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Abstract

Access to useful knowledge is crucial for fostering modern economic growth. We show, for the first time, that knowledge accumulated and stored in monasteries was useful for innovation. In 1866, anticlerical legislation in Italy led to the suppression of religious orders, the expropriation of their properties, and the transfer of their manuscripts to local public libraries. From a contemporary survey on public libraries, we construct a unique dataset on municipalities which received monastic volumes. This information is then linked to newly digitized annual data on patents issued in Italy between 1863 and 1883. Difference-in-differences estimates show that municipalities exposed to an influx of monastic manuscripts experienced a significant increase in innovation. The effect is driven by the increase in the number of manuscripts in previously existing libraries. We show that the innovation advantage also persisted in the long run and had no impact on human capital.

JEL-Codes: N330, O300, Z120.

Keywords: books, manuscripts, knowledge, religion, monastery, libraries, patents.

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1 Introduction

Increasing evidence suggests that the application of so-called "useful knowledge" in agriculture and manufacturing from the second half of the eighteenth century enhanced productivity and technological progress, therefore triggering economic growth (Mokyr, Joel, 2005; Squicciarini and Voigtländer, 2015). In this context, two factors became increasingly important: the ability to master and tweak useful knowledge, and access to such knowledge. Lowering access costs allowed (i) learning best-practice techniques, (ii) improving and filling technological gaps, and (iii) tapping into propositional knowledge upon which the new techniques rested (Mokyr, Joel, 2005). However, the identification of the sources and the institutions that facilitate access to useful knowledge is still an unresolved question. Universities and economic societies have been suggested as crucial institutions instrumental to the spread of knowledge (Dittmar and Meisenzahl, 2022; Cinnirella et al., 2023). We propose medieval monasteries as an additional, and unexplored, source of useful knowledge. We argue that access to knowledge stored in monasteries was relevant for innovation, specially in the context of a backward economy characterized by low levels of human capital and innovation. Italy around the period of unification in 1861 constitutes an ideal setting to study this question, as the country's path to modern economic growth was characterized by initially low levels of education and innovation (Giannetti, 1998; Nuvolari and Vasta, 2017, 2019).

In this paper, we study the impact of a pivotal reform in Italy which suddenly made available the stock of knowledge accumulated for centuries in monasteries. Shortly after unification in 1861, the Italian State ceased to recognize religious orders, leading to the closure of their houses. Monastic properties were expropriated and sold through public auctions. In some cases, monastic establishments were handed over to local municipalities for conversion into public schools, kindergartens, or hospitals. Importantly, this process also involved transferring books, manuscripts, and scientific documents, once jealously guarded in monastic libraries, to existing local public libraries or using them to establish new ones. Therefore, as one of the immediate (and arguably unintended) consequences of this anticlerical policy, much of the knowledge safeguarded in monastic libraries suddenly became available to the public. We investigate whether and to what extent this change in access to knowledge affected innovation.

The stock of knowledge accumulated in religious institutions is generally not considered among the main determinants of innovation. Yet, for centuries, monasteries have been the keepers of traditional and classical knowledge, and their libraries were the "heart of western learning" (Harris, 1999). In many cases, monks themselves pushed forward the knowledge (and technological) frontier in

different domains ranging from agriculture, glass-making, music, accounting, aeronautics, to genetics. For instance, Luca Pacioli, a Franciscan friar mostly known as the father of accounting, wrote in 1494 a mathematical encyclopedia (*Summa de arithmetica, geometria proportioni et proportionalità*); Francesco Lana de Terzi, a Jesuit priest, regarded as the founder of aeronautic science, wrote in 1670 an "Essay on new inventions premised on the master art"; Antonio Neri, a priest from Florence, wrote the first book on glass-making in 1612, which remained a standard reference for glassmakers up until 1900; Alessandro Della Spina, a Dominican friar, is regarded as the inventor of eyeglasses first built around 1290.

These significant scientific contributions were unveiled, however, in a period of technological stagnation. At the time of the reform, Italy was characterized by low levels of innovation, both in terms of quantity and quality. During the early phase of industrialization, Italy was able of adopting existing foreign technology but lacked the necessary skills to advance the technological frontier (Giannetti, 1998). By conducting a text analysis of the inventions patented in the period under consideration, we will provide evidence about the low technological content of these innovations. We argue that in such a low-technology economy, even basic knowledge, such as that contained in monastic books, could have spurred innovation.

For this research, we digitized detailed information on public libraries from a contemporary survey published in 1893 by the Ministry of Agriculture, Industry, and Trade. The survey lists all major and minor public libraries in Italy, including information on the location, name, origin, type of ownership, year of establishment, and number of volumes. Importantly for our purpose, the survey indicates which library received volumes from monastic collections following the 1866 suppression of monastic orders. We match this information with newly digitized yearly data on patents granted to Italian residents from 1863 to 1883, reporting the inventors' locations. We assess the impact of book and manuscript transfers from monastic libraries by implementing a difference-in-differences model, which provides credible causal estimates on the effect of knowledge access on innovation. Identification rests on the assumption that recipient municipalities, absent the transfer of monastic materials, would have exhibited an innovation paths parallel to non-recipient municipalities. In fact, the law governing the redistribution of monastic assets–both movable and immovable– only prescribed that books should remain within their province and be devolved in agreement with the Ministry of Education. We will adopt different strategies to ensure that the estimated impact of increased knowledge access on innovation is not biased by selection into treatment.

We find that municipalities receiving books and manuscripts previously stored in monasteries experienced a large increase in innovative activity, measured by patents per capita. For larger

municipalities (over 10,000 inhabitants), access to monastic books increased innovation by about 50 percent of the mean. Placebo tests assigning fake treatment years, in addition to graphic diagnostics on trends in innovation during the pre-treatment period, support a causal interpretation of the results. To further increase the similarity between the control and treatment group in the pre-treatment period, we combine the difference-in-differences estimator with a matching approach. In particular, we match municipalities on pre-treatment observable characteristics such as population size, pre-existing libraries, the number of monasteries in the province and education indicators such as municipal expenditures for primary schooling, schools per capita, and student-teacher ratios. Matching on these characteristics mitigates potential selection biases, as the law suppressing monastic orders did not clarify how recipient municipalities were selected.

The details provided by the contemporary survey allow us to investigate potential mechanisms behind our findings. In particular, we explore: (i) whether monastic books increased the stock of a previously existing public library or formed a new one; (ii) whether monastic books contributed to a general or specific-purpose public library. "Horse-race" estimates provide robust and consistent results, revealing that the enlargement of previously existing libraries and general-purpose libraries significantly affected innovation. Since the establishment of new public libraries did not affect innovation, we can reasonably exclude that the main mechanism is related to creating a public space for the exchange and discussion of new ideas. Moreover, the positive impact of general-purpose libraries supports the notion that access to generally useful knowledge, rather than religious knowledge, spurred innovation. These heterogeneous results provide another important interpretation. The suppression of monastic orders also came with the expropriation of buildings and land, the latter partitioned and sold through public auctions. One could argue that, rather than monastic books, it was the redistribution of other monastic properties that affected innovation, perhaps through an income or wealth channel. Finding an effect only for general-purpose libraries and not for religious ones, however, allows us to discard this alternative hypothesis.

Further analysis addresses other potential confounders related to the anticlerical legislation, including: (i) the grant of monastic establishments for public utility purposes (e.g., schools and hospitals); (ii) land redistribution; (iii) the integration of former monks, who could have shared their skills and knowledge, into secular society. By examining province-level data on suppressed monasteries and presence of the clergy in secular society, establishments granted for public utilities, and monastic land auctions, difference-in-differences estimates find no significant impact on innovation, reinforcing our interpretation that access to monastic books was the key driver of innovation.

Finally, we also study the long-run effect of enhanced access to useful knowledge. Given Italy's relatively backward economy and the incremental nature of technological innovations at that time, the knowledge advantage estimated in the 1870s plausibly persisted through decades. In order to test this hypothesis, we use patents granted to Italian inventors in the period 1910-12 and the location of exhibitors at the 1911 World's Fair in Turin. Looking at this period, which is about 45 years after the monastic orders suppression, allows us to use an alternative proxy for innovation,[1] and, for 1911, to have a full record of literacy rates across Italian municipalities.[2] This allows us to offer additional insights on the potential role of human capital as a mechanism.

Using a cross-sectional instrumental-variable analysis, we estimate how the number of books in public libraries in 1893, instrumented by monastic book acquisitions post-1866, affects patenting in 1910-12. Second-stage least squares indicate a significant and large positive relationship between the 1893 public library book count and innovation in 1910-12, a result corroborated by the number of 1911 Turin World's Fair exhibitors. Importantly, using literacy rates as outcome variable, we find minimal or no impact, suggesting that the access to monastic books did not increase literacy. Thus, human capital improvement seems not to explain the impact on innovation but it was rather access by a few literate individuals to knowledge previously stored in monasteries.

Literature review. Our paper contributes to different strands of literature. First, our paper adds to the literature on access to useful knowledge. Squicciarini and Voigtländer (2015) study the growth effect of having access to Diderot's Encyclopédie in France. They find a sizable effect on city growth after the onset of the industrial revolution for those cities with a larger number of Encyclopédie subscriptions. An important mechanism is innovation and the adoption of modern techniques. Cinnirella et al. (2023) investigate the role of German economic societies in the eighteenth and nineteenth centuries in adopting, producing, and diffusing new ideas. They find that areas with a higher density of economic society members were significantly more innovative. Dittmar and Meisenzahl (2022) propose research universities in nineteenth-century Germany as engines for the production of useful knowledge and industrial activity. In particular, for a sample of more than 2,000 cities, they show that manufacturing expanded significantly in cities near universities in the early 1800s. Danna et al. (2022) show that the diffusion of new mathematical knowledge, the Hindu-Arabic numerals, through manuscripts and printed sources positively affected European city growth between the thirteenth and sixteenth centuries in Europe.

[1] The local density of exhibitors at World's Fairs has been proposed and used as an innovation proxy by Moser (2005, 2012).
[2] The literacy rate at the municipal level is available only after 1911.

Access to knowledge can be facilitated not only by institutions such as libraries but also by individuals. Iaria et al. (2018) show how the collapse of international scientific cooperation after World War I negatively affected scientists who relied on frontier research from abroad. Moser et al. (2014) study how knowledge brought by Jewish émigrés from Nazi Germany revolutionized the chemical sector in the US, leading to a 31 percent increase in innovation after 1933 in the research fields of the émigrés. Similarly, Hornung (2014) and Boberg-Fazlic and Sharp (2024) illustrate the substantial economic contributions of Huguenots in Prussia and Danish migrants in the U.S., respectively.

Our paper also adds to the relatively recent literature which focuses on the role of monasteries in economic growth. Andersen et al. (2017) argue that the Cistercian monastic order was a precursor of the Reformation and show that English counties exposed to Cistercian monasteries experienced faster productivity growth from the 13th century. Heldring et al. (2021) argue that the dissolution of English monasteries in the 1530s had a positive impact on economic growth through the release of productive resources such as land and labor. Rossignoli and Trombetta (2019) leverage the Norman conquest as a quasi-natural experiment and estimate a higher growth rate in productive capacity for holdings governed by Benedictine monasteries. Doucette and Møller (2021) find that medieval towns near Cluniac monasteries were substantially more likely to establish autonomous town councils. Cantoni et al. (2018) study religious competition and the reallocation of resources as a result of the Protestant Reformation. By examining the expropriation of monasteries and wealth transfers, they find a strong reallocation toward secular control of resources.

We also contribute to the recent literature on public libraries. Berkes and Nencka (2021) study the impact of the rollout of public libraries financed by Andrew Carnegie between 1883 and 1919 in the U.S. Estimating a difference-in-differences model which exploits the timing of the library construction, they find a positive effect on patenting. Our paper differs from theirs in, at least, two important dimensions. First, we study the effect of an expansion of useful knowledge in the context of a backward, low technological content economy, as Italy was right after unification. Second, our analysis shows that it was the expansion of knowledge embedded in monastic books and *not* the opening of new libraries that had a significant impact on innovation in Italy. The mechanisms are therefore partially different. Karger (2021) exploits the Carnegie library rollout in the U.S. to study the long-run effect of public libraries. He finds that access to public libraries during childhood increased educational attainment and non-wage income.

Finally, our paper also contributes to the literature on the development and determinants of innovation in Italy. Nuvolari and Vasta (2017) study the spatial pattern of innovation during 1861-1913 and find a strong correlation with secondary technical education and university science

education. Nuvolari and Vasta (2014) find that independent inventors made important contributions to technological change in Italy, although their quality was lower compared to innovations of firms and foreign patentees.

2 Historical background

2.1 Anticlerical legislation

At the beginning of the nineteenth century, the Italian peninsula witnessed a surge in anticlerical legislation that had its roots in Napoleon's invasion of Italy at the end of the eighteenth century. The Cisalpine Republic, in 1798, decreed the suppression and expropriation of religious order properties in Lombardy, leading to the dissolution of 529 religious corporations (Zangheri, 1979). These anticlerical measures were not limited to Lombardy and similar expropriations occurred successively in other areas in what was then known as the Republic of Italy. Although the Concordat signed with the Pope in 1803 declared Catholicism the state religion, Napoleon disregarded it. The State continued to regulate religious orders and expropriate church properties (Duggan, 2008). For example, in Bologna, the share of properties owned by religious entities decreased from 19% of the total in 1789 to 4% in 1804 (Zangheri, 1979). The suppression of religious orders continued in the Kingdom of Italy, which enacted a decree in 1810, leading to the general suppression of religious orders and prohibiting individuals from wearing religious dresses. In Tuscany, Napoleonic suppressions occurred in 1808 and 1810, resulting in the closure of 460 convents (Chapron, 2009), while in Naples around 1,300 religious houses were suppressed (Zangheri, 1979).

The expropriation of monastic orders had also consequences for libraries, as some of them experienced an increase in the number of volumes. For instance, in the Venetian provinces, the State collected books from the suppressed religious entities in Padua. These books were cataloged and then distributed to various institutions. Natural History books were assigned to Milan's Council of Mines, Italian city history books to the Directorate of Public Education, music books to the Milan Conservatory, art books to the Venice Academy of Arts, and valuable manuscripts and fifteenth-century editions to the Brera Library in Milan. The remaining books stayed at the University Library of Padua, as documented in the "Statistics of Libraries" published by Ministero di Agricoltura, Industria e Commercio [MAIC]. Direzione generale della statistica (1893). Likewise, during the 1810s wave of suppression in Florence, more than 16,000 books were stored at the San Marco Convent and distributed to various cultural institutions, including libraries, academies, and museums (Chapron, 2009).

The Kingdom of Sardinia, which encompassed the regions of Piedmont, Liguria, Sardinia, and a portion of the province of Pavia, marked the onset of another wave of religious orders suppresion in 1855. The law stipulated that religious order houses not involved in preaching, education, and healing would lose legal recognition. Consequently, twenty-one male and fourteen female religious orders, including the Benedictines, Dominicans, and Franciscans, were dissolved and 335 religious houses were suppressed (Bertozzi, 1879).[3] The law also contained a provision regarding the allocation of books preserved in religious houses. Although the law did not specify their final destination, it indicated that in the process of distribution of the books, priority should be given to the needs of educational institutions such as public schools and national colleges.

During the unification process, as new territories were annexed to the Kingdom of Sardinia to form the Kingdom of Italy, another wave of dissolution of religious orders occurred in Central and Southern Italy. In December 1860, in the Umbria region—formerly part of the Papal States—approximately 299 religious houses were suppressed (Bertozzi, 1879). Unlike the law passed in the territories originally belonging to the Kingdom of Sardinia, the law implemented in Umbria contained detailed guidelines on the destination of religious houses' libraries. First, it stipulated that the books would remain within the district (*Circondario*)[4] where the religious houses were located and indicated university libraries as their recipients. If a district did not have a university, the books were to be transferred to the upper secondary education institutes (*licei nazionali*). However, shortly after it, this provision was suspended and the destination of monastic libraries was decided in April 1862. The books were considered property of the municipalities, provided they could guarantee appropriate space for their preservation and make them publicly available.[5] A similar policy was implemented in 1861 in the Marche region and Southern Italy (with the notable exception of Sicily) where 419 and 1022 religious houses were suppressed, respectively (Bertozzi, 1879). In both cases, the books were allocated to public libraries.[6]

Anticlerical policies continued after the unification of Italy, culminating with the nationwide dissolution of religious orders in 1866. During this period, the Kingdom of Italy, still not including the Veneto region and part of the Mantua province, engaged in the Third War of Independence against Austria, which resulted in the cession of the region to Italy. The expropriation of ecclesiastical

[3] See the Royal Decree No. 879 for a comprehensive list of all the abolished religious orders.

[4] *Circondario* refers to an administrative unit lower than the province level and higher than the municipality.

[5] When these conditions were not met, the books were transferred to upper administrative units such as districts or provinces.

[6] In the Marche region, they were devolved to university libraries or were assigned to district capitals to establish public libraries. Specifically, the law devolved the books in the province of Pesaro and Urbino and in the districts of Macerata and Camerino to university libraries. In the rest of the Marche region, they were assigned to the district capitals to establish public libraries.

properties served, in part, to finance the significant costs of the war. In 1866, the State enacted Law No. 3036, concerning the suppression of religious orders, and a year later, in 1867, Law No. 3848 was passed. This latter law suppressed various secular clergy bodies, including collegiate churches and choral chaplaincies, as well as abbeys and priories. It also established a set of administrative rules for the liquidation of confiscated religious properties. Finally, the last wave of the dissolution of religious orders took place in the province of Rome, which joined the Kingdom of Italy in 1871. A special law for the province of Rome was enacted in 1873, extending the measures of the previous laws to this area.

