a property that is required in the estimation of propensity scores. However, as a robustness check, we use an expanded model (with all the covariates mentioned earlier that capture male literacy, as well as geographic, social, political, demographic and economic aspects) to estimate the propensity scores and the impact of the Reform on human capital accumulation.

5 Results

Table 5 shows the probit model used to calculate the propensity scores, where marginal effects are reported. The probit model identifies many municipalities in both the treatment and control groups that are characterized by very similar levels of development.
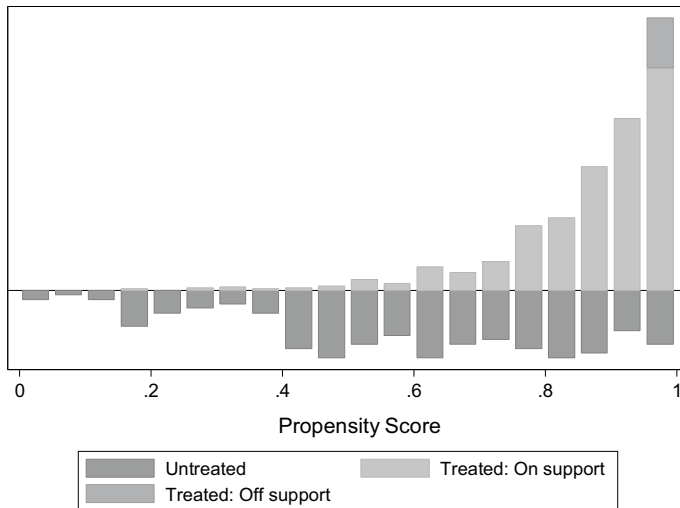
Fig. 5 Common support between treatment and control groups: "core" PSM model

We match municipalities between the treatment and control groups using radius matching, so that each treated municipality can be matched to several non-treated municipalities, which is an ideal solution given the small size of our control group. Indeed, the overlapping municipalities are skewed to the right in Fig. 5, meaning that the matching observations for each treated municipality will be limited.

When we impose common support, 55 municipalities are left out, which is equal to only 5 percent of the total observations in our 10-percent sample. As a robustness check on our matching procedure, we further restrict the common support by excluding, a priori, the municipalities with extreme propensity scores, i.e., scores lower than 0.1 and larger than 0.99.[15]

This more conservative matching procedure leads to more similar treatment and control groups, as expected. The left-hand side of Fig. 6 presents the extent to which the radius matching leads to two comparable groups when imposing common support, while its right-hand side concerns the matching excluding extreme-propensity-score municipalities (retaining the common support).

Based on our matched observations, Table 6 shows the magnitude and significance of the average treatment effect on the treated (ATT). The impact of centralization is significant at 5 percent, showing that the treated municipalities experienced an average annual growth of female literacy equal to 3.60 percent in 1911–1921, while the value was 2.82 percent for the control group during the same period. This result implies a premium on female human capital accumulation of 0.78 percentage points per annum—0.70 percentage points with the most restrictive matching procedure excluding extreme propensity scores. When

