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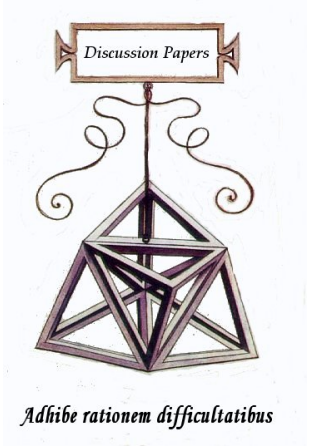

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Educational Take-off and the Role of Wealth

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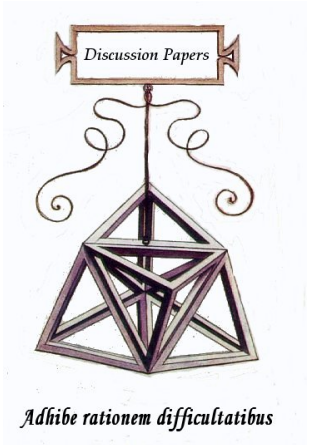

Michele Battisti, Antonio Francesco Gravina, Andrea Mario Lavezzi, Giuseppe Maggio, Giorgio Tortorici

Educational Take-off and the Role of Wealth

Abstract

What is the role of a society's wealth in influencing educational choices? Although the theoretical literature provides several possible answers, from an empirical viewpoint answering question is not straightforward. Indeed, nowadays such an issue cannot be typically inspected before starting the college, due to the compulsory public education laws in force at lower education levels in nearly all countries. We investigate this problem by employing a unique dataset covering Sicilian wealth shares and primary school enrollment in the year 1858 at municipal level. This represents an ideal setting to study our research question as, at that time, schools at the lowest grade