In our empirical strategy, we exploit the law enacted in 1866 which no longer recognized religious orders and suppressed their houses and establishments nationwide. Except for specific cases explicitly stated in the law, all the assets belonging to religious corporations were transferred to the State. According to the report of the commission on the Administration of Ecclesiastical Assets, by 1875 the State had taken possession of 2,151 religious corporations.[7] The majority of these houses were located in the regions of Sicily (1,050), Tuscany (266), Rome (239), and Emilia (201). From the same reports, it emerges that 33,730 ecclesiastical entities were confiscated following the implementation of the 1867 Law. These properties were divided into smaller plots and sold in public auctions.[8] The report reveals that 137,736 plots were auctioned between 1867–1875, with approximately 83% sold successfully. Given the lack of information about the buyers, it is challenging to assess the impact of this process on property distribution in Italy. Nevertheless, Bertozzi (1879) offers insights, especially for the case of Rome. According to the report, 731 plots were acquired by 531 individuals from diverse social backgrounds, with the majority residing in the city and province of Rome. Notably, many prominent buyers in Rome belonged to the Catholic aristocracy, often referred to as the "black" aristocracy (Duggan, 2008).

Religious properties were not all transferred to the State. Some monastic buildings could be granted to municipalities and provinces upon request for usage as public facilities, such as schools, kindergartens, and hospitals. This provision was applicable to both the houses suppressed by the laws enacted prior to 1866 and those affected by the 1866 law. According to the report from the Commission on the Administration of Ecclesiastical Assets until 1875, a total of 1,591 monastic buildings were assigned to local governments. Of these, 766 were suppressed monastic buildings from the laws before 1866, and 825 buildings resulted from the 1866 suppression.

[7] In Italian this report is titled: "Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze nella tornata dell'8 giugno 1876".

[8] In 1872, the state passed a law allowing private sales negotiations for those plots which went unsold until December 31, 1871 (Bertozzi, 1879).

Additionally, annual pensions were assigned to monks and nuns based on their age and the type of religious order to which they belonged. While both male and female members of suppressed religious houses were granted full civil and political rights, the law differed in its provisions for communal living. Male members were not given the option to continue communal life in the cloisters. In contrast, female members were allowed to retain their communal life in the cloisters, provided they made a formal request for this arrangement (Bertozzi, 1879).

Unfortunately, there is limited statistical information available regarding the fate of monks and nuns dismissed after the suppression of religious orders. According to the national census of 1861, prior to the suppression, there were approximately 30,632 monks (friars), a figure that drastically reduced to 8,681 by 1871. Conversely, the suppression had a lesser impact on female religious orders; their numbers decreased from 42,664 in 1861 to 29,707 in 1871.[9] A report from the administration of the "Fondo per il Culto" indicates that, at the beginning of 1875, 41,632 pensions were disbursed to members of religious orders. More detailed statistics are available for the city of Rome, where 1,819 pensions were awarded to male members and 1,069 to female members. Notably, among the male recipients, approximately 60% were priests, as highlighted in Bertozzi (1879).

2.2 Monastic books

The 1866 law specified that books, manuscripts, and scientific documents from monastic libraries were to be transferred to public libraries. These items were to be allocated based on agreements with the Ministry of Education and were required to remain within the province where the religious orders were located. For instance, the library of Ascoli Piceno, as shown in Figure A.1, received books from various religious institutions within its province. However, the practical enforcement of this provision is not clearly delineated in the law. As Traniello (1997) observes, municipalities could apply to receive books, with the condition that they would establish a public library if one did not already exist.

The aim of the 1866 law was to enhance the collections of existing public libraries and facilitate the creation of new ones. However, opinions vary regarding the effectiveness of this book allocation strategy. In practice, many libraries established with books from abolished monastic houses did not function effectively as public institutions. According to the Ministero di Agricoltura, Industria e Commercio [MAIC]. Direzione generale della statistica (1893), numerous new libraries did not open to the public and thus could not be truly considered as such. For example, the library in Oristano in

[9] Note that the statistics of 1871 includes the Veneto region and the province of Rome. When excluding them, it emerges that the number of monks was 4,738 and the number of nuns was 25,440.

Sardinia, despite being formally established in 1866, was never fully operational and remained open only briefly (Granata, 2020).

Between 1886 and 1888, the Ministry of Education conducted an inquiry into the libraries of 31 municipalities that had received books from monasteries. This inspection revealed that several beneficiary municipalities did not establish local public libraries (Traniello, 1997). However, the situation appeared to be different in cases where the books were allocated to pre-existing libraries. For instance, the librarian of the Biblioteca Marucelliana in Florence noted that among the received books, some were of exceptional quality, including a notable collection of mathematic books (Ciccarello, 2013). It is important to note that specific details about the books received by the libraries are not available. Some anecdotal evidence comes from the analysis of the Jesuit library transferred to the National Library in Rome. An excerpt from the index of the manuscripts, as shown in Figure A.2, reveals notes on a variety of subjects, including mathematics, mechanics, and medicine.

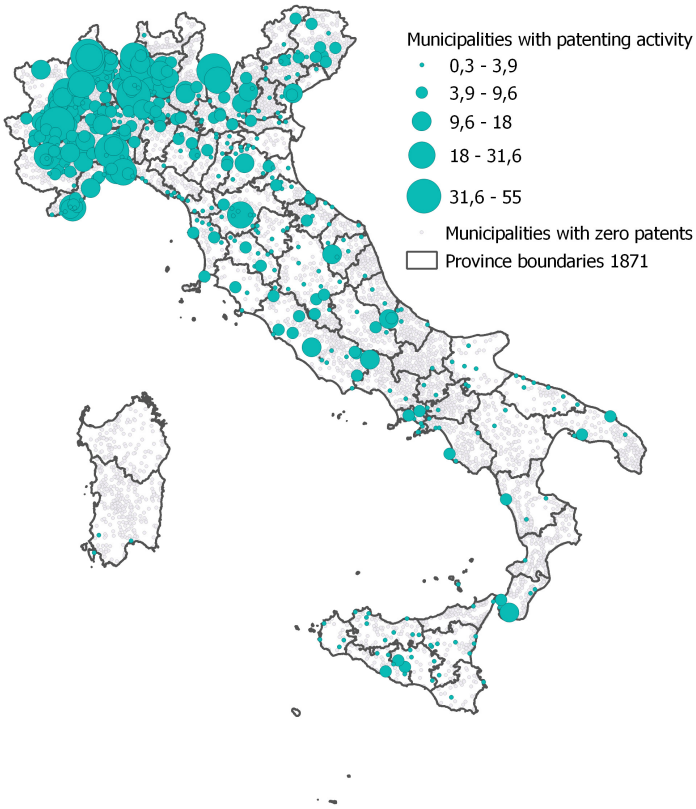
Our analysis yields results in line with the historical context previously described. Our findings suggest that, while the establishment of new libraries did not significantly impact innovation, the expansion of existing libraries through manuscripts from monastic libraries did increase innovation. Consistent with what reported by the librarian of the "Biblioteca Marucelliana" in Florence, the knowledge accumulated over the centuries in monasteries became particularly valuable and relevant during the initial phase of the industrial revolution.

2.3 Innovation

On the eve of unification, innovation in Italy was limited, predominantly featuring patents of low technological content primarily from independent innovators. Giannetti (1998) suggests that during the initial phase of industrialization, Italy was capable of adopting existing technology but lacked the skills to advance the technological frontier. Corroborating this, Nuvolari and Vasta (2014) found that the quality of patents from independent inventors was generally lower than those from firms and foreign patentees. There is a consensus that the limited quantity and quality of innovation were due to low levels of human capital and scarce technical competencies.

Concerning the geography of innovation in Italy, Nuvolari and Vasta (2017) provide a detailed analysis for the liberal period of 1861-1913. During our period of interest, innovation was concentrated in the provinces of the "industrial triangle" (Milan, Turin, and Genoa), as well as in populous provinces like Palermo and Napoli. Figure 1 illustrates the geographic distribution of the stock of patents, confirming the pattern observed by Nuvolari and Vasta (2017) over the longer period of 1861-1913.

Figure 1: innovation across Italian municipalities 1863-1883



Note: The figure shows the geographic distribution of innovation across municipalities between 1863–1883. The gray dots depict municipalities with no innovation. The green dots show patents per 10,000 inhabitants. Data sources: Official Gazette and "Bollettino delle privative industriali del Regno d'Italia".

Regarding the institutional aspect, the patent law of the Kingdom of Sardinia was extended to the Kingdom of Italy in 1864. In fact, the Italian patent system was an intermediate case between expensive systems, such as in Germany, and inexpensive systems, as in the U.S. In Italy, an inventor could decide to register a patent for a duration ranging from 1 to 15 years. Initial fees were proportional to the length of the patent duration, and an increasing annual renewal fee was required to maintain the patent. Patents registered for a short period could also be prolonged, giving the system a certain degree of flexibility.

Our dataset covers the universe of patents granted to Italian firms or individuals in the period 1863–83. Consistent with the notion that the level of technological sophistication in Italy in the period under consideration was low, we find that the average duration of the patents was about four years.[10] This notion is further substantiated by the analysis of the technological classes of patents granted during this period. First, it is important to note that, in the earlier phases of innovation in Italy, there

[10] The average duration reported does not consider prolongations.

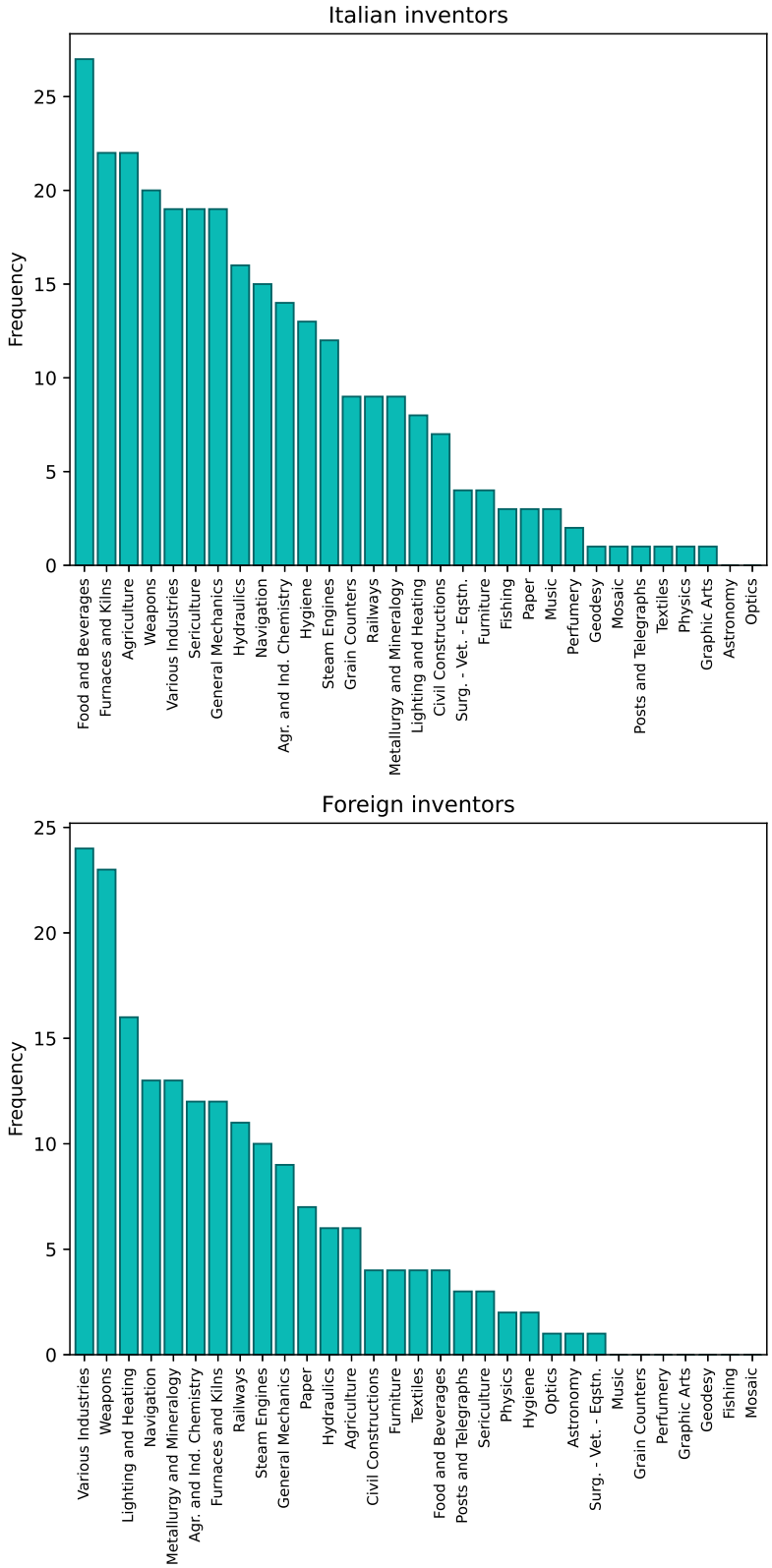
is not a time consistent classification of technological classes. In Figure 2, we plot the distribution of patents granted in 1871 based on the reported technological class by the origin of the inventor. For Italian inventors, the predominant technological classes align with traditional sectors like "Food and Beverages", "Furnaces and Kilns for Construction Materials and Ceramics" and "Agriculture". In contrast, foreign residents, excluding the elusive "Various Industries and Manufactures" category, exhibited a greater propensity for patenting in more modern sectors such as "Weapons", "Lighting and heating" and "Navigation".

We further substantiate the claim that the level of technological innovation was low by conducting a text analysis of the titles of domestic patents granted in 1871. Specifically, we extracted the most frequently occurring nouns from these titles. As shown in Figure 3, the most common nouns include terms such as *fucile* (rifle), *macchina* (machine), *cottura* (baking), *seta* (silk), *calce* (lime), and *mattone* (brick). For completeness, Figure A.3 displays a word cloud of all the nouns contained in the patent titles.[11]

In summary, innovation in Italy after unification in 1861 was primarily concentrated within the industrial triangle and around major urban centers. It was characterized by low levels of technological sophistication, partly due to the population's lack of technical skills. In this context, it is reasonable to expect that even a modest expansion of the practical and useful knowledge contained in monastic books could have been patented and utilized in manufacturing.

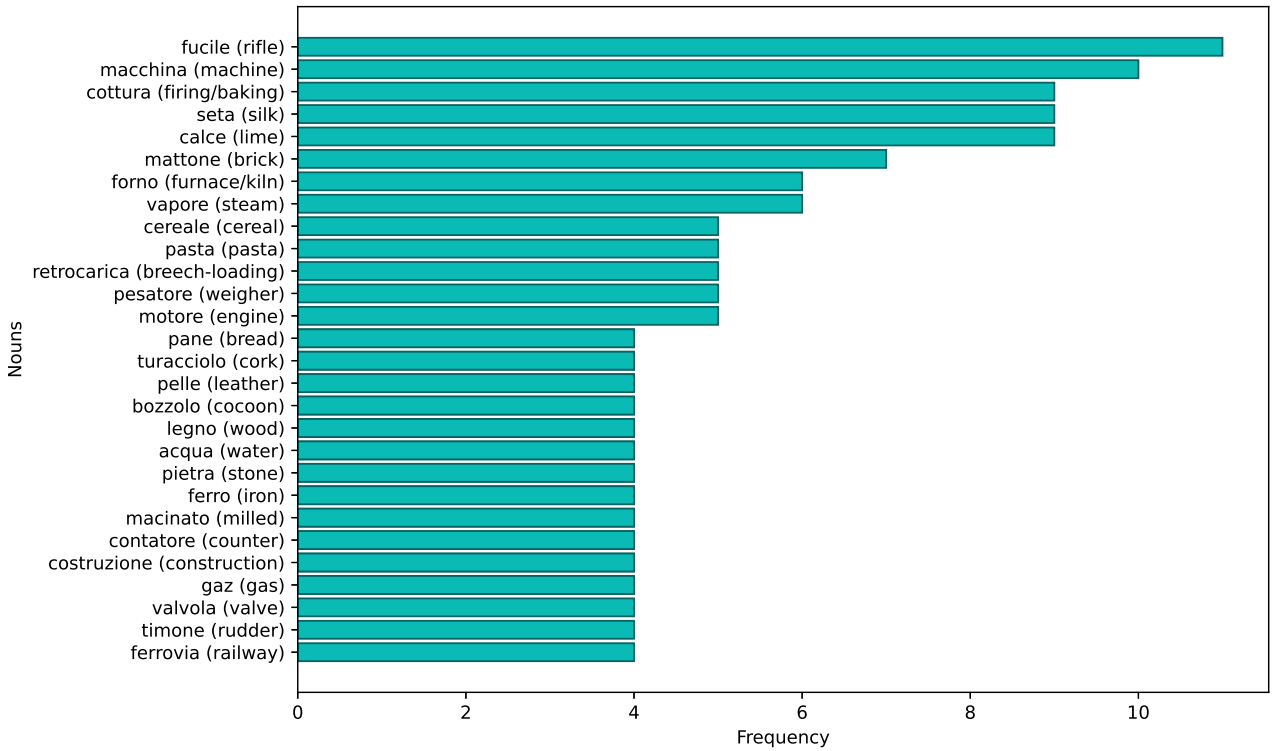
[11] One should not get misled by the word "machine". In fact, many of these machines were small and simply used in agriculture and/or food processing.

Figure 2: Frequency of patents by technological class for Italian and Foreign inventors in 1871



Note: The figure shows the frequency of patents by technological class for both domestic and foreign patents as reported in 1871. Source: "Bollettino delle privative industriali del Regno d'Italia, 1871"

Figure 3: Frequency of nouns in the titles of domestic patents



Note: The figure shows the top frequencies of the nouns in the titles of patents granted to Italian residents. Data source: "Bollettino delle privative industriali del Regno d'Italia, 1871".

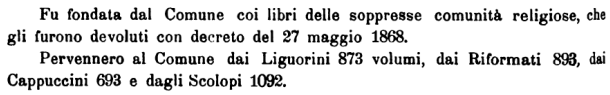
3 Data

We digitized library data from a contemporary survey titled "Statistics of Libraries", published by the Ministry of Agriculture, Industry and Trade. The survey is divided in two parts: the first part, published in two volumes in 1893 and 1894, contains information on libraries owned by local governments, including municipalities and provinces, as well as private libraries open to the public. The second part, published in 1896, focuses on "secondary" libraries, which are owned by academies, secondary schools, and military academies.