---

[15] See Semrad (2015) for a similar approach. Such thresholds were chosen to provide a balance between eliminating municipalities that are very unlikely to be matched and maintaining a relatively large sample size—966 units, of which only 11 are now excluded by imposing common support, as expected.
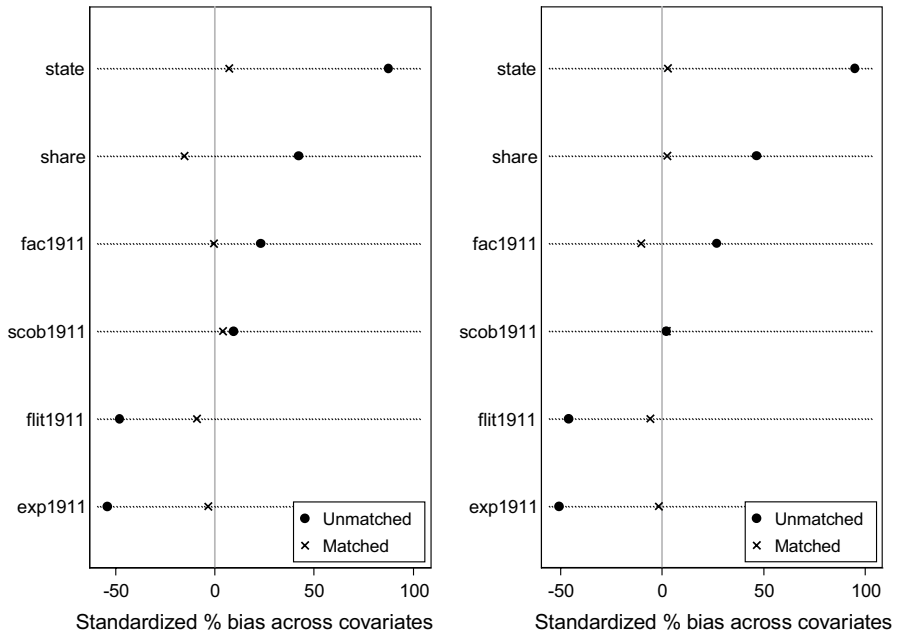
Fig. 6 Treatment and control groups: post-matching differences in "core" variables. Notes: the figure shows the difference between the treatment and control group across the covariates that we take into account to estimate propensity scores, before and after matching, when imposing common support (left-hand side) versus excluding extreme-propensity-score municipalities (right-hand side): "state" refers to state expenditure on education % of total; "share" to the share of the municipal budget destined to education; "fac1911" and "scob1911" are the numbers of elective and compulsory schools, respectively, normalized to 1000 inhabitants; "flit1911" is the female literacy rate; "exp1911" is expenditure on education per capita

Table 6 Results based on PSM, core model, caliper 0.05

Variable	Sample	Treated	Controls	Difference	*T*-stat
Average annual growth female literacy 1911–1921	Unmatched	3.65	1.98	1.68	4.30
Caliper 0.05 matching (core model)	Matched	3.60	2.82	0.78	2.47

relying on the latter procedure, the mean value of female literacy (in levels) for both treated and non-treated municipalities in 1911 was about 55 percent. (The difference between them was not statically significant: *p* value equal to 0.26.) Our estimated coefficient means that the respective mean female literacy rates would be 76 and 72 percent in 1921: in just one decade, the treatment group had surpassed the control group and distanced itself from it. Cappelli and Vasta (2020) estimate that the aggregate effect of the Reform was a literacy growth premium equal to 0.42 percentage points per year. Therefore, the Daneo-Credaro Reform might be deemed a "Silent Revolution," since it produced a first rapid acceleration of aggregate (male and female) human capital accumulation, together with
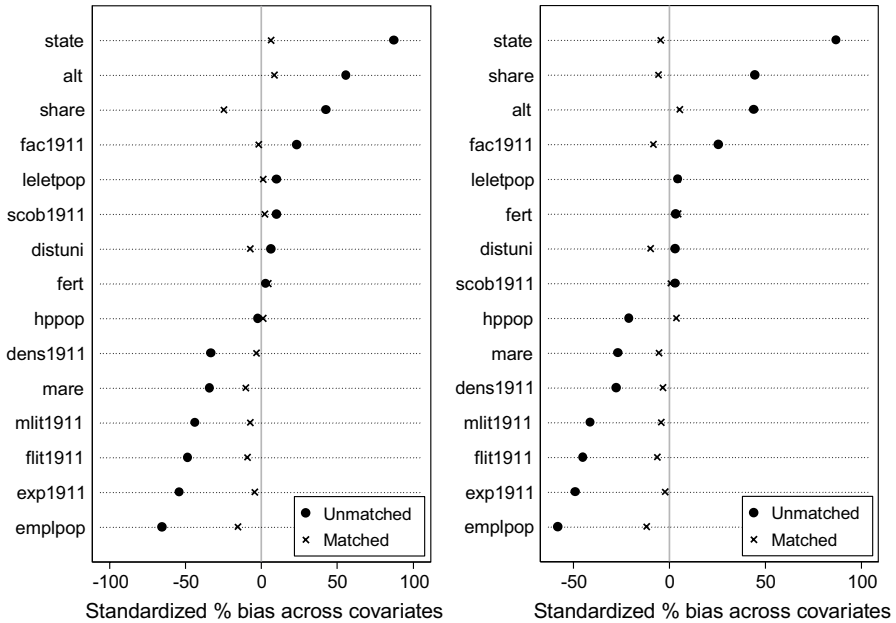
Fig. 7 Treatment and control groups: post-matching differences in "extended" list of variables. *Note*: the figure shows the difference between the treatment and control group across the covariates that we take into account to estimate propensity scores, before and after matching, when imposing common support (left-hand side) versus excluding extreme-propensity-score municipalities (right-hand side): "state" refers to state expenditure on education % of total; "alt" is altitude MSL; "share" to the share of the municipal budget destined to education; "fac1911" and "scob1911" are the numbers of elective and compulsory schools, respectively, normalized to 1000 inhabitants; "mlit1911" is the male literacy rate; "flit1911" is the female literacy rate; "exp1911" is expenditure on education per capita. "leletpop" is the share of local electors on the population; "distuni" is the linear distance from the nearest university; "fert" is the provincial average fertility rate; "hppop" is the ratio of industrial HP to population; "dens1911" is population density; "mare" is access to sea; "emplpop" is the industrial employment divided by total population

a sharp reduction in the educational gender gap provided the large premium on female literacy expansion—even though this effect may be considered an unintended consequence from the perspective of coeval politicians.

We perform several robustness checks on these results. First, we conduct the same analysis by using an extended probit model, which includes all the variables that we have previously discussed: female literacy, male literacy, all the variables capturing primary schooling, the share of local electors on total population, indices of industrial activity, altitude, population density, access to sea, the distance from the nearest university and the provincial fertility rate.[16] The result of the radius matching procedure is shown in Fig. 7, while the results on the impact of the Reform are shown in Table 7. Next, we perform the matching (using both the core and the extended probit models) adopting the nearest-neighbor and the kernel matching instead of the

---

[16] World War I deaths per 1000 population is excluded since this happened after the Daneo-Credaro Reform. However, including it does not affect the results in any significant way.

Table 7 Results based on PSM, extended model, caliper 0.05

Variable	Sample	Treated	Controls	Difference	T-stat
Average annual growth female literacy 1911–1921	Unmatched	3.66	1.98	1.69	4.32
Caliper 0.05 matching (extended model)	Matched	3.57	2.78	0.79	2.38

radius one. For all these combinations, the PSM leads to consistent, virtually similar results.[17]

6 Conclusions

This paper is the first contribution based on a historical perspective to unfold the link between human capital accumulation, the educational gender gap and public policy in Italy. Differently from other countries that managed to catch up with the UK and the USA during the First and Second Industrial Revolutions, Italy lagged behind in terms of human capital, innovative capacity and technological change; hence, it struggled to achieve—and stick to—high-income levels throughout most of its history.

Within this narrative, the educational gender gap has been surprisingly neglected thus far. We document a very large gap between the literacy of men and that of women—both in a comparative perspective and within Italy. Concerning the former, Italy lagged some 40/60 years behind other Western European regions (England, France and Prussia). This can be partially explained by the fact that Italy was a "latecomer" country, belonging to "third wave" of industrialization, roughly taking place in the second half of the nineteenth century (Gerschenkron 1962). Equally important, by 1911, the literacy of women in the South of Italy was still about 50 percent of that in the North—the ratio being very similar to what it had been in the early nineteenth century, almost 100 years before. This means that the South lagged some 60/80 years behind the most advanced Western European countries, an impressive gap.