The survey was formally initiated in 1889, with the Ministry of Education responsible for preparing and distributing the questionnaire to the libraries. It collected information such as the name of the library, location, founding year, type of library, and in some cases, the number of volumes, periodical publications, and the average yearly number of users. Importantly, the questionnaire also inquired whether libraries had received books from the dissolved religious houses, asking them to "name the monastic libraries devolved to it and the number of volumes received from each". Additionally, it gathered data on the period when the books were granted. We utilize this information to identify libraries, and consequently, municipalities, that were affected by the dissolution of monastic libraries.

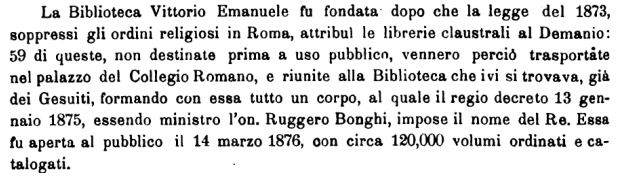
Figure 4: Examples of the text data on libraries

(a) Francavilla Fontana – Municipal Library



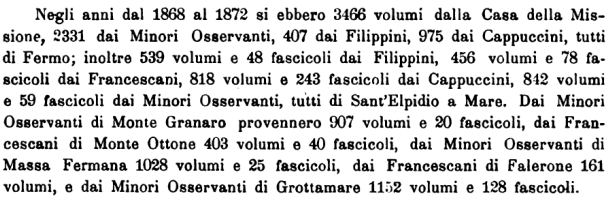
Fu fondata dal Comune coi libri delle soppresse comunità religiose, che gli furono devoluti con decreto del 27 maggio 1868.
Pervennero al Comune dai Liguorini 873 volumi, dai Riformati 893, dai Cappuccini 693 e dagli Scolopi 1092.

(b) Rome – Central National Library



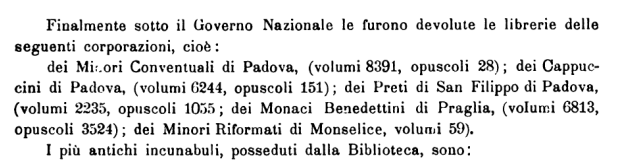
La Biblioteca Vittorio Emanuele fu fondata dopo che la legge del 1873, soppressi gli ordini religiosi in Roma, attribuì le librerie claustrali al Demanio: 59 di queste, non destinate prima a uso pubblico, vennero perciò trasportate nel palazzo del Collegio Romano, e riunite alla Biblioteca che ivi si trovava, già dei Gesuiti, formando con essa tutto un corpo, al quale il regio decreto 13 gennaio 1875, essendo ministro l'on. Ruggero Bonghi, impose il nome del Re. Essa fu aperta al pubblico il 14 marzo 1876, con circa 120,000 volumi ordinati e catalogati.

(c) Fermo –Municipal Library



Negli anni dal 1868 al 1872 si ebbero 3466 volumi dalla Casa della Missione, 2331 dai Minori Osservanti, 407 dai Filippini, 975 dai Cappuccini, tutti di Fermo; inoltre 539 volumi e 48 fascicoli dai Filippini, 456 volumi e 78 fascicoli dai Francescani, 818 volumi e 243 fascicoli dai Cappuccini, 842 volumi e 59 fascicoli dai Minori Osservanti, tutti di Sant'Elpidio a Mare. Dai Minori Osservanti di Monte Granaro provennero 907 volumi e 20 fascicoli, dai Francescani di Monte Ottone 403 volumi e 40 fascicoli, dai Minori Osservanti di Massa Fermana 1028 volumi e 25 fascicoli, dai Francescani di Falerone 161 volumi, e dai Minori Osservanti di Grottamare 1152 volumi e 128 fascicoli.

(d) Padua – University Library



Finalmente sotto il Governo Nazionale le furono devolute le librerie delle seguenti corporazioni, cioè:
dei Minori Conventuali di Padova, (volumi 8391, opuscoli 28); dei Cappuccini di Padova, (volumi 6244, opuscoli 151); dei Preti di San Filippo di Padova, (volumi 2235, opuscoli 1055; dei Monaci Benedettini di Praglia, (volumi 6813, opuscoli 3524); dei Minori Riformati di Monselice, volumi 59).
I più antichi incunabuli, posseduti dalla Biblioteca, sono:

Note: The figure displays excerpts from the textual data that we utilize to identify the libraries affected by the dissolution of religious orders. Source: "Statistica delle biblioteche, Parte I, Biblioteche dello stato, delle province, dei comuni ed altri enti morali".

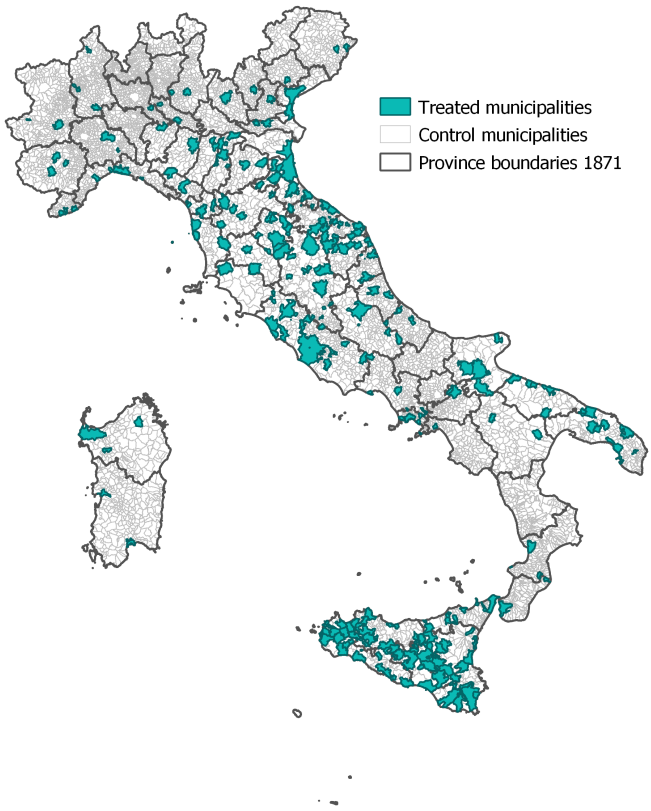
Books from monastic libraries either augmented the collections of existing public libraries or formed the foundation for new ones. Figure 4 illustrates some examples of the textual information that we used to compile our dataset. Panel (a) shows the municipal library of Francavilla Fontana, which was established as a public library *after* the dissolution of religious orders. Panel (b) displays the National Central Library in Rome, established with resources from 59 monastic libraries. Panel (c) and (d) present examples of the municipal library of Fermo and the University Library of Padua, both founded *before* the law came into force, but that received volumes from monastic libraries.

Overall, we have data for 615 public libraries. We exclude from the sample those libraries founded after our period of interest and those with missing information on the founding year.[12] Consequently, our final sample consists of 524 public libraries. The analysis is conducted at the municipality level. In our baseline specification, we classify a municipality as treated if it either established a new library or if at least one of its existing libraries received volumes from monastic libraries of suppressed religious orders. In the baseline sample, without the province of Rome, the number of treated municipalities is 232; by including the province of Rome, we have 249 treated municipalities. Figure 5 shows the geographic distribution of the treated municipalities including Rome.

We have digitized also the second part of the survey which provides information on the library's name, location, founding year, type, and number of volumes. The survey initially contained data for 1,252 libraries. After excluding libraries founded after our period of interest and those with missing information on the founding year, our final sample consists of 879 libraries. It is important to note

[12] This was the case for 70 libraries. Only 3 of them received books from the monastic libraries.

Figure 5: The geographic distribution of treated municipalities



Note: Treated municipalities (in green) are those which established a new library and/or those where at least one existing library received volumes from monastic libraries of suppressed religious orders. Province boundaries as in 1871. Source: "Statistica delle biblioteche, Parte I, Biblioteche dello stato, delle province, dei comuni ed altri enti morali".

that most libraries in this sample are relatively small and only 19 received additional volumes due to the dissolution of religious houses. Our baseline analysis will include this sample as well. However, our preferred sample remains the one from the first part of the survey, which encompasses the main public libraries.

We investigate whether increasing access to useful knowledge, in the form of monastic books, impacts innovation. Following the approach of previous literature,[13] our outcome measure is the number of patents per 10,000 inhabitants at the municipality level.[14] The primary sources for innovation are the Official Gazette and various publications by the Ministry of Agriculture, Industry and Trade.[15] These sources provide information on the inventors' names, their municipalities of

[13] See for instance Nuvolari and Vasta (2017) and Cinnirella and Streb (2017).

[14] We use administrative boundaries as of 1871 and our sample consists of 8,363 municipalities. Data on municipal population were drawn from the national census of 1871.

[15] These publications were titled "Bollettino delle privative industriali del Regno d'Italia" and were published yearly. See the Online Appendix C.1 for a detailed description of the data sources for each year.

residence, and the patents' durations. We digitized all patents granted to Italian inventors from 1863 to 1883 and assigned each patent to the municipality where the inventor resided.[16]

The control variables used in our analysis include: population size and measures for municipal school supply in the school year 1862/63. For population data, we relied on the 1861 census, while information on primary schooling is drawn from a publication by the Ministry of Agriculture, Industry and Trade on schooling conditions across Italian municipalities.[17] In particular, we have information on the number of primary schools, students, teachers, and local expenditures for primary schooling.

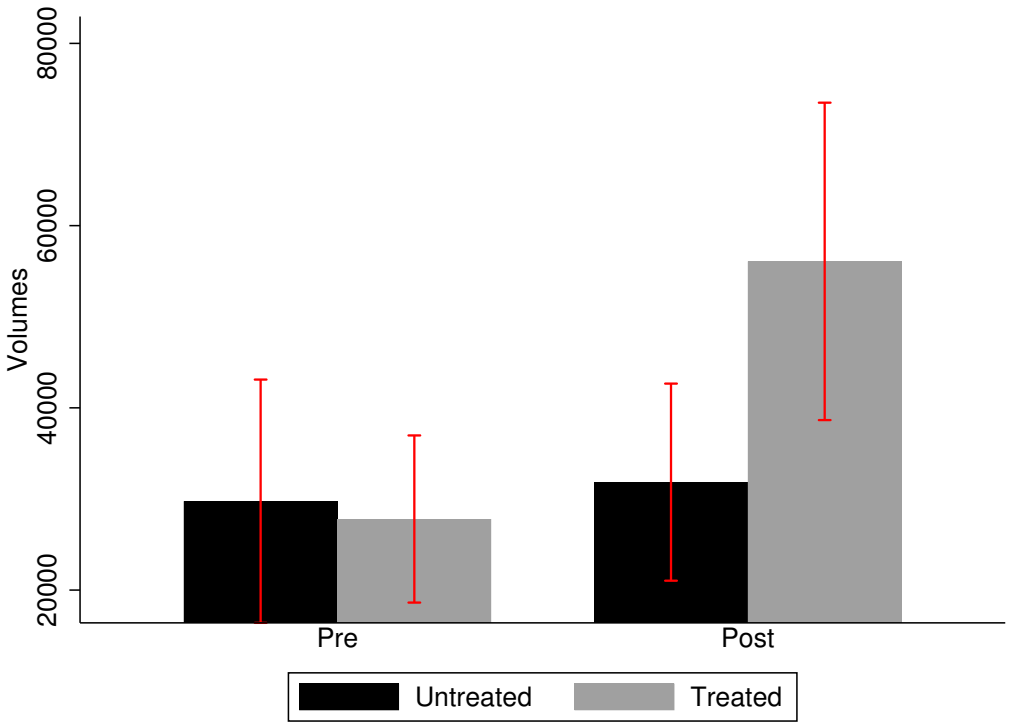
We also digitized provincial-level data related to various aspects of the anticlerical legislation. This dataset includes information on the number of suppressed monasteries, the number of monastic establishments granted for public-utility purposes, and the surface area of immovable properties offered and sold at public auctions, as well as through private negotiations. These data are drawn from the Commission on the Administration of Ecclesiastical Assets 1875 report, which covers the period from the enactment of the anticlerical legislation up to the end of 1875.[18] Additional variables incorporated into our analysis at the provincial level include the number of monks and nuns, obtained from the national population censuses of 1861 and 1871, as well as the population and surface area of the provinces.

4 Methods and results

In order to assess whether the suppression of monastic libraries actually increased the stock of books accessible to the public, we show that the number of volumes varied considerably between treated and untreated libraries after the implementation of the law. We matched our data with an earlier survey of libraries conducted in 1863. Overall, we were able to match 129 libraries from our sample. Figure 6 shows the average number of volumes in both treated and untreated libraries, before and after the dissolution of religious orders in 1866. In 1863, the average number of volumes was comparable between the two groups, with 27,797 volumes in the treated group and 29,751 in the untreated group. After the dissolution of the monasteries and the subsequent reallocation of their books, the treated libraries had an average of 56,075 volumes, while the untreated libraries had around 31,845.

[16] For those few cases in which there are multiple inventors, we assigned the municipality of residence of the first inventor.
[17] The publication, titled "Istruzione elementare pubblica per comuni, anno scolastico 1862-1863", was published in 1865.
[18] The title of the report is "Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze (DEPRETIS) nella tornata dell'8 giugno 1876".

Figure 6: Number of volumes in public libraries before and after monastic libraries expropriations



Note: The figure shows the average number of volumes for treated and untreated libraries. The red line shows the 95% confidence intervals. Data sources: "Statistica delle biblioteche, Parte I, Biblioteche dello stato, delle province, dei comuni ed altri enti morali" and Statistica del Regno d'Italia: Biblioteche. Anno 1863.

After assessing the effectiveness of the reform, we investigate whether receiving volumes from monastic libraries affected innovative activity by implementing a difference-in-differences (DiD) model. Formally, we estimate the following generalized DiD model:

$$\text{Patents}_{mt} = \gamma_m + \lambda_t + \beta(\text{Library}_m \times \text{Post}_t) + \varepsilon_{mt} \tag{1}$$

where Patents_{mt} denotes the number of patents per 10,000 residents in the municipality m at time t.[19] Post_t is a dummy variable equal to 1 for the period after the law came into force (from 1867 onwards), while Library_m indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. Finally, γ_m and λ_t represent municipality and time fixed effects, respectively. In alternative specifications, we will also include macro-area by time fixed effects to account for trends in innovation that vary across North, Center, and South. Standard errors are clustered at the municipality level.

[19] In our robustness checks, we also consider other transformations including log(1+patents) and the inverse hyperbolic sine *(ihs)* transformation.

In our baseline analysis, we exclude the province of Rome, which became part of the Kingdom of Italy in 1871. This approach ensures that all our units receive the treatment at the same time, thus avoiding issues related to staggered treatment timing discussed in recent literature on difference-in-differences (Goodman-Bacon, 2021). However, for completeness, we estimate Equation 1, including also the province of Rome, and provide the relative decomposition of our DiD estimate.

4.1 Baseline results

In Table 1, we report estimates of Equation 1. In column (1), we consider all libraries affected by the law, thus considering as treated all municipalities that opened a new library or, when a library already existed, those that received volumes from monastic libraries. As one can see, the coefficient is positive and highly significant, indicating that municipalities which increased the number of manuscripts from the closure of monasteries experienced a significant increase in the number of patents. In column (2), we include macro-area by year fixed effects to account for macro-area specific shocks that varied over time.[20] The DiD coefficient becomes larger and is highly significant. In columns (3) and (4), the definition of treatment is restricted to only include municipalities where "large libraries" received monastic volumes, i.e., the libraries reported in the first part of the original survey. The coefficients are virtually the same as those in columns (1) and (2), indicating that the results are driven by municipalities with large libraries.[21]

An important concern regarding our identification is that the dissolution of monastic orders might capture other features that could impact innovation. In fact, as mentioned in Section 2, the dissolution of monastic orders was accompanied by the sale of church land, which might have triggered a process of land redistribution. We implement different strategies to address this issue. One strategy is to restrict the sample to urban municipalities, which are expected to be less affected by land redistribution due to their urban economy base. In columns (5) and (6), we estimate our baseline model on municipalities with more than 10,000 inhabitants. In this case, the sample consists of 134 treated and 220 control municipalities. We find that urban municipalities with a larger stock of manuscripts from the suppression of monastic libraries significantly increased innovation compared to municipalities without any increase in monastic books. In terms of magnitude, the coefficients range between 0.031 and 0.035, which, relative to an average number of patents per 10,000 people of about 0.074, indicates a large but plausible effect.

[20] The macro-areas are three: (i) north, (ii) center, (iii) south and islands.
[21] Estimates with only "small libraries" are not reported as, in that case, there are only 19 treated municipalities.

Table 1: Baseline estimates: The effect of monastic libraries expropriation on patenting

	All libraries		Large libraries		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Library x post	0.0308***	0.0364***	0.0303***	0.0360***	0.0311**	0.0354***
	(0.00843)	(0.00846)	(0.00886)	(0.00891)	(0.0140)	(0.0127)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro-area by time FE	No	Yes	No	Yes	No	Yes
Observations	170856	170856	170856	170856	7434	7434
Treated	248	248	232	232	134	134
Control	7888	7888	7904	7904	220	220
N° of clusters	8136	8136	8136	8136	354	354
Mean of outcome	0.0170	0.0170	0.0170	0.0170	0.0741	0.0741

Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

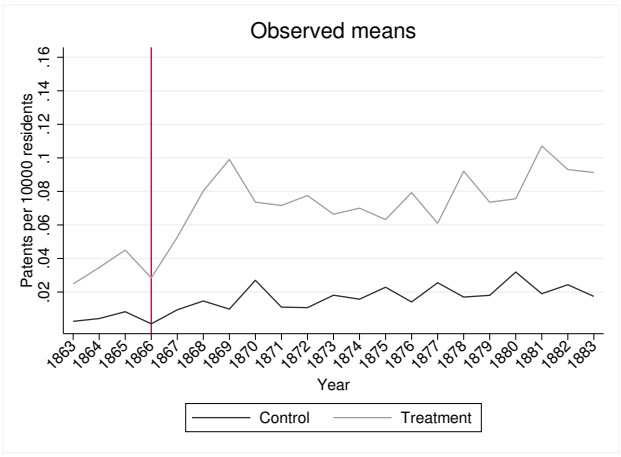
Identification rests on the parallel trend assumption, i.e., municipalities which received books due to the dissolution of monastic libraries, in the absence of treatment, would have followed the same trend in innovation as the municipalities which never received any monastic book. To assess the plausibility of this assumption, we begin by providing some graphical diagnostics. In Panel (a) of Figure 7, we plot the observed means of the number of patents per 10,000 inhabitants for both the pre- and post-treatment periods for all libraries for both groups. In Panel (b), we show a plot for the linear trends model. Both panels suggest that treated and control municipalities followed similar trends in patenting before 1867. There is a clear divergence between the two groups only afterward . Similarly, we provide the same graphical diagnostics also for "large" libraries (Panels (c) and (d)) and for the urban municipalities (Panels (e) and (f)). In all cases, the parallel trend assumption appears to hold.