We also test whether the centralization of primary schooling in 1911—introduced by the Daneo-Credaro Reform—fostered the literacy of women. We rely on the quasi-experimental feature of the Reform (the shift to state funding and management by all municipalities except district and provincial capitals) and PSM to explore if the municipalities that were funded and administered by the state system were characterized by a positive premium on the growth of female literacy. Our results show that this is the case: being under centralized primary schooling brought about a premium on the average annual growth of female literacy equal to a significant 0.78 percentage points (in the baseline specification).

---

[17] These estimates are available upon request.

Despite this clear-cut result, at this stage, it remains difficult to identify the exact channel through which the Reform affected the education of women. Some potential mechanisms are likely to be: (1) the improvement in the management of primary education introduced by relying on the new provincial school boards, which tackled limited schooling more effectively thanks to, e.g., the participation of more members elected among teachers (by 1907 female teachers had doubled male ones); (2) the redistributive policy introduced by the Reform that, combined with additional funding, allowed to target the most disadvantaged areas. Although such changes are well documented in the historical literature and are consistent with our results, further research is needed to shed more light on the issue. Our results suggest that, similarly to what Ciccarelli and Weisdorf (2019) have shown focusing on Italy's unification in 1861, institutional change brought about by the Daneo-Credaro Reform was effective in prompting aggregate growth and regional convergence in female schooling after 1911.

This successful "Silent Revolution" has important implications that must be further explored. Although we find evidence of an acceleration of women's human capital accumulation, the result in terms of demographic change and development has not yet been fully quantified—even though a positive shock on human capital accumulation likely improved human and economic development, even in the long run. Future research should investigate more thoroughly how large gender inequality, as well as institutional changes that reduced it over time, affected both Italy's economic-growth potential and its long-lasting regional divide.

Appendix: OLS models

Our first specification is the OLS model used to regress to the growth of female literacy rates in 1911–1921 on the Reform dummy, treating it as if it were a randomized experiment (Eq. 1). The coefficient of this OLS estimation might be biased given the potential endogeneity of the assignment into treatment, because policymakers wanted the Reform to push the most disadvantaged areas down a path of human capital-sustained growth. In the second model, the initial female literacy rate in 1911 is included to capture the negative relationship between literacy rates and their growth over time given an upper bound of 100 percent. In the third model (Eq. 2), we also include a vector *X* of control variables that might have influenced the development

of literacy in early twentieth-century Italy. The fourth model is equal to Eq. 3 but is based on weighted least squares (WLS) instead of OLS. According to Solon et al. (2015), WLS may model the impact of the Reform better if the effectiveness of the Reform depends on, e.g., how populous each municipality is. Since this may be the case based on coeval historical evidence (Corradini Inquiry), we use the population in 1911 to assign weights to each municipality in the WLS model. The fifth OLS model (Eq. 3) introduces more flexibility in the estimates, in that it explicitly models heterogeneity concerning the impact of the Reform between the North and the South. It does so by including a dummy for municipalities belonging to the former Kingdom of the Two Sicilies (South and Islands) and an interaction of the latter with the Reform dummy.[18] The summary statistics are shown in Table 4 in the paper.

$$litgr_i = \beta_0 + \beta_1 ref_i + \varepsilon_i \tag{1}$$

$$litgr_i = \beta_0 + \beta_1 lit_i + \beta_2 ref_i + \beta_3 X_i + \varepsilon_i \tag{2}$$

$$litgr_i = \beta_0 + \beta_1 lit_i + \beta_2 ref_i + \beta_3 ref_i * SI_i + \beta_4 SI_i + \beta_5 X_i + \varepsilon_i \tag{3}$$