To further assess the plausibility of the parallel trend assumption, we conduct a placebo test by shifting our *Post* indicator by k years and estimating our baseline model with only pre-treatment data. Formally, we estimate the following model:

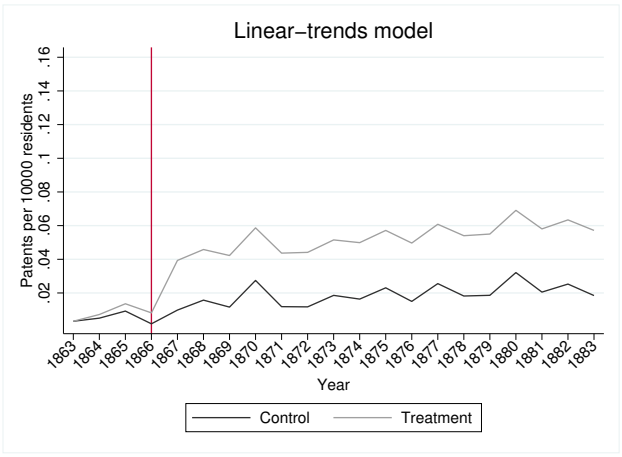
$$\text{Patents}_{mt} = \gamma_m + \lambda_t + \beta(\text{Library}_m \times \text{Post}_{mt-k}) + \epsilon_{mt}; \quad k = 1, 2, 3; \quad t < 1867$$

Figure 7: Parallel trend assumption: graphical diagnostics

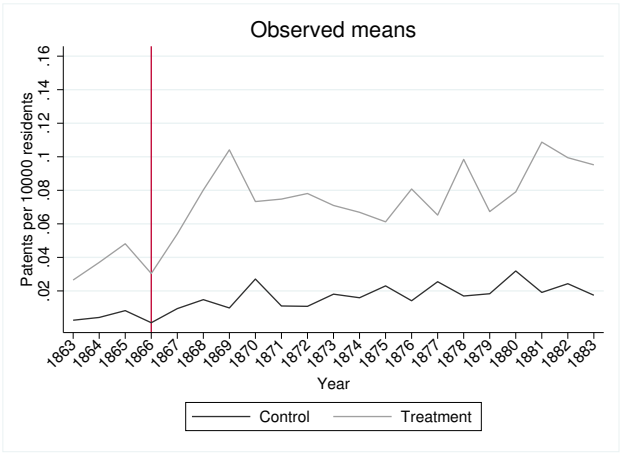
(a) All libraries: Observed means



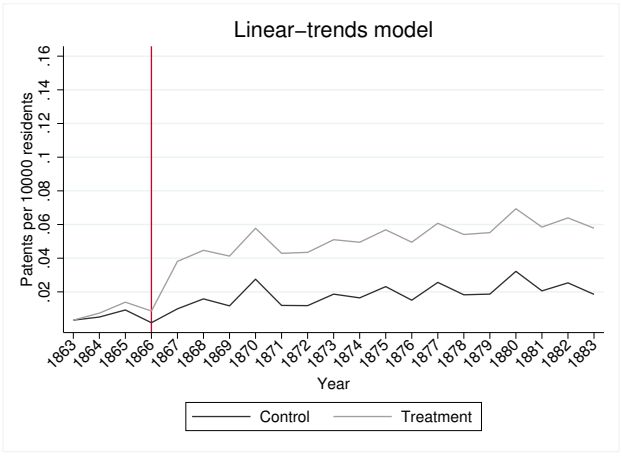
(b) All libraries: Linear trend model



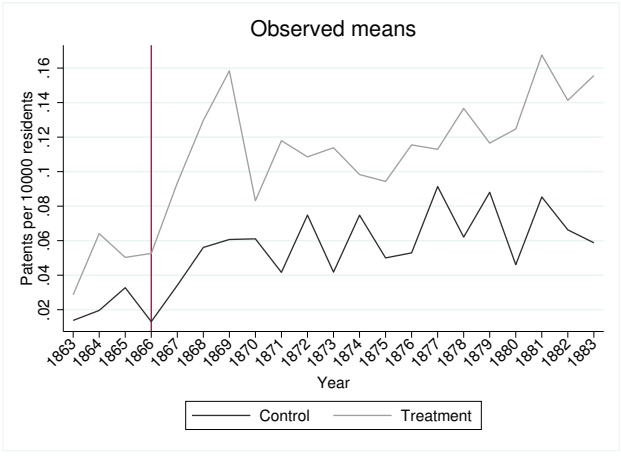
(c) Large libraries: Observed means



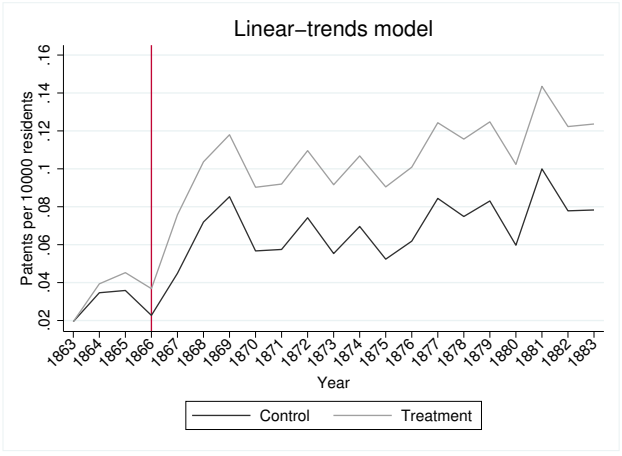
(d) Large libraries: Linear trend model



(e) Urban sample: Observed means



(f) Urban sample: Linear trend model



Note: Panels (a), (c), and (e) show the observed means of the number of patents for 10,000 inhabitants for both treated and control group for the three samples. Panels (b), (d), and (f) display the linear trend model.

Table 2: Placebo test: Assessing the plausibility of the parallel trend assumption

	Placebo treatment year is:		
	(1)	(2)	(3)
	1866	1865	1864
Library x placebo post	-0.00289	0.00621	0.0100
	(0.00918)	(0.0114)	(0.0133)
Time FE	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes
Observations	32544	32544	32544
Treated	232	232	232
Control	7904	7904	7904
N° of clusters	8136	8136	8136
Mean of outcome	0.00490	0.00490	0.00490

Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. The dummy *placebo post* refers to fake treatment years. All regressions are estimated with data from the pre-treatment period. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 shows the results of this placebo test which considers "large libraries" as treatment as we found that these are the main drivers of our results. Column (1) reports the estimates when the placebo treatment year is 1866, i.e. the indicator *Post* is equal to one for 1866 and zero for 1863, 1864, and 1865. Similarly, column (2) shows the results when the indicator *Post* equals one for 1865 and 1866 and zero for 1863 and 1864. Finally, column (3) displays the estimates when we shift the treatment period by three years. In all cases, we do not find any statistically significant coefficient. Similar to the graphical diagnostics, the placebo estimates strongly suggest that treated and untreated municipalities did not differ in terms of innovation *before* the treatment occurred.

4.2 Different treatments

For the baseline results presented above, we have defined a comprehensive treatment (*Libraries*). Yet, receiving books from monastic libraries entailed either augmenting the stock of an existing public library or opening a new public library. In fact, we can exploit this difference of treatment to shed some light on the potential mechanism. We start by distinguishing between receiving new books in

an already-existing library (treatment *Volumes*) and opening a new library (treatment *New library*). In column (1) of Table 3, we run a "horse-race" between the two treatments. As one can see, the coefficient for *Volumes* is large and highly significant whereas the coefficient for *New library* is basically zero. This result strongly suggests that the effect of the expansion of useful knowledge on innovative activity worked through the enrichment of previously existing libraries. Conversely, the opening of new libraries with books from suppressed monasteries has no impact on innovative activity. This result is in line with the judgment of contemporary observers who deemed the policy as inadequate to form a basis for *new* local public libraries.[22] Conversely, municipalities with a previously existing library had the know-how to manage and catalog the new books. This result seems also to imply that it was only the expansion of the stock of knowledge that had an impact on innovation, whereas the opening of a new public space did not have any significant impact on innovation (Berkes and Nencka, 2021).

To gain additional insights into the mechanism, we exploit the information on the *type* of library. The original survey categorizes the libraries as either "general" or "specific". Since we argue that the stock of knowledge embedded in monastic libraries, once accessible to the public, provided knowledge that was useful for innovations, we expect that a general-purpose library would have a greater impact on innovation than a specific-purpose library focused, for instance, on theology, literature, or history. In column (2) of Table 3, we run a "horse-race" between the two types of treatment: (i) the opening of (or the contribution to) a general public library (the number of treated municipalities is 180) (ii) the opening of (or the contribution to) a religious library (31 treated municipalities). [23] Also in this case the results are clear-cut: the effect on innovation is positive and significant only for the opening of (or the contribution to) a general-purpose public library. The coefficient for the opening of (or contribution to) religious libraries is negative but not significant.

This result is consistent with our argument that books previously stored in monasteries contained knowledge useful for some innovation. Furthermore, this finding can also rule out that our treatment is capturing other aspects of the religious orders' dissolution reform. As already mentioned, the policy also entailed the redistribution of monastic land. Such redistribution of wealth could directly impact innovation. Yet, if land redistribution were the main driver of our results, we should find a positive effect also for the opening of (or contribution to) a religious library, which allegedly came with some land redistribution (column 2 of Table 3). In fact, the same interpretation can be applied to the

[22] See the introduction to the survey (Ministero di Agricoltura, Industria e Commercio [MAIC]. Direzione generale della statistica, 1893).

[23] We exclude from the analysis the 14 municipalities that received both of these treatments. In both "horse races", the control group includes municipalities which did not receive any type of treatment.

Table 3: The effect of monastic libraries expropriation by type of treatment and type of library

	(1)	(2)
Volumes x post	0.0644***	
	(0.0153)	
New library x post	-0.00257	
	(0.00884)	
General library x post		0.0398***
		(0.0103)
Religious library x post		-0.00605
		(0.0238)
Time FE	Yes	Yes
Municipality FE	Yes	Yes
Observations	170793	170415
Treated	229	211
Control	7904	7904
N° of clusters	8133	8115
Mean of outcome	0.0169	0.0170

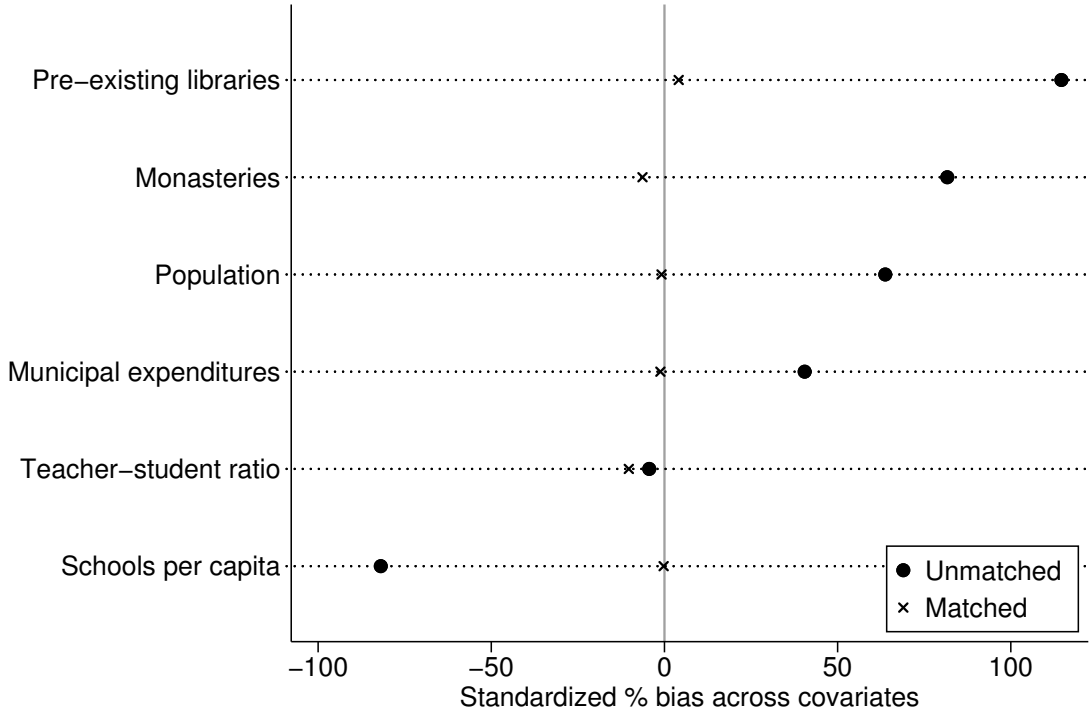
Note: The dependent variable is the number of patents for 10,000 inhabitants. *Volumes* indicates municipalities receiving books in an already-existing library. *New library* indicates municipalities opening a new library. *General library* indicates municipalities opening a new general library or enlarging existing general libraries. *Religious library* indicates municipalities opening a new religious library or enlarging existing religious libraries. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

opening of new libraries which, even if not successful, should have included some land redistribution. The fact that only the treatment with volumes and with general-purpose libraries has an impact on innovation is a strong indication that the effect operates through knowledge access and not through wealth redistribution.

4.3 Difference-in-Differences with Matching

The graphical diagnostics and the placebo test provide reassuring results concerning the parallel trend assumption. We can further enhance our estimates by making the control group as similar as possible to the treatment group by adopting a matching approach. This is particularly important as the assignment to treatment of the municipalities is not clearly specified by the law, and therefore

Figure 8: The extent of balancing before and after matching



Note: The figure shows the extent of balancing of the pre-determined covariates for both matched and unmatched sample. A detailed description of these covariates and the data sources are presented in the Online Appendix C.2

balancing on pre-treatment observable characteristics can reduce potential biases. In particular, we choose a set of predictor variables from the pre-treatment period that includes population in 1861, whether a municipality had a public library prior to the dissolution of religious orders, the number of monasteries suppressed at the province level, education variables such as municipal expenditures for primary schooling, schools per capita, and teacher-student ratio during the 1862-1863 school year.

We perform a nearest neighborhood matching. Since assignment to treatment was more likely for large towns and for municipalities with monasteries in the province, the variables employed in the matching approach should balance the two groups. This "correction" is also very important if there is the concern that municipalities with a higher preference for education (and in turn potentially more innovative) lobbied for obtaining more monastic books. By including educational input and output measures, we directly account for that. Figure 8 shows that the matched municipalities are well balanced across the six pre-treatment covariates.

The sample matched with the variables listed above consists of 777 municipalities, 560 of which are in the control group and 217 are treated. Difference-in-differences estimates based on the matched sample are reported in Table 4. In column (1), we show the results of our baseline model on the matched sample. The coefficient is slightly smaller compared to the baseline estimates presented in

Table 4: The effect of monastic libraries expropriation on patenting: Diff-in-diff estimates with matching

	(1)	(2)	(3)
Library x post	0.0167*		
	(0.00962)		
Volumes x post		0.0478***	
		(0.0163)	
New library x post		-0.00763	
		(0.00982)	
General library x post			0.0260**
			(0.0110)
Religious library x post			-0.0113
			(0.0241)
Time FE	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes
Observations	16317	16296	15918
Treated	217	216	198
Control	560	560	560
N° of clusters	777	776	758
Mean of outcome	0.0341	0.0341	0.0347

Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. *Volumes* indicates municipalities receiving books in an already-existing library. *New library* indicates municipalities opening a new library. *General library* indicates municipalities opening a new general library or enlarging existing general libraries. *Religious library* indicates municipalities opening a new religious library or enlarging existing religious libraries. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1, column (1). Similar to the analysis conducted in Table 3, we distinguish between the different treatments and perform a "horse race" between the contribution of volumes and new libraries (column (2)) and general vs. specific libraries (column (3)). Consistent with the previous results, we find that the effect is driven by the expansion of the stock of books of existing libraries and the contribution to general-purpose libraries. Also in this case, the coefficient for religious libraries and religious volumes is negative but not statistically significant. In terms of magnitude, the estimated coefficients in columns (2) and (3) are quite large, considering that the average number of patents per 10,000 inhabitants in the matched sample is around 0.034.[24]

[24] Similar to the analysis reported in Table 3, we exclude municipalities that received both types of treatment.

In sum, difference-in-differences estimates on the matched sample provide a picture that is fully consistent with the previous results, suggesting that the expansion of general knowledge through books previously stored in monasteries triggered innovation. The non-result for the establishment of new libraries and for religious libraries is consistent with the interpretation that other aspects of the reform, such as the redistribution of land property, had no bearing on the results. We will provide further evidence that other aspects of the reform did not have any impact on innovation.