Table 8 shows the results for all models. In model 1, the coefficient of the Reform dummy is statistically significant, positive as expected, and large in magnitude, representing a premium of 1.68 percentage points on the average annual growth of female literacy: the latter was, between 1911 and 1921, equal to 3.6 percent among the municipalities that shifted to centralized education in 1911, while it was about 2 percent for those retaining school autonomy. However, as we have discussed above, this likely overestimates the impact of the Reform, given that backward municipalities were more likely to end up in the new state school administration. A main factor that captures this pre-treatment difference is the literacy rate in 1911. Indeed, once the initial literacy is considered (model 2), the coefficient is still positive and statistically significant, but the magnitude is greatly reduced. Initial literacy is, as expected, negatively correlated with its growth in the following decade. Model 3 introduces all controls: among them, compulsory-school density is positively correlated with the growth of female schooling as is industrial employment—but, interestingly, not mechanization. The Reform dummy is not statistically significant, although it retains the positive sign. As we discussed, this may be linked to heterogeneity linked to the size of the municipality that the equation fails to model. The fourth model tackles this problem by relying on WLS: in column 4, the Reform dummy is positive and highly statistically significant, capturing an annual premium of 0.40 percentage points on the growth of female literacy between 1911 and 1921.[19] While industrial employment is still a relevant explanatory factor, now electoral franchise, municipal expenditure on education per capita and state funding have all the expected signs

[18] The results do not change if we use all of Italy's NUTS-1 regions (Northwest, Northeast, Centre, South and Islands) separately.

[19] It is important to note that, if we model heterogeneity linked to the population in 1911 (by introducing the variable and its interaction with the Reform dummy in a simple OLS model), the results are very consistent with those obtained through WLS, as they should (Solon et al. 2015).

Table 8 OLS models to explore the relationship between the Daneo-Credaro Reform and the spread of female literacy, 1911–1921

Dependent variable	(1)	(2)	(3)	(4)	(5)
Average annual growth female literacy 1911–1921					
Reform	1.6763***	0.3510**	0.2822	0.4888***	−0.4075**
	(0.232)	(0.155)	(0.346)	(0.162)	(0.181)
Reform×South and Islands (dummy)					1.7999***
					(0.428)
SI regions (dummy)					−2.3848***
					(0.586)
Female literacy 1911		−0.1193***	−0.1833***	−0.1639***	−0.1887***
		(0.008)	(0.015)	(0.012)	(0.019)
Male literacy 1911			0.0712***	0.0754***	0.0661***
			(0.019)	(0.014)	(0.022)
Electors (local)/pop.			1.9610	9.1976***	1.8490
			(2.259)	(2.461)	(2.192)
Compulsory schools×1000 inh.			0.5366***	−0.0532	0.5370
			(0.185)	(0.180)	(0.609)
Elective schools×1000 inh.			0.0729	−0.0495	0.0713
			(0.137)	(0.293)	(0.094)
Education budget: state % total			1.2955	2.6998**	1.3758
			(1.171)	(1.173)	(1.696)
Education total % municipal budget			−0.4721	−0.6637	0.0061
			(1.227)	(0.773)	(1.051)
Municipal exp. education p.c. (Lire)			−0.0158	0.0500***	−0.0332
			(0.056)	(0.019)	(0.044)
Altitude MSL			−0.0002	−0.0004	−0.0001
			(0.001)	(0.000)	(0.001)
HP×1000 inh.			0.0000	−0.0000	0.0000
			(0.000)	(0.001)	(0.000)
Ind. workers×1000 inh.			0.0035**	0.0037***	0.0031***
			(0.002)	(0.001)	(0.001)
Population density 1911			0.0075	0.0102***	0.0084
			(0.009)	(0.003)	(0.006)
Access to sea<5 km			−0.3489	−0.4160**	−0.1215
			(0.337)	(0.176)	(0.389)
Lin. dist. from nearest university km			0.0033	−0.0009	0.0048
			(0.002)	(0.001)	(0.003)
Provincial fertility rate			0.0074	0.0155*	0.0063
			(0.016)	(0.009)	(0.014)
WWI deaths×1000 inh.			−0.0261	−0.0247	−0.0387**
			(0.022)	(0.019)	(0.020)
Observations	1073	1073	1070	1070	1070
Adjusted R^2	0.016	0.386	0.403	0.473	0.409

Robust standard errors in parentheses

***$p<0.01$; **$p<0.05$; *$p<0.1$

and are statistically significant. The coefficient of access to sea is negative, but this may be driven by the good performance of municipalities in the far North, for example those that benefitted from the skill premia due to the proximity to Switzerland, Germany and Austria (Ciccarelli and Weisdorf 2019). The last regression (model 5), which introduces heterogeneous effects of the Reform by dividing between the North and the South, shows that the estimated impact of the Reform was actually very big in the South, but more negative in the North: this is consistent with estimates of the impact of the Reform at the regional level for the period 1861–1936, provided by Cappelli (2016b). It is important to note that the variables linked to literacy and schooling seem to be the most relevant to explain the growth of literacy over time. Indeed, the adjusted R squared does not grow much between model 2 and 3—even when interaction terms are taken into account (model 5).

References

A'Hearn B, Vecchi G (2017) Education. In: Vecchi G (ed) Measuring wellbeing: a history of Italian living standards. Oxford University Press, New York

Amartya Sen (1990) More than 100 million women are missing

Austin PC (2011) Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. Pharm Stat 10(2):150–161

Barro RJ (1991) Economic growth in a cross section of countries. Q J Econ 106(2):407–443

Barro RJ, Lee J-W (2015) Education matters: global schooling gains from the 19th to the 21st century. Oxford University Press, Oxford

Basile R, Ciccarelli C (2018) The location of the Italian manufacturing industry, 1871–1911: a sectoral analysis. J Econ Geogr 18(3):627–661

Baudelot C, Establet R (2006) Allez les filles! Une revolution silencieuse. Points, Paris

Becker SO, Woessmann L (2008) Luther and the girls: religious denomination and the female education gap in nineteenth-century Prussia. SSRN Scholarly Paper ID 1308723. Social Science Research Network, Rochester

Becker S, Cinnirella F, Hornung E, Woessmann L (2014) iPEHD—the ifo Prussian economic history database. Hist Methods J Quant Interdiscip Hist 47(2):57–66

Bertocchi G, Bozzano M (2016) Women, medieval commerce, and the education gender gap. J Comp Econ 44(3):496–521

Bils M, Klenow PJ (2000) Does schooling cause growth. Am Econ Rev 90(5):1160–1183

Bozzano M (2019) Fertility and education across Italian provinces, 1861–1911. Mimeo

Cappelli G (2016a) One size that didn't fit all? Electoral Franchise, fiscal capacity and the rise of mass schooling across Italy's Provinces, 1870–1911. Cliometrica 10(3):311–343

Cappelli G (2016b) Escaping from a human capital trap? Italy's regions and the move to centralized primary schooling, 1861–1936. Eur Rev Econ Hist 20(1):46–65. https://doi.org/10.1093/ereh/hev020

Cappelli G (2017a) The missing link? Trust, cooperative norms, and industrial growth in Italy. J Interdiscip Hist 47(3):333–358

Cappelli G (2017b) Capitale umano e crescita economica: l'evoluzione del sistema educativo italiano. In: Di Martino P, Vasta M (eds) Ricchi per caso. La parabola dello sviluppo economico italiano. Il Mulino, Bologna, pp 75–128

Cappelli G, Vasta M (2020) Can school centralization foster human capital accumulation? A quasi-experiment from early twentieth-century Italy. Econ Hist Rev 73(1):159–184

Ciccarelli C, Weisdorf J (2019) Pioneering into the past: regional literacy developments in Italy before Italy. Eur Rev Econ Hist 23(3):299–328

Cinnirella F (2019) Marital fertility and investment in children's education. In: Diebolt C, Rijpma A, Carmichael S, Dilli S, Störmer C (eds) Cliometrics of the family. Springer Nature, Cham, pp 33–54