5 Robustness checks

The analysis carried out so far considers the number of patents per 10,000 inhabitants as outcome. In our first robustness check, we consider alternative definitions of the outcome variable. In columns (1)-(3) of Table B1 in the Online Appendix B, we employ $\log(1+patents)$, and in columns (4)-(6), we take the inverse hyperbolic sine (ihs) transformation of the number of patents, which has the advantage, compared to the logarithmic transformation, of being defined at zero.[25] Estimates of the different treatments are consistent with our previous results: only books allocated to previously existing libraries and general-purpose libraries have an impact on innovation. Interestingly, the magnitude of the coefficients when using the inverse hyperbolic sine transformation is comparable to Berkes and Nencka (2021). However, one should be cautious in interpreting these estimates as elasticities because, as emphasized by Chen and Roth (2023), these are influenced by the unit of measurement of the outcome. In Panel B of Table B1, we also report results controlling for the population and the point estimates remain similar.[26]

Rome joined the Kingdom of Italy in 1871, and the allocation of manuscripts was regulated in 1873. This means that the timing of the treatment was different for the municipalities in the province of Rome. In Table B2 (Panel A) in the Online Appendix B, we present estimates including the province of Rome. The coefficients for the unrestricted, restricted, and urban samples are in line with the baseline results of Table 1. Yet, the inclusion of municipalities from the province of Rome implies a staggered treatment timing. Recent advances in the econometric literature suggest that such a design could lead to biased estimates. Therefore, we have performed the decomposition proposed by Goodman-Bacon (2021). Most of our difference-in-differences estimate stems from the "right" comparison, i.e., comparing treated municipalities to the never treated, with the relative weight being 99.7 percent.

[25] See Bellemare and Wichman (2020) for a discussion on the pros and cons of using the inverse hyperbolic sine transformation.

[26] The population data are available only for the census years, i.e., 1861, 1871 and 1881. We employ the *ipolate* function in Stata to predict the population for the years between the censuses. For two municipalities in the Veneto region, it was not possible to predict the population because they were suppressed, and we only have information for the population of 1871.

We address the issue of selection into treatment, that is, the concern that municipalities receiving books from monastery dissolutions were systematically different, in different ways. One approach is to consider only treated municipalities and exploit information on the number of received books. The logic is to assume selection into treatment as given and study only the intensity of the treatment. For about half of the treated municipalities, we have information on the number of books they received from suppressed monasteries. We define a binary treatment, which equals one if the number of received books from monastic libraries exceeds the sample mean, and estimate the same models as in Table 1. The results, shown in Panel B of Table B2, show that, conditional on receiving books, municipalities which received relatively more books increased innovation. In terms of magnitude, the estimates in columns (1) to (6) range from 0.08 to 0.10. Compared to the average number of patents per 10,000 people (ranging from 0.098 to 0.116), these estimates suggest that municipalities receiving a higher number of books from monastic libraries experience a significant increase in innovation.

As discussed in Section 2, the reform under study was not the first attempt to dissolve monastic orders. In order to account for previous laws that affected the Kingdom of Sardinia, the regions of Marche and Umbria, and the Kingdom of Naples, we include a set of indicators for these areas interacted with year-fixed effects. The results are reported in Table B3 in the Online Appendix B. In column (1) we run our baseline estimate, whereas in columns (2) and (3) we perform our "horse-race" models. Even after accounting in a flexible way for the regions previously affected by similar laws, the results hold and are fully consistent with our baseline estimates.

Throughout the analysis, we have included the region of Veneto and part of the province of Mantua which, in fact, became part of the Kingdom of Italy only in 1866. Although the timing of the implementation of the policy in these areas was the same as in the other parts of Italy, for the pre-treatment period we have data only on patents from "foreign" inventors who requested protection in the Kingdom of Italy. In fact, it is possible that most of the inventors applied for patents (also) in Austria. In columns (4)-(6), we show estimations excluding these areas from the sample. Reassuringly, our main findings are confirmed as the coefficients are virtually identical to our baseline estimates.

Standard errors in our regression analysis are clustered at the municipality level. To account for spatial correlation in the data, we compute Conley (1999) standard errors by making different assumptions on the distance level for the spatial correlation. In Table B4 in the Online Appendix B, we present estimates and standard errors when accounting for spatial correlation within, respectively, 25, 50, 100, and 200 km for the three treatments: baseline, volumes, and general library. In all cases, the coefficient remains highly significant.

Access to a larger stock of useful knowledge could also have spillover effects. Neighboring municipalities could have benefited from the increase in the number of manuscripts in local public libraries. We test for the presence of spillover effects by dropping the treated municipalities and consider as treated the municipalities within, respectively, 5, 10, 15, and 20 km from the centroid of the true treated municipality. The results reported in Table B5 in the Online Appendix B, indicate the absence of any spillover effect for all types of treatment.

One could claim that the effect of monastic books is related to (or amplified by) the presence of a university, where the latter would suggest the presence of a knowledge elite. To understand the potential role of universities, we report in Table B6 estimates when excluding municipalities with universities. We consider all the universities present in Italy in 1871.[27] We mantain the same structure, namely we present the baseline estimates in column (1) and the "horse-race" specifications in columns (2) and (3). We find that the point estimates are slightly lower when excluding municipalities with universities. The coefficient for the treatment "Library" decreases from 0.03 to 0.024, while the treatments "Volumes" and "General Library" decrease from 0.064 and 0.04 to 0.057 and 0.033, respectively. Nevertheless, the coefficients remain significant and robust suggesting that our results are not driven by municipalities with universities. In fact, these results should not surprise, as in the period considered the share of the population enrolled in universities was relatively modest.[28] Furthermore, municipalities like Milan, Florence, and Genoa, which had no universities, are among those with higher innovation.

In order to test whether there is geographic heterogeneity in the effect of monastic books on innovation, we split the sample into three macro areas: North, Center, and South (which includes the islands of Sicily and Sardinia). The results reported in Table B7 show a large effect in Northern Italy, but the coefficient is noisily estimated and is marginally significant (column (1)). The coefficients for the Center and the South are relatively smaller but more precisely estimated (columns (2) and (3)). The higher precision of the results for Central and Southern Italy is due to the larger number of treated municipalities in those regions, as shown in Figure 5.

We also test for the potential confounding effect of the institutional settings of the pre-unification states. Different institutions might have shaped systematic differences in the propensity to patent new ideas, thus explaining some of the variation in our outcome variable.[29] We test for possible

[27] We exclude from the sample the following municipalities/universities: Bologna, Cagliari, Catania, Genova, Macerata, Messina, Modena, Napoli, Padova, Palermo, Parma, Pavia, Pisa, Roma, Sassari, Siena, Torino, Camerino, Ferrara, Perugia, Urbino.

[28] As reported by contemporary statistics ("L'Italia Economica nel 1873"), excluding the University of Naples, there were 6,957 students enrolled in state universities in the academic year 1872-1873. The total number of full professors across state universities, including Naples, was 487.

[29] See **?** for differences in Italian patent systems before unification.

heterogeneity by splitting the sample in the following groups: the Kingdom of Sardinia; Lombardy and Veneto; Tuscany, Modena, and Parma; Papal States; the Kingdom of the Two Sicilies. The estimates are reported in Table B7. Essentially, we find a negligible effect in the Kingdom of Sardinia (column 4) as these areas have been subject to a secularization movement before the reform under study. The effect in Lombardy, Veneto, and Tuscany is large and highly significant (columns 5-6). The effect of monastic books in the Papal States is also large if standardized by the average innovation in those regions, but the coefficient is not precisely estimated.[30] Finally, the effect in the Kingdom of the Two Sicilies is also large and highly significant.

As a final robustness check, we show that our results cannot be replicated if we randomly assign our treatment "Library" to municipalities within the province. We estimate 10,000 difference-in-differences coefficients from Equation 1 and display the distribution of the coefficients in panel (a) of Figure B1. As expected, the distribution is normal and centered around zero. The "true" coefficient (red line) lies well above the 99th percentile (black dashed line), indicating that the geographic structure of our treatment is not random. For completeness, we randomly assigned 10,000 times also the treatments of our "horse race" estimates. In panel (b) of Figure B1, we present the distribution of the coefficients for the treatment "Volumes" whereas in panel (c) the distribution of the coefficients for the treatment "New Library". The true coefficient for the treatment "Volumes" lies above the 99th percentile whereas the true coefficient for the treatment "New Library" falls in the middle of the distribution centered at zero. Similarly, in panels (d) and (e) of Figure B1, we present the distribution of, respectively, the treatment for "General Library" and the treatment for "Religious Library". Also in this case, the true coefficient for "General Library" lies well above the 99th percentile of the distribution whereas the true coefficient for "Religious Library" falls in the middle of the distribution. These tests strongly suggest that the estimated effects of monastic books reflect a true underlying relationship.

6 Analysis at the province level

In this section, we carry out the analysis at the province level for two purposes: first, to further address the issue of selection into treatment, and second, to take advantage of data availability regarding other provisions of the law, such as the reallocation of monastic establishments and land redistribution. At this level of aggregation, we are also able to address the issue related to the role of the "dismissed" monks.

[30] These results are without the province of Rome which joined the Kingdom of Italy in 1871. The point estimate is 0.025 and marginally significant when including the province of Rome (not shown here).

The analysis of pre-trends in innovation, the placebo test, and to some extent also the matching approach, all point to discard any observable selection into treatment. We exploit the law prescription according to which the recipient municipality should have been within the province of the suppressed monastery and collapse the treatment and estimate our difference-in-differences models at the province level. The results presented in Table 5 are fully consistent with the findings discussed so far, namely there is a large effect when monastic books are allocated to an existing library (column (2)) and when libraries are of general-purpose interest (column (3)).[31]

In a next step, we explore whether other aspects of the anticlerical legislation had an impact on innovative activity. We start by inspecting if the concession of monastic establishments for public-utility purposes (such as schools and hospitals) affected innovation. We estimate our difference-in-differences model at the province level using the density of monastery concessions as variable of interest. Note that, in this case, the treatment is continuous and defined as the density of monastic establishments, i.e., the number of concessions per square kilometer.[32] Panel (a) of Figure 9 shows the geographical distribution of the density of monastic concessions across Italian provinces. The results, presented in column (1) of Table 6, indicate that there is no significant relationship between monastery concessions and innovation.

Subsequently, we investigate the potential impact of monastic land redistribution. In this case, we define two treatments: first, the treatment is defined as the ratio of the area of land properties offered at public auctions and private negotiations over the area of the province; second, we define the treatment using the area of land effectively sold at public auctions and private negotiations normalized by the province's area. The geographical distribution across provinces is similar for both measures and the most affected provinces are mostly located in Central and Southern Italy (panels (b) and (c) of Figure 9). The estimates when using these two variables as treatment are reported in columns (2) and (3) of Table 6. We do not find any statistically significant effect, further supporting our hypothesis that access to knowledge is the only underlying channel driving our findings.[33]

The role of the "dismissed" monks constitutes another concern as potential confounding factor. As we reported in the Introduction, there is ample evidence that monks, historically, advanced the knowledge frontier and made significant contributions in various fields, from agriculture to aeronautics. It could be argued that monks (and nuns), once dismissed from their monasteries, contributed to innovation in the secular society.

[31] Note that for the "horse-race" estimates, when a province received both treatments, we randomly assign the type of treatment.

[32] A detailed description of the variables used in this analysis and their data sources is provided in the Online Appendix C.3.

[33] Data on the area of monastic land redistribution is missing for the province of Genova.

Table 5: The effect of monastic libraries expropriation on patenting: estimates at the province level

	(1)	(2)	(3)
Library x post	0.0220**		
	(0.0108)		
Volumes x post		0.0310**	
		(0.0131)	
New library x post		0.00788	
		(0.0104)	
General library x post			0.0282**
			(0.0120)
Religious library x post			0.00498
			(0.0117)
Time FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Observations	1428	1428	1407
Treated	59	59	58
Control	9	9	9
N° of clusters	68	68	67
Mean of outcome	0.0564	0.0564	0.0572

Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates provinces that received monastic volumes in an existing library or constructed a new library with monastic volumes. *Volumes* indicates provinces receiving books in an already-existing library. *New library* indicates provinces opening a new library. *General library* indicates provinces opening a new general library or enlarging existing general libraries. *Religious library* indicates provinces opening a new religious library or enlarging existing religious libraries. The unit of observation is province-year. All regressions include province and time-fixed effects. Standard errors shown in parenthesis are clustered at the province level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To address this issue, we use the number of monks and nuns per 1,000 inhabitants drawn from the 1871 Population Census as a continuous treatment variable. Estimates of a difference-in-differences model are reported in column (4) of Table 6. The estimated coefficient is negative and not statistically significant. We perform the same analysis using the 1861 Population Census data, which provides the number of monks and nuns across Italian provinces before the treatment.[34] As shown in column (5) of Table 6, there is no significant relationship between the presence of monks (and nuns) and innovation in the years following the suppression of religious orders. For comparison with our baseline estimates,

[34] For this analysis, the sample consists of a smaller number of provinces because the Veneto region and the province of Rome did not belong the Kingdom of Italy.

we also include a binary treatment in columns (6)-(10), defining the treatment as equal to one when the value is above the sample mean. In all cases, the estimates are small and statistically insignificant.

In summary, we have demonstrated that there is no relationship between other aspects of the monastic dissolution reform and innovation. Specifically, the estimates suggest that our findings cannot be attributed to the usage of monasteries for public-utility purposes, land redistribution, or the number of monks and nuns resident in the province. Therefore, this analysis further supports our interpretation that the expansion of useful knowledge, through the enrichment of existing and general-purpose libraries, affected innovation.

7 Long-run effects

The main analysis, based on the period 1863-1883, indicates that the innovation advantage of municipalities treated with monastic books remained constant in the post-treatment period (Figure 7). It is reasonable to ask whether the innovation advantage persisted even over a longer period. On the one hand, the advantage might have vanished considering the relatively low technological content of the patents in the 1870s. Laggard municipalities could have thus closed the technological gap. On the other hand, the initial advantage could have laid the groundwork for more incremental innovation, thus allowing to mantain a persistent superiority in terms of innovation.

To investigate the existence of potential long-run effects, we examine patents granted in the period 1910-1912, approximately 45 years after the enactment of the law regulating the dissolution of monastic orders. Empirically, we estimate the following cross-sectional model:

$$\text{Patents}_{i,1910-12} = \alpha_i + \beta\ \text{Books}_{i,1893} + X_i'\gamma + \varepsilon_i \tag{2}$$

where $\text{Books}_{i,1893}$ is the number of books contained in public libraries across all Italian municipalities as reported in the 1893 survey. We instrument the number of books in public libraries in 1893 with the number of manuscripts received with the expropriation of monastic libraries in 1866. In this way we can isolate exogenous variation in the number of books in 1893 and, importantly, assess the long-run impact of the sudden availability of monastic books in 1886. In fact, identification is based on the assumption that the expropriation of monastic books in 1866 has an impact on innovation in 1910-12 only through the number of books in public libraries in 1893. To increase the credibility of our identification, we include as a control variable in X the stock of patents between 1863-1883.[35] Further

[35] We have also estimated the model including only the stock of patents of the pre-treatment period (1863-1866) and results are virtually the same (not shown).

controls included in X are standard geographic variables such as average precipitation, temperature, distance to rivers, and average altitude. We include also controls for major Roman roads and for whether the municipality was a large city (i.e. with more than 5,000 inhabitants) in 1300. Since innovation depends also on the production structure, we control for the occupational structure of the population at the district level, using data from the 1911 Population Census.[36] Finally, we include fixed effects for pre-unification states.[37]

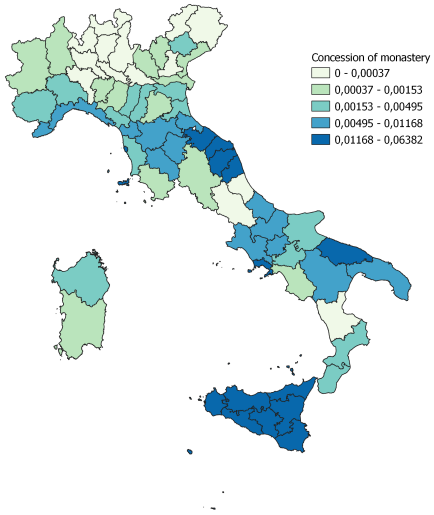
Patents, despite being commonly used as a proxy for innovation in historical context, can be problematic. Indeed, not all innovations were patented and, in some cases, secrecy was a viable alternative. World Exhibition data have been proposed as a valid alternative (Moser, 2012). As these fairs were used to present innovations to a large audience, the location of the exhibitors provides an alternative measure for local innovation intensity. In the analysis of long-term effects, we use also information on exhibitors at the 1911 World Fair in Turin.[38]

Two-stage least squares estimates of the long-term effect of monastic books are reported in Table 7.[39] The estimates in columns (1) and (2) show a positive and highly significant effect of books in 1893 on both innovation and exhibitors. The F-statistics of the first stage estimates, as reported at the bottom of the table, are very large, indicating a strong instrument. Thus, the estimates in columns (1) and (2) suggest that the reform in 1866, which increased the stock of books publicly available, had a long-lasting effect on innovation, although relatively small.

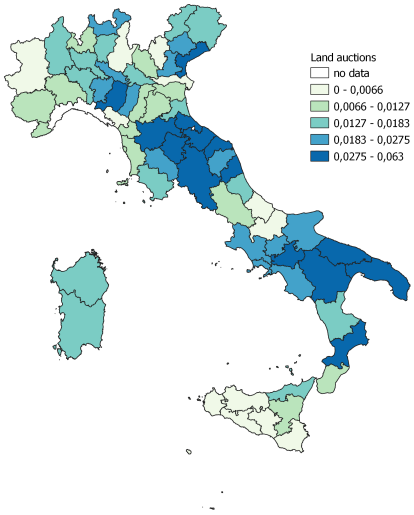
[36] In particular, we add a full set of controls for the shares of population employed in agriculture, extractive industries, industries related to agriculture, metalworking industries, minerals processing and construction, textile industries, chemical industries, public utilities and services, commerce, public and private administration, liberal professions.
[37] See Appendix C.4 for a detailed description of the variables and data sources.
[38] We are very grateful to Giacomo Domini for sharing his data on exhibitors at the Turin World Fair.
[39] Since both the dependent variables (patents or exhibitors) and the main variable of interest (the number of volumes in public libraries) have a skewed distribution and a large number of zeros, they are transformed using the inverse hyperbolic sine.

Figure 9: Geographical distribution of other policies implemented after the suppression of religious orders

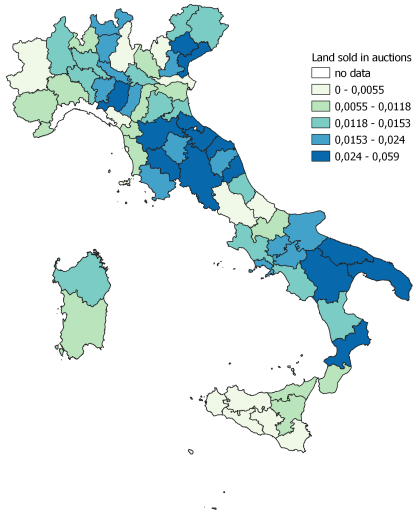
(a) Density of monastery concessions



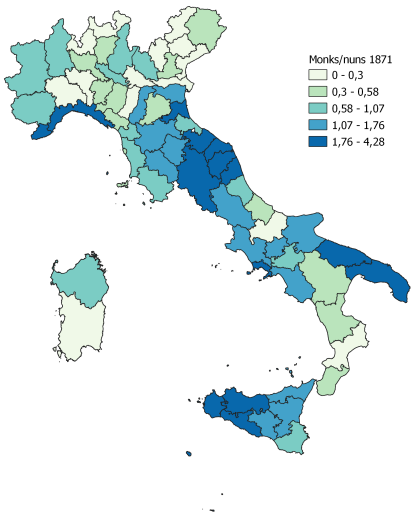
(b) Share of land offered at public auctions



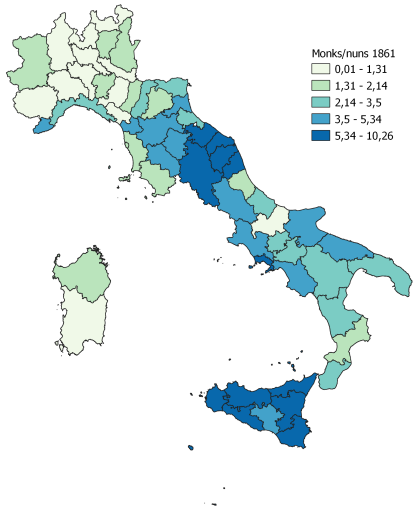
(c) Share of land sold at public auctions



(d) Monks and nuns per capita 1871



(e) Monks and nuns per capita 1861



Note: Geographic distribution at province level of possible confounding factors related to other provisions of the law. A detailed description of the variable definitions and their data sources is provided in the Online Appendix C.3.

Table 6: Assessing the impact of other policies implemented due to the suppression of religious orders

	Continuous Treatment					Binary Treatment				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Monastery concessions x post	0.209					-0.00844				
	(0.700)					(0.0118)				
Land auctions x post		-0.203					-0.00322			
		(0.324)					(0.0116)			
Land sold in auctions x post			-0.0499					-0.00349		
			(0.368)					(0.0117)		
Monks and nuns 1871 x post				-0.00464					-0.0148	
				(0.00617)					(0.0108)	
Monks and nuns 1861 x post					-0.00310					-0.0175
					(0.00279)					(0.0120)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1428	1407	1407	1428	1239	1428	1407	1407	1428	1239
Treated						21	26	26	26	25
Control						47	41	41	42	34
N° of clusters	68	67	67	68	59	68	67	67	68	59
Mean of outcome	0.0564	0.0531	0.0531	0.0564	0.0593	0.0564	0.0531	0.0531	0.0564	0.0593

Note: The dependent variable is the number of patents for 10,000 inhabitants. A detailed description of the variable definitions and their data sources is provided in the Online Appendix C.3. The unit of observation is province-year. All regressions include province and time-fixed effects. Standard errors shown in parenthesis are clustered at the province level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: IV estimates long term effects

	All municipalities			Municipalities with libraries		
	(1)	(2)	(3)	(4)	(5)	(6)
	Ihs n° patents	Ihs n° exhibitions	Literacy rate	Ihs n° patents	Ihs n° exhibitions	Literacy rate
Ihs n° of books	0.0451***	0.0414***	0.721***	0.167***	0.134***	0.0158
	(0.0107)	(0.0105)	(0.138)	(0.0500)	(0.0475)	(0.631)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Pre-unification states FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupational structure	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8322	8322	8317	423	423	423
Mean of outcome	0.112	0.0880	65.19	0.874	0.714	56.35
F-stat of excluded instrument	1900.9	1900.9	1901.0	57.25	57.25	57.25

Note: Controls include average precipitation, temperature, distance to rivers, average altitude, major roman roads, municipality was a large city in 1300, patenting per 10,000 inhabitants in 1863-1883. Occupational structure includes the shares of population employed in agriculture, extractive industries, industries related to agriculture, metalworking industries, minerals processing and construction, textile industries, chemical industries, public utilities and services, commerce, public and private administration, liberal professions. See Appendix C.4 for a detailed description of the variables and data sources. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We have argued that the initial innovation advantage caused by the increase in useful knowledge might have laid the groundwork for incremental innovation, thus explaining the persistent advantage. Yet, a possible alternative mechanism is the accumulation of human capital. It could be argued that enriching existing libraries might have led to an increase in human capital, which in turn could have spurred more innovation. In fact, we can test this mechanism using literacy data from 1911, the first year for which such data is available at the municipality level. In column (3) of Table 7, we estimate the model with literacy rate as the dependent variable. Indeed, there appears to be a positive impact of the number of books on literacy, though the effect is very small.

In fact, we argue that, since we focus on the number of books in public libraries, one should examine the effect at the intensive margin, i.e., conditional on the existence of a public library. In columns (4)-(6), we constrain our sample to the 423 municipalities with large public libraries. The estimates confirm the finding of a long-term effect of monastic books on innovation also along this margin. Taken at face value, a 10 percent increase in the number of books in public libraries in 1893 increases patents per capita in 1910-12 by about 1.7 percent, and exhibitors at the Turin World's Fair by about 1.3 percent. Interestingly, when focusing only on municipalities with libraries, there is no significant effect of monastic books on the literacy rate, as shown in column (6).

In sum, the long-term analysis strongly suggests that the increase in publicly available knowledge had a persistent effect on innovation but without affecting the population literacy level.

8 Conclusions

Access to useful knowledge in the eighteenth and nineteenth century was crucial for economic growth. Economic societies and research universities have been proposed as crucial institutions for the diffusion of useful knowledge, especially in the German context. We show that useful knowledge could originate also from monasteries.

In this paper, we exploit the expropriation of monastic libraries that occurred in nineteenth-century Italy to examine whether and to what extent knowledge previously stored in century-old monasteries affected innovation. Relying on unique, detailed administrative data on public libraries, we create a novel dataset of municipalities which received manuscripts from monastic libraries and combine this information with yearly patent data.

Estimating a difference-in-differences model, we find that innovation increased significantly in municipalities that were granted books from the suppressed religious orders. In particular, we document that innovation increased in municipalities that expanded *existing* public libraries, while

we do not find any effect in municipalities establishing *new* libraries. Furthermore, consistent with the interpretation that knowledge embedded in the monastic books was relevant, we show that the acquisition of general-purpose books had a significant effect on innovation, as opposed to the acquisition of religious books.

Results from falsification tests, matching on pre-treatment characteristics, and analysis at the provincial level, strongly indicate that selection into treatment is not an issue. Furthermore, the analysis at the provincial level allows us to tackle directly other possible confounding effects due to other aspects of the reform. In particular, we show that the redistribution of land previously owned by monasteries and the reallocation of monks and nuns has no bearing on our results.

The contribution of our analysis is twofold: first, we show that the knowledge accumulated over centuries in monasteries was valuable and useful. In the short-run, the knowledge embedded in monastic books was likely used for basic innovation, thus providing an initial advantage. Second, we show that this initial advantage persisted also in the long-run but without affecting the level of human capital of the population. From a policy perspective, we demonstrate that public access to knowledge is crucial for innovation and that even a modest technological advantage could translate into a long-term technological advantage.

References

Andersen, T. B., Bentzen, J., Dalgaard, C., and Sharp, P. (2017). Pre-Reformation Roots of the Protestant Ethic. *The Economic Journal*, 127(604):1756–1793.

Bellemare, M. F. and Wichman, C. J. (2020). Elasticities and the Inverse Hyperbolic Sine Transformation. *Oxford Bulletin of Economics and Statistics*, 82(1):50–61.

Berkes, E. and Nencka, P. (2021). Knowledge Access: The Effects of Carnegie Libraries on Innovation. *Available at SSRN: https://ssrn.com/abstract=3629299*.

Bertozzi, G. C. (1879). *Annali di Statistica, 1879, Vol. 4: Serie 2; Notizie Storiche e Statistiche sul Riordinamento dell'Asse Ecclesiastico nel Regno d'Italia*. Tipografia Eredi Botta.

Boberg-Fazlic, N. and Sharp, P. (2024). Immigrant Communities and Knowledge Spillovers: Danish Americans and the Development of the Dairy Industry in the United States. *American Economic Journal: Macroeconomics*.

Bosker, M., Buringh, E., and van Zanden, J. L. (2013). From Baghdad to London: Unraveling Urban Development in Europe, the Middle East, and North Africa, 800–1800. *The Review of Economics and Statistics*, 95(4):1418–1437.

Cantoni, D., Dittmar, J., and Yuchtman, N. (2018). Religious Competition and Reallocation: The Political Economy of Secularization in the Protestant Reformation. *The Quarterly Journal of Economics*, 133(4):2037–2096.

Chapron, E. (2009). Il Patrimonio Ricomposto. Biblioteche e Soppressioni Ecclesiastiche in Toscana da Pietro Leopoldo a Napoleone. *Archivio Storico Italiano*, 167(2 (620)):299–346.

Chen, J. and Roth, J. (2023). Logs with Zeros? Some Problems and Solutions. *The Quarterly Journal of Economics*, page qjad054.

Ciccarello, D. (2013). Ex Pluribus Unum, Ex Uno Plura. Aggregazioni e Dispersioni del Patrimonio Librario-Archivistico nelle Città Italiane con la Soppressione degli Ordini Religiosi dopo l'Unità. In *S. Adorno, G. Cristina, A. Rotondo (a cura di), VisibileInvisibile. Percepire la città tra descrizioni ed omissioni. II. Visibilità dell'antico: patrimonio e istituzioni culturali (pp. 587-596). Catania : Scrimm.*

Cinnirella, F., Hornung, E., and Koschnick, J. (2023). Flow of Ideas: Economic Societies and the Rise of Useful Knowledge. *CEPR Discussion Paper No. 17422*.

Cinnirella, F. and Streb, J. (2017). The Role of Human Capital and Innovation in Economic Development: Evidence from Post-malthusian Prussia. *Journal of Economic Growth*, 22(2):193–227.

Colella, F., Lalive, R., Sakalli, S., and Thoenig, M. (2020). ACREG: Stata Module to Perform Arbitrary Correlation Regression.

Conley, T. G. (1999). GMM Estimation with Cross Sectional Dependence. *Journal of Econometrics*, 92(1):1–45.

Danna, R., Iori, M., and Mina, A. (2022). A Numerical Revolution: The Diffusion of Practical Mathematics and the Growth of Pre-Modern European Economies. *Available at SSRN: https://ssrn.com/abstract=4143442*.

Dittmar, J. E. and Meisenzahl, R. R. (2022). The Research University, Invention, and Industry: Evidence from German History. Cepr discussion paper no. 17383.

Domini, G. (2020). Exhibitions, Patents, and Innovation in the Early Twentieth Century: Evidence from the Turin 1911 International Exhibition. *European Review of Economic History*, 24(3):578–600.

Doucette, J. S. and Møller, J. (2021). The Collapse of State Power, the Cluniac Reform Movement, and the Origins of Urban Self-Government in Medieval Europe. *International Organization*, 75(1):204–223.

Duggan, C. (2008). *The Force of Destiny: A History of Italy Since 1796*. Houghton Mifflin.

Fick, S. E. and Hijmans, R. J. (2017). WorldClim 2: New 1-km Spatial Resolution Climate Surfaces for Global Land Areas. *International Journal of Climatology*, 37(12):4302–4315.

Giannetti, R. (1998). *Tecnologia e Sviluppo Economico Italiano: 1870-1990*. Il Mulino.

Goodman-Bacon, A. (2021). Difference-in-Differences with Variation in Treatment Timing. *Journal of Econometrics*, 225(2):254–277. Themed Issue: Treatment Effect 1.

Granata, G. (2020). Patrimonio Librario Antico e Biblioteche Religiose. Il Caso della Sardegna. *Bibliothecae. it*, 9(2):167–202.

Harka, E., Nunziata, L., and Rocco, L. (2023). The Alabaster Ceiling: The Gender Legacy of the Papal States. GLO Discussion Paper 1315, Global Labor Organization (GLO), Essen.

Harris, M. (1999). *History of Libraries of the Western World*. Scarecrow Press.

Heldring, L., Robinson, J. A., and Vollmer, S. (2021). The Long-Run Impact of the Dissolution of the English Monasteries. *The Quarterly Journal of Economics*, 136(4):2093–2145.

Hornung, E. (2014). Immigration and the Diffusion of Technology: The Huguenot Diaspora in Prussia. *American Economic Review*, 104(1):84–122.

Iaria, A., Schwarz, C., and Waldinger, F. (2018). Frontier Knowledge and Scientific Production: Evidence from the Collapse of International Science. *Quarterly Journal of Economics*, 133(2):927–991.

Karger, E. (2021). The Long-Run Effect of Public Libraries on Children: Evidence from the Early 1900s.

McCormick, M., Huang, G., Zambotti, G., and Lavash, J. (2013). *Roman Road Network (version 2008)*. DARMC Scholarly Data Series, Data Contribution Series #2013-5. DARMC, Center for Geographic Analysis, Harvard University, Cambridge MA 02138.

Ministero di Agricoltura, Industria e Commercio [MAIC]. Direzione generale della statistica (1893). *Statistica delle Biblioteche, Parte 1, Biblioteche dello Stato, delle Provincie, dei Comuni ed altri Enti Morali*. Tipografia nazionale, G. Bertero.

Mokyr, Joel (2005). The Intellectual Origins of Modern Economic Growth. *Journal of Economic History*, 65(2):285–351.

Moser, P. (2005). How Do Patent Laws Influence Innovation? Evidence from Nineteenth-century World's Fairs. *American Economic Review*, 95(4):1214–1236.

Moser, P. (2012). Innovation without Patents: Evidence from World's Fairs. *The Journal of Law and Economics*, 55(1):43–74.

Moser, P., Voena, A., and Waldinger, F. (2014). German Jewish émigrés and US invention. *American Economic Review*, 104(10):3222–3255.

Nuvolari, A. and Vasta, M. (2014). Independent Invention in Italy during the Liberal Age, 1861–1913. *The Economic History Review*, 68(3):858–886.

Nuvolari, A. and Vasta, M. (2017). The Geography of Innovation in Italy, 1861–1913: Evidence from Patent Data. *European Review of Economic History*, 21(3):326–356.

Nuvolari, A. and Vasta, M. (2019). Patenting the Risorgimento: Economic Integration and the Formation of the Italian Patent System (1855–1872). *Jahrbuch für Wirtschaftsgeschichte / Economic History Yearbook*, 60(1):93–122.

Rossignoli, D. and Trombetta, F. (2019). Ora et Guberna. The Economic Impact the Rule of St Benedict in Medieval England. *Available at SSRN: https://ssrn.com/abstract=3457764*.

Squicciarini, M. P. and Voigtländer, N. (2015). Human Capital and Industrialization: Evidence from the Age of Enlightenment. *Quarterly Journal of Economics*, 130(4):1825–1883.

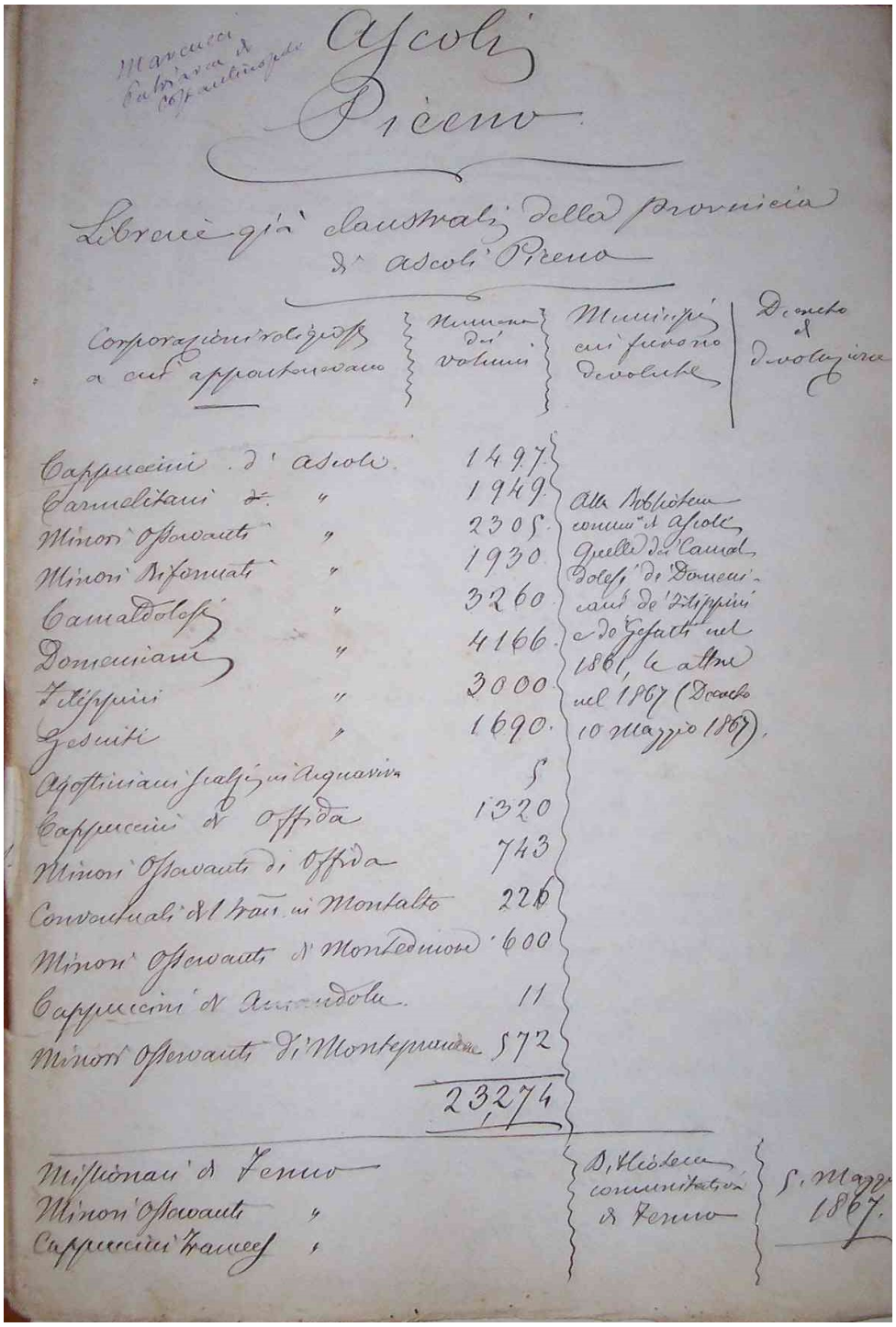
Traniello, P. (1997). *La Biblioteca Pubblica: Storia di un Istituto nell'Europa Contemporanea*. Il Mulino.