Cipolla CM (1969) Literacy and development in the west. Penguin, London

Cives G (1990) La scuola elementare e popolare. In: Cives G (ed) La scuola italiana dall'Unità ai nostri giorni. Nuova Italia, Firenze, pp 50–60

Clark G (2007) A farewell to Alms. Princeton University Press, Princeton

Clay K, Lingwall J, Stephens Jr. M (2012) Do schooling laws matter? Evidence from the introduction of compulsory attendance laws in the United States. Working Paper 18477, National Bureau of Economic Research

Coccia M, Della Torre G (2007) La ricostruzione dei consumi pubblici nel campo dell'istruzione nell'Italia liberale: 1861–1913. Department of Economic Policy, Finance and Development (DEP-FID) Working Paper Series, University of Siena

D'Ascenzo M (2006) Tra centro e periferia. La scuola elementare a Bologna dalla Daneo-Credaro all'avocazione statale (1911–1933). CLUEB, Bologna

De Fort E (1996) La scuola elementare dall'Unità alla caduta del fascismo. Il Mulino, Bologna

Di Martino P, Vasta M (eds) (2017) Ricchi per caso. La parabola dello sviluppo economico italiano. Il Mulino, Bologna

Diebolt C, Jaoul-Grammare M (2006) Convergence of higher education and economic growth during the european construction: a contribution to the cliometrics of growth (EU-15). Res Comp Int Educ 1(1):14–30

Diebolt C, Perrin F (2013) From stagnation to sustained growth: the role of female empowerment. Am Econ Rev 103(3):545–549

Diebolt C, Perrin F (2019) A cliometric model of unified growth: family organization and economic growth in the long run of history. In: Diebolt C, Rijpma A, Carmichael S, Dilli S, Störmer C (eds) Cliometrics of the family. Springer Nature, Cham, pp 7–31

Diebolt C, Menard A-R, Perrin F (2017) Behind the fertility–education nexus: what triggered the french development process? Eur Rev Econ Hist 21(4):357–392

Duflo E (2012) Women empowerment and economic development. J Econ Lit 50(4):1051–1079

Engerman S, Sokoloff K (2002) Factor endowments, inequality, and paths of development among new world economics. Working Paper 9259, National Bureau of Economic Research

Federico G, Nuvolari A, Vasta M (2019) The origins of the Italian regional divide: evidence from real wages, 1861–1913. J Econ Hist 79(1):63–98

Felice E (2012) Regional convergence in Italy, 1891–2001: testing human and social capital. Cliometrica 6(3):267–306

Felice E, Vasta M (2015) Passive modernization? The new human development index and its components in Italy's regions. Eur Rev Econ Hist 19(1):44–66

Galfré M (2017) Tutti a scuola!. Carocci Editore, Roma

Galor O (2005) From stagnation to growth: unified growth theory. In: Aghion P, Durlauf SN (eds) Handbook of economic growth, 1, Part A. Elsevier, Amsterdam, pp 171–293

Galor O (2011) Unified growth theory. Princeton University Press, Princeton

Gerschenkron A (1962) Economic backwardness in historical perspective. Harvard University Press, Cambridge

Hippe R, Perrin F (2017) Gender equality in human capital and fertility in the European regions in the past. Investig Hist Econ 13(3):166–179

Jaoul-Grammare M, Perrin F (2017) A gendered approach of economic and demographic interactions: evidence from France. Revue d'Economie Politique 127(69):1083–1108

Klasen S (2002) Low schooling for girls, slower growth for all? Cross-country evidence on the effect of gender inequality in education on economic development. World Bank Econ Rev 16(3):345–373

Lindahl M, Krueger AB (2001) Education for growth: why and for whom? J Econ Lit 39(4):1101–1136

Lucas RE (1988) On the mechanics of economic development. J Monet Econ 22(1):3–42