Zangheri, R. (1979). Gli Anni Francesi in Italia: Le Nuove Condizioni della Proprietà. *Studi Storici*, 20(1):5–26.

Online Appendix

A Historical Background

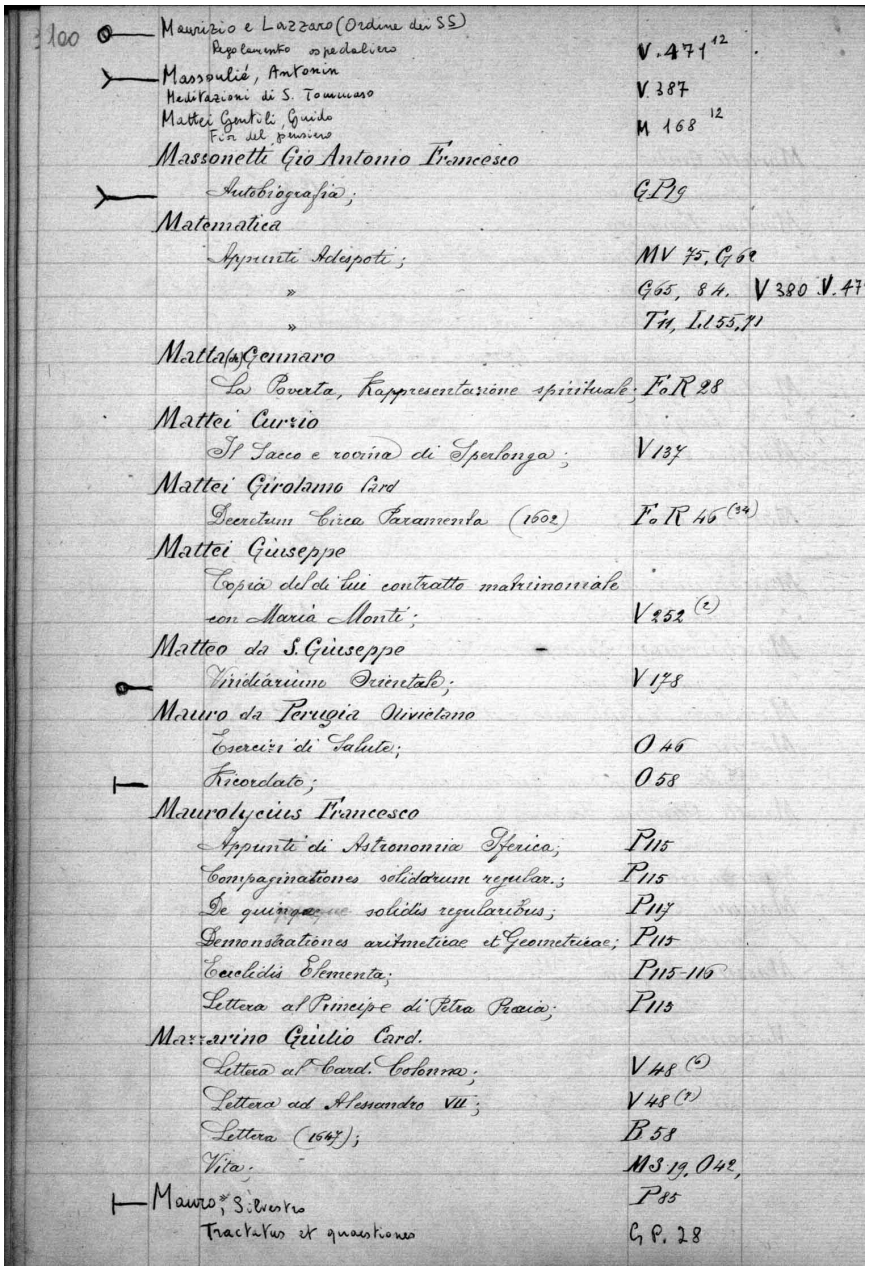
Figure A.1: Example



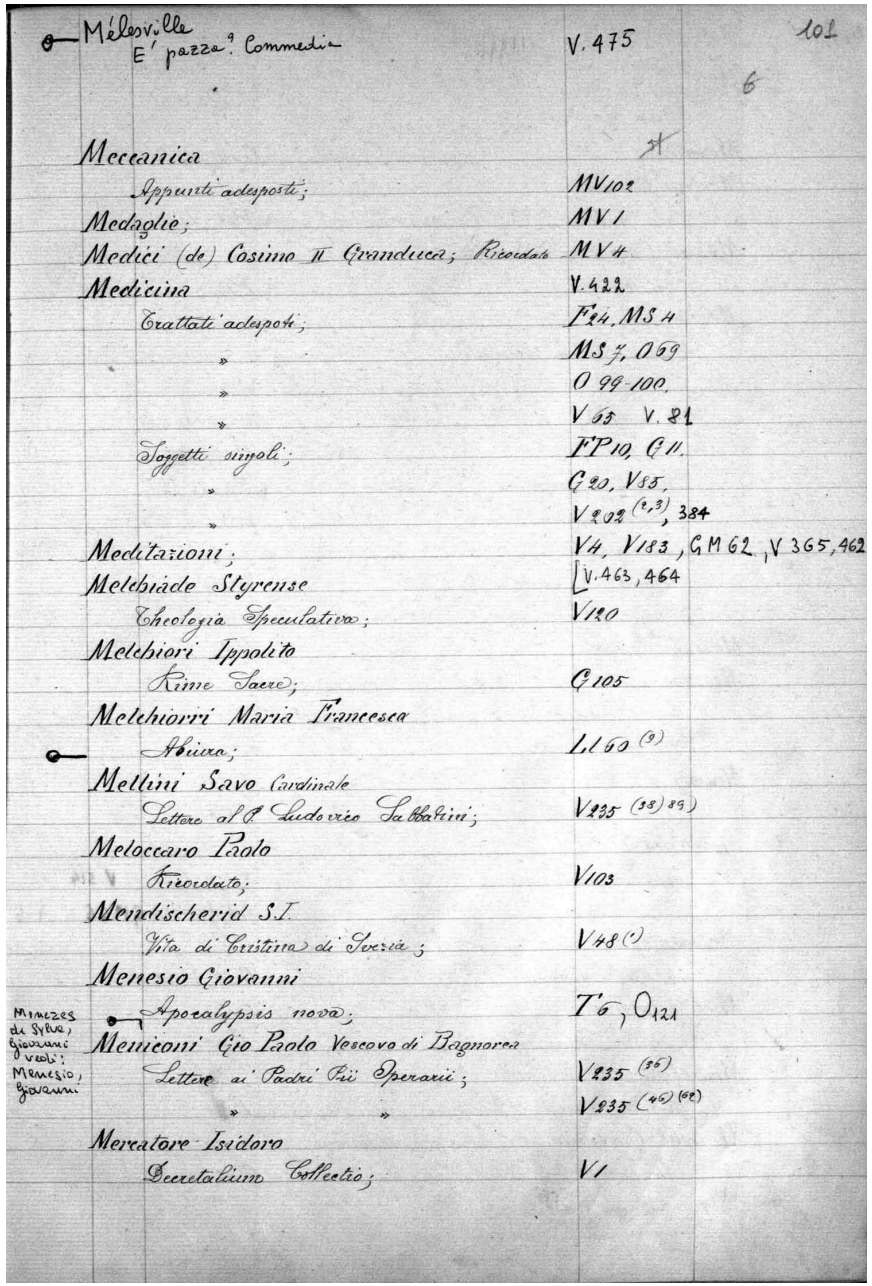
Note: The figure shows the monastic libraries devolved to the municipal library of Ascoli Piceno. Source: Le Carte dela Storia. Le biblioteche claustrali delle Marche di fronte all'Unità d'Italia.

Figure A.2: Examples of the index of manuscripts of the Jesuit library

(a)



(b)



Note: Source: Istituto Centrale per il Catalogo Unico (ICCU) delle Biblioteche Italiane e per le informazioni bibliografiche.

Figure A.3: Nouns in the titles of Italian patents

Note: The figure shows the nouns in the titles of domestic patents i.e., those granted to Italian resident inventors. Data source: "Bollettino delle privative industriali del Regno d'Italia, 1871".

B Robustness checks

Table B1: Transformations of the dependent variable

	Log (1+ n° patents)			Ihs n° patents		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Library x post	0.0793***			0.101***		
	(0.0141)			(0.0180)		
Volumes x post		0.149***			0.190***	
		(0.0247)			(0.0315)	
New library x post		0.00303			0.00378	
		(0.00290)			(0.00368)	
General library x post			0.0931***			0.118***
			(0.0157)			(0.0200)
Religious library x post			0.00373			0.00484
			(0.00853)			(0.0109)
Observations	170856	170793	170415	170856	170793	170415
Treated	232	229	211	232	229	211
Control	7904	7904	7904	7904	7904	7904
N° of clusters	8136	8133	8115	8136	8133	8115
Panel B						
Library x post	0.0658***			0.0859***		
	(0.0132)			(0.0169)		
Volumes x post		0.129***			0.169***	
		(0.0230)			(0.0295)	
New library x post		-0.00351			-0.00356	
		(0.00335)			(0.00420)	
General library x post			0.0768***			0.100***
			(0.0144)			(0.0184)
Religious library x post			0.00212			0.00302
			(0.00866)			(0.0110)
Population	Yes	Yes	Yes	Yes	Yes	Yes
Observations	170816	170753	170375	170816	170753	170375
Treated	232	229	211	232	229	211
Control	7904	7904	7904	7904	7904	7904
N° of clusters	8136	8133	8115	8136	8133	8115

Note: The dependent variable is the number of patents for 10,000 inhabitants. A detailed description of the treatments – *Library*, *Volumes*, *New library*, *General library*, and *Religious library* – is provided in the Online Appendix C.1. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B2: The effect of monastic libraries expropriation on patenting – including Rome and treatment intensity

	All libraries		Large libraries		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Including Rome						
Library x post	0.0327***	0.0379***	0.0323***	0.0376***	0.0398***	0.0431***
	(0.00829)	(0.00830)	(0.00867)	(0.00870)	(0.0149)	(0.0136)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro-area by time FE	No	Yes	No	Yes	No	Yes
Observations	175623	175623	175623	175623	7602	7602
Treated	265	265	249	249	139	139
Control	8098	8098	8114	8114	223	223
N° of clusters	8363	8363	8363	8363	362	362
Mean of outcome	0.0169	0.0169	0.0169	0.0169	0.0742	0.0742
Panel B: Treatment Intensity						
Intensity x post	0.0802***	0.0837***	0.0907***	0.0915***	0.103***	0.0986***
	(0.0283)	(0.0257)	(0.0299)	(0.0271)	(0.0324)	(0.0295)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro-area by time FE	No	Yes	No	Yes	No	Yes
Observations	2604	2604	2457	2457	1932	1932
Treated	38	38	35	35	32	32
Control	86	86	82	82	60	60
N° of clusters	124	124	117	117	92	92
Mean of outcome	0.0979	0.0979	0.0998	0.0998	0.116	0.116

Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. *Intensity* indicates municipalities in which the number of books received from monastic libraries exceeds the sample mean. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B3: Robustness checks: Alternative specifications and samples

	Previous Laws			Veneto excluded		
	(1)	(2)	(3)	(4)	(5)	(6)
Library x post	0.0326***			0.0262***		
	(0.00892)			(0.00899)		
Volumes x post		0.0659***			0.0600***	
		(0.0154)			(0.0160)	
New library x post		0.000323			-0.00258	
		(0.00892)			(0.00900)	
General library x post			0.0416***			0.0365***
			(0.0103)			(0.0105)
Religious library x post			-0.00252			-0.00624
			(0.0240)			(0.0238)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	170856	170793	170415	154203	154161	153804
Treated	232	229	211	222	220	203
Control	7904	7904	7904	7121	7121	7121
N° of clusters	8136	8133	8115	7343	7341	7324
Mean of outcome	0.0170	0.0169	0.0170	0.0176	0.0176	0.0177

Note: The dependent variable is the number of patents for 10,000 inhabitants. A detailed description of the treatments – *Library*, *Volumes*, *New library*, *General library*, and *Religious library* – is provided in the Online Appendix C.1. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B4: Accounting for spatial correlation

	Coefficient	Cluster	25km	50km	100km	200km
	(1)	(2)	(3)	(4)	(5)	(6)
Library x post	0.0303	(0.00886)***	(0.00701)***	(0.00747)***	(0.00795)***	(0.00880)***
Volumes x post	0.0644	(0.0153)***	(0.0121)***	(0.0125)***	(0.0131)***	(0.0151)***
New library x post	-0.00257	(0.00884)	(0.00790)	(0.00785)	(0.00797)	(0.00752)
General library x post	0.0398	(0.0103)***	(0.00825)***	(0.00882)***	(0.00907)***	(0.00978)***
Religious library x post	-0.00605	(0.0238)	(0.0213)	(0.0212)	(0.0197)	(0.0189)

Note: The dependent variable is the number of patents for 10,000 inhabitants. A detailed description of the treatments – *Library*, *Volumes*, *New library*, *General library*, and *Religious library* – is provided in the Online Appendix C.1. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Each row reports standard errors accounting for spatial correlation and are computed using Stata module by Colella et al. (2020). In brackets is shown the distance at which spatial correlation is assumed to fade away. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B5: Spillover effects

	Distance to treated municipalities is:			
	(1) ≤5km	(2) ≤10km	(3) ≤15km	(4) ≤20km
Panel A				
Library x post	-0.00181	-0.000225	0.000382	0.00257
	(0.00690)	(0.00399)	(0.00337)	(0.00296)
Observations	162918	162918	162918	162918
Treated	257	1201	2300	3334
Control	7501	6557	5458	4424
N° of clusters	7758	7758	7758	7758
Mean of outcome	0.0148	0.0148	0.0148	0.0148
Panel B				
Volumes x post	0.0111	-0.000572	-0.00152	0.00125
	(0.0112)	(0.00373)	(0.00321)	(0.00298)
New library x post	-0.00956	-0.00000548	0.00269	0.00416
	(0.00856)	(0.00686)	(0.00574)	(0.00459)
Observations	163254	163254	163254	163254
Treated	257	1197	2307	3340
Control	7517	6577	5467	4434
N° of clusters	7774	7774	7774	7774
Mean of outcome	0.0148	0.0148	0.0148	0.0148
Panel C				
General library x post	-0.00144	0.000118	0.00150	0.00405
	(0.00900)	(0.00366)	(0.00361)	(0.00308)
Religious library x post	-0.00163	0.00155	-0.00223	0.000422
	(0.0130)	(0.0175)	(0.0104)	(0.00783)
Observations	163191	163191	163191	163191
Treated	228	1095	2133	3141
Control	7543	6676	5638	4630
N° of clusters	7771	7771	7771	7771
Mean of outcome	0.0148	0.0148	0.0148	0.0148

Note: The dependent variable is the number of patents for 10,000 inhabitants. Municipalities located within 5, 10, 15, and 20 km from the originally treated municipalities are classified as treated, while the originally treated municipalities are excluded from the analysis. A detailed description of the treatments – *Library*, *Volumes*, *New library*, *General library*, and *Religious library* – is provided in the Online Appendix C.1. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B6: Baseline estimates excluding municipalities with universities

	(1)	(2)	(3)
Library x post	0.0242***		
	(0.00911)		
Volumes x post		0.0572***	
		(0.0168)	
New library x post		-0.00329	
		(0.00888)	
General library x post			0.0327***
			(0.0108)
Religious library x post			-0.00602
			(0.0238)
Time FE	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes
Observations	170436	170394	169995
Treated	217	215	196
Control	7899	7899	7899
N° of clusters	8116	8114	8095
Mean of outcome	0.0164	0.0163	0.0164

Note: The dependent variable is the number of patents for 10,000 inhabitants. A detailed description of the treatments – *Library*, *Volumes*, *New library*, *General library*, and *Religious library* – is provided in the Online Appendix C.1. The unit of observation is municipality-year. All regressions include municipality and time fixed effects. Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

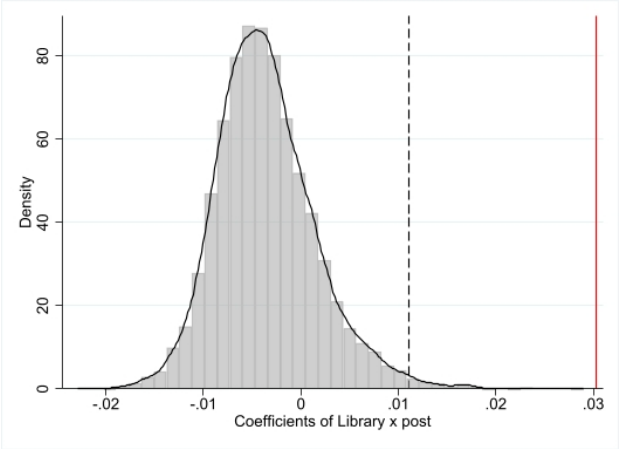
Table B7: Estimation by macro-area and pre-unification State