Manacorda MA (1989) Istruzione ed emancipazione della donna nel risorgimento. In: Soldani S (ed) Riletture e considerazioni, L'educazione delle donne. Scuole e modelli di vita dell'Ottocento. Franco Angeli, Milano, pp 1–33

Mankiw NG, Romer D, Weil DN (1992) A contribution to the empirics of economic growth. Q J Econ 107(2):407–437

Mansuri G, Rao V (2013) "Localizing development: does participation work?" A world bank policy research report. The World Bank, Washington

Ministero della Pubblica Istruzione (1872) Documenti sulla istruzione elementare nel Regno d'Italia. Tipografia Eredi Botta, Roma

Ministero della Pubblica Istruzione (1897) L'istruzione elementare nell'anno scolastico 1895–1896: relazione a S.E. il Ministro. L. Cecchini, Rome. http://archive.org/details/listruzioneelem00nazigoog

Ministero della Pubblica Istruzione (1910) L'istruzione primaria e popolare in Italia: con speciale riguardo all'anno scolastico 1907–1908, vol 1, 4 vols. Tip. Operaia Romana Cooperativa, Roma

Ministero di Agricoltura, Industria e Commercio (1897) Statistica elettorale: composizione del corpo elettorale politico e amministrativo e statistiche delle elezioni generali amministrative nell'anno 1895. Stabilimento Tipografico dell'Opinione, Rome

Ministero di Agricoltura, Industria e Commercio (1913) Censimento degli opifici e delle imprese industriali al 10 giugno 1911. Tipografia Nazionale di G. Bertero e C, Rome

Missiaia A (2018) Market versus endowment: explaining early industrial location in Italy (1871–1911). Cliometrica, May, pp 1–35

Nelson R, Phelps E (1966) Investment in humans, technological diffusion and economic growth. Am Econ Rev 56(2):69–75

Nuvolari A, Vasta M (2015) Independent invention in Italy during the Liberal Age, 1861–1913. Econ Hist Rev 68(3):858–886

Nuvolari A, Vasta M (2017) The geography of innovation in Italy, 1861–1913: evidence from patent data. Eur Rev Econ Hist 21(3):326–356

Prados de la Escosura L (2015) World human development: 1870–2007. Rev Income Wealth 61(2):220–247

Romer PM (1990) Endogenous technological change. J Polit Econ 98(5):S71–S102

Rosenbaum PR, Rubin DB (1983) The central role of the propensity score in observational studies for causal effects. Biometrika 70(1):41–55

Seguino S (2000) Gender inequility and economic growth: a cross-country analysis. World Dev 28(7):1211–1230

Semrad A (2015) Modern secondary education and economic performance: the introduction of the Gewerbeschule and Realschule in nineteenth-century Bavaria. Econ Hist Rev 68(4):1306–1338

Soldani S (1993) Nascita della maestra elementare. In: Soldani S, Turi G (eds) Fare gli italiani: scuola e cultura nell'Italia contemporanea, vol I La nascita dello Stato nazionale. Il Mulino, Bologna

Solon G, Haider SJ, Wooldridge JM (2015) What are we weighting for? J Hum Resour 50(2):301–316

van Zanden JL, De Moor T, Carmichael S (2019) Capital women: the European marriage pattern, female empowerment and economic development in Western Europe 1300–1800. Oxford University Press, Oxford

Vasta M (1999) Innovazione tecnologica e capitale umano in Italia (1880–1914). Le traiettorie della seconda Rivoluzione industriale. Il Mulino, Bologna

Vigo G (1971) Istruzione e sviluppo economico in Italia nel secolo XIX. ILTE, New Albany

Wang Y, Cai H, Lee C, Jiang Z, Wang L, Song J, Xia J (2013) Optimal caliper width for Propensity Score Matching of three treatment groups: a Monte Carlo study. PLoS ONE 8(12):20

Zamagni V (1993) The economic history of Italy, 1860–1990. Clarendon Press, Oxford