	(1) North	(2) Center	(3) South	(4) King. Sardinia	(5) Lombardy Venetia	(6) Tusc Mod and Parma	(7) Papal States	(8) King. Two Sicilies
Library x post	0.0918*	0.0331***	0.0212***	0.0188	0.177***	0.0662**	0.0114	0.0206***
	(0.0480)	(0.0124)	(0.00496)	(0.0598)	(0.0453)	(0.0261)	(0.0100)	(0.00507)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95613	21357	53886	49203	54243	9471	11928	46011
Treated	33	85	114	23	15	34	51	109
Control	4520	932	2452	2320	2568	417	517	2082
N° of clusters	4553	1017	2566	2343	2583	451	568	2191
Mean of outcome	0.0244	0.0152	0.00471	0.0291	0.0167	0.0212	0.0104	0.00534

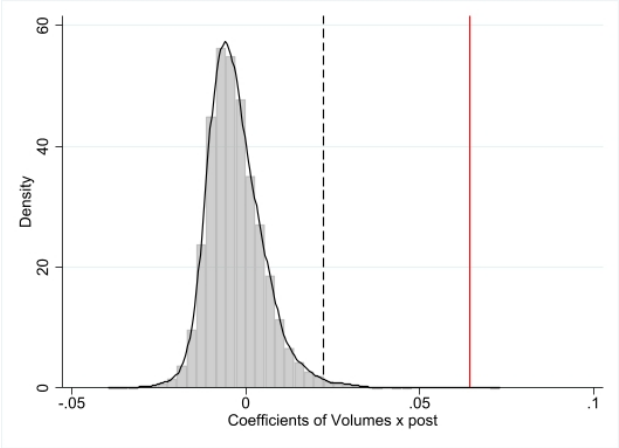
Note: The dependent variable is the number of patents for 10,000 inhabitants. *Library* indicates municipalities that received monastic volumes in an existing library or constructed a new library with monastic volumes. The unit of observation is municipality-year. All regressions include municipality and time fixed effects Standard errors shown in parenthesis are clustered at the municipality level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure B1: Distributions of the difference-in-differences estimates with randomly assigned treatments

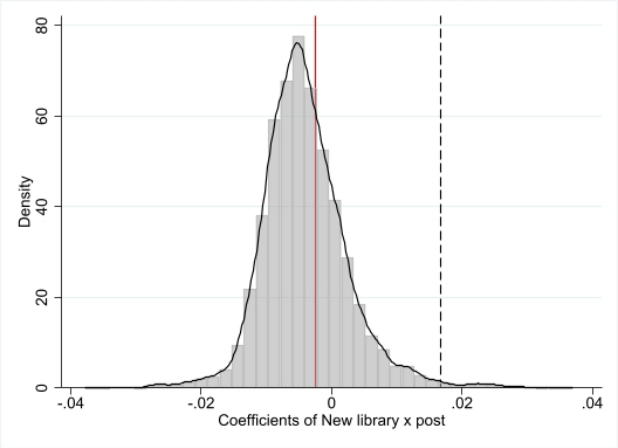
(a) Library × post



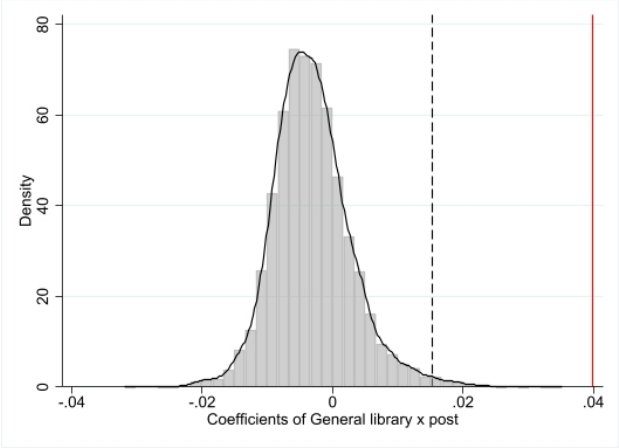
(b) Volumes × post



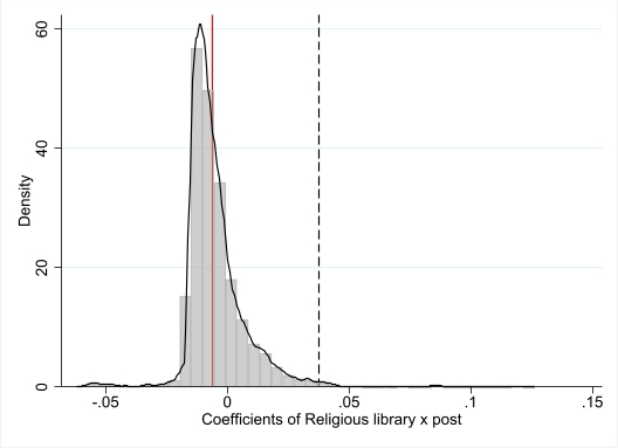
(c) New library × post



(d) General library × post



(e) Religious library × post



Note: Panel (a) shows the distribution of the coefficients randomly assigning the treatment "Library". The red line depicts the difference-in-differences coefficient from estimating Equation 1 for the sample of large libraries (column 3 of Table 1). Panels (b) and (c) show the distribution of the coefficients randomly assigning the treatments "Volumes" and "New library", respectively. The red lines show the difference-in-differences coefficients from the "horse race" models (column 1 of Table 3). Panels (d) and (e) display the distribution of the coefficients randomly assigning the treatments "General library" and "Religious library", respectively. The red lines show the difference-in-differences coefficients from the "horse race" models (column 2 of Table 3). In all panels the dashed black lines show the 99th percentile of the distribution.

Table B8: Descriptive statistics for the long-run effects analysis

	All municipalities		Municipalities w/ libraries	
	Mean	sd	Mean	sd
Ihs n° patents	0.112	0.474	0.874	1.377
Ihs n° exhibitions	0.088	0.395	0.714	1.216
Literacy rate	65.188	24.537	56.349	20.159
Ihs n° of books	0.444	2.006	8.730	2.615
Ihs n° of volumes received	0.137	1.105	2.700	4.140
Annual precipitation	862.409	246.787	731.695	220.096
Annual temperature	12.291	2.863	13.933	2.024
Distance to rivers (km)	7.126	9.079	7.471	9.726
Altitude	444.103	424.829	315.028	271.349
Presence of major road in the municipality	0.221	0.415	0.513	0.500
Urbanization (1300s)	0.007	0.082	0.123	0.329
Population (1911)	4306.495	15078.802	26475.073	61065.543
Patents for 10,000 inhabitants (1863-1883)	0.350	2.130	1.321	3.373
Employment in agriculture	0.386	0.117	0.375	0.108
Employment in extractive industries	0.004	0.012	0.006	0.015
Employment in agriculture-related industries	0.044	0.018	0.041	0.018
Employment in metalworking industries	0.017	0.014	0.014	0.013
Employment in construction and minerals	0.035	0.019	0.031	0.014
Employment in textile industries	0.060	0.049	0.038	0.027
Employment in chemical industries	0.003	0.003	0.003	0.003
Employment in utilities and services	0.020	0.010	0.022	0.012
Employment in commerce	0.031	0.012	0.029	0.012
Employment in public administration	0.048	0.020	0.046	0.021

Note: The table shows the summary statistics of the variables used in the IV approach in Section 7. Variable definitions and data sources are described in Appendix C.4.

C Variable description and data sources

C.1 Variable definitions and data sources for the difference-in-differences analysis

Library. An indicator equal to one for municipalities that opened a new library or, in cases where a library already existed, received volumes from monastic libraries. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica. Biblioteche appartenenti ad accademie, scuole secondarie, seminari, biblioteche militari, gabinetti di lettura e biblioteche private facilmente accessibili agli studiosi, non comprese nella prima parte della statistica delle Biblioteche, 1896. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Intensity. An indicator equal to one when the number of books received from monastic libraries exceeds the sample mean. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica. Biblioteche appartenenti ad accademie, scuole secondarie, seminari, biblioteche militari, gabinetti di lettura e biblioteche private facilmente accessibili agli studiosi, non comprese nella prima parte della statistica delle Biblioteche, 1896. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Volumes. An indicator equal to one for municipalities that augmented existing libraries. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

New Library. An indicator equal to one for municipalities opening a new public library with monastic books. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

General Library. An indicator equal to one for municipalities opening a new general library or augmenting an existing general library. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Religious Library. An indicator equal to one for municipalities opening a new religious library or augmenting an existing religious library. *Source: Statistica delle biblioteche, Parte I: Biblioteche*

dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.

Patents. Yearly number of patents per 10,000 inhabitants in the Italian municipalities from 1863 to 1883. We use population data from the 1871 census for normalization. Each patent is attributed to the municipality corresponding to the inventor's residence (domicile). In a few cases involving multiple inventors, the patent is assigned based on the residence of the first inventor listed. The primary sources for innovation are the Official Gazette and "Bollettino delle privative industriali del Regno d'Italia" published from the Ministry of Agriculture, Industry and Trade. The Table C1 lists the source for each year.

Table C1: Patents data sources by year

Year	Source
1863	Official Gazette – Supplement of No. 144 (1863), Supplement of No. 226 (1863), Supplement of No. 276 (1863), Supplement of No. 74 (1864).
1864	Bolletino Industriale del Regno d'Italia Volume I.
1865	Bolletino Industriale del Regno d'Italia Volume II.
1866	Bolletino Industriale del Regno d'Italia Volume III.
1867	Bolletino Industriale del Regno d'Italia Volume IV.
1868	Bolletino Industriale del Regno d'Italia Volume V.
1869	Official Gazette – No. 122 (1869), Supplement of No. 193 (1869), No. 299 (1869), No. 41 (1870).
1870	Official Gazette – No. 123 (1870), No. 214 (1870), No. 293 (1870), No. 36 (1871).
1871	Bolletino Industriale del Regno d'Italia, 2^a Serie – Volume 2°
1872	Official Gazette – No. 126 (1872), No. 127 (1872), No. 216 (1872), No. 217 (1872), No. 301 (1872), No. 302 (1872), 38 (1872), No. 39 (1872).
1873	Official Gazette – No. 123 (1873), No. 124 (1873), No. 228 (1873), No. 229 (1873), No. 300 (1873), No. 301 (1873), Supplement of No. 48 (1874).
1874	Official Gazette – Supplement of No. 111 (1874), No. 201 (1874), No. 202 (1874), Supplement of No. 269 (1874), No. 43 (1875), No. 44 (1875).
1875	Bolletino Industriale del Regno d'Italia, 2^a Serie – Volume 6°
1876	Official Gazette – Supplement of No. 106 (1876), No. 192 (1876), No. 259 (1876), No. 260 (1876), No. 56 (1877), No. 57 (1877).
1877	Official Gazette – Supplement of No. 116 (1877), No. 184 (1877), No. 185 (1877), No. 268 (1877), No. 269 (1877), Supplement of No. 49 (1878)
1878	Official Gazette – No. 98 (1878), No. 99 (1878), No. 189 (1878), No. 192 (1878), No. 253 (1878), No. 254 (1878), No. 36 (1879); No. 38 (1879).
1879	Official Gazette – No. 111 (1879), No. 112 (1879), Supplement of No. 197 (1879), No. 263 (1879), No. 264 (1879), No. 265 (1879), Supplement of No. 49 (1880).
1880	Official Gazette – Supplement of No. 116 (1880), Supplement of No. 194 (1880), No. 262 (1880), No. 263 (1880), Supplement of No. 48 (1881).
1881	Official Gazette – Supplement of No. 132 (1881), Supplement of No. 194 (1881), Supplement of No. 269 (1881), Supplement of No. 52 (1882).
1882	Official Gazette – Supplement of No. 135 (1882), Supplement of No. 211 (1882), Supplement of No. 282 (1882), Supplement of No. 80 (1883).
1883	Official Gazette – Supplement of No. 100 (1883), Supplement of No. 181 (1883), Supplement of No. 263 (1883), Supplement of No. 41 (1884).

Note: The table shows the sources of patent data for each respective year. Where the source is the Official Gazette the table further details the number of the Gazette along with the year of publication within brackets.

C.2 Variable definitions and data sources for the difference-in-difference with matching analysis

Monasteries. The number of monasteries at the province level. The calculation includes monasteries transferred to the State ("Demanio") following the 1866 religious orders' suppression and monastic buildings allocated to local governments, including those suppressed by earlier laws. *Source: Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze (DEPRETIS) nella tornata dell'8 giugno 1876*

Municipal expenditures. The total municipal expenditures for primary schooling in the school year 1862-1863. *Source: Statistica del Regno d'Italia, Istruzione Primaria, Istruzione elementare pubblica per comuni, anno scolastico 1862-1863.*

Population. The total population at the municipality level in 1861. *Source: National Census of 1861.*

Pre-existing libraries. Indicator that equals one if a municipality had a library before the dissolution of religious orders in 1866, and zero otherwise. For libraries founded in 1866, the indicator equals one provided they were not established with volumes from monastic orders. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Schools per capita. Number of primary schools in the school year 1862-1863 divided by the municipal population. *Source: Statistica del Regno d'Italia, Istruzione Primaria, Istruzione elementare pubblica per comuni, anno scolastico 1862-1863.*

Teacher-student ratio. Number of teachers divided by the number of students in the school year 1862-1863. *Source: Statistica del Regno d'Italia, Istruzione Primaria, Istruzione elementare pubblica per comuni, anno scolastico 1862-1863.*

C.3 Variable definitions and data sources for the analysis at the province level

Monastery concessions. The density of monastic establishments granted for public utility purposes. The computation is based on the total number of monastic concessions divided by the province area (in square kilometers) as per the 1871 census data. *Source: Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze (DEPRETIS) nella tornata dell'8 giugno 1876.*

Land auctions. Share of immovable property area offered at public auctions and private negotiations relative to the province's total area. *Source: Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze (DEPRETIS) nella tornata dell'8 giugno 1876.*

Land sold in auctions. Share of immovable property area effectively sold through public auctions and private negotiations relative to the province's total area (in square kilometers). *Source: Relazione della Commissione Centrale di Sindacato sull'Amministrazione dell'Asse Ecclesiastico per l'anno 1875 presentata dal presidente del Consiglio, ministro delle finanze (DEPRETIS) nella tornata dell'8 giugno 1876.*

Monks and nuns 1871. The number of monks and nuns per 1,000 inhabitants in 1871.*Source: National Census 1871.*

Monks and nuns 1861. The number of monks and nuns per 1,000 inhabitants in 1861.*Source: National Census 1861.*

C.4 Variable definitions and data sources for long-run effects analysis

Ihs Number of Patents. Inverse hyperbolic sine transformation of the number of patents in Italian municipalities during the period 1910-1912. *Source: "Bollettino Della Proprietà Intellettuale", 1910, 1911, 1912, Ministry of Agriculture, Industry and Trade.*

Ihs Number of Exhibitions. Inverse hyperbolic sine transformation of the number of exhibitions across Italian municipalities exposed at Turin World Fair 1911. *Source: Domini (2020).*

Literacy Rate. The number of literate people above the age of 6 divided by the population of the same age group who answered the education question. *Source: National Census of 1911.*

Ihs number of books. Inverse hyperbolic sine transformation of the total number of printed volumes contained in public libraries across Italian municipalities as reported in the 1893 survey. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Ihs number of volumes received. Inverse hyperbolic sine transformation of the total number of volumes and manuscripts received from the monastic libraries. *Source: Statistica delle biblioteche, Parte I: Biblioteche dello stato, delle province, dei comuni ed altri enti morali. Vol. 1, 1893; Vol. 2, 1894. Ministero di Agricoltura, Industria e Commercio (MAIC), Direzione generale della statistica.*

Annual Precipitation. The average annual precipitation at the municipal level is computed using the BIO12 bioclimatic variable (total annual precipitation), with data averaged over the period 1970-

2000 from WorldClim version 2. We construct the variable using data with a spatial resolution of 30 seconds (30s). *Source: Fick and Hijmans (2017).*

Annual Temperature. The average annual temperature at the municipal level is computed using the BIO1 bioclimatic variable (mean annual temperature), with data averaged over the period 1970-2000 from WorldClim version 2. We construct the variable using data with a spatial resolution of 30 seconds (30s). *Source: Fick and Hijmans (2017).*

Distance to Rivers (km). Distance (km) from the nearest river constructed using data from *Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA).*

Altitude. Mean altitude at the municipality level. *Source: National Institute of Statistics (ISTAT).*

Presence of Major Road in the Municipality. Indicator equal to 1 if a major Roman road crosses the territory of the municipality, zero otherwise. *Source: McCormick et al. (2013).*

Urbanization (1300s). Indicator equal to 1 if the municipality was a city with more than 5,000 inhabitants in 1300. *Source: Bosker et al. (2013).*

Population (1911). Legal population at the municipality level in 1911. *Source: National Census of 1911.*

Patents for 10,000 inhabitants (1863-1883). Number of patents per 10,000 inhabitants in Italian municipalities during the period 1863-1883, calculated using population data from the 1871 census. The variable was constructed using administrative borders of 1911. *Source: Official Gazette and "Bollettino delle privative industriali del Regno d'Italia" published from the Ministry of Agriculture, Industry and Trade.*

Occupation Structure. The shares of population employed in agriculture, extractive industries, industries related to agriculture, metalworking industries, minerals processing and construction, textile industries, chemical industries, public utilities and services, commerce, public and private administration, liberal professions at the district ("circondario") level in 1911. *Source: National Census of 1911.*

Pre-unification states FE. Italian pre-unification states binary variables according to the political boundaries of 1850. Specifically, we include binary variables for the following states: Kingdom of Sardinia, Duchy of Parma, Duchy of Modena, Kingdom of Lombardy-Venetia, Grand Duchy of Tuscany, Papal States, and Kingdom of the Two Sicilies. *Source: Harka et al. (2023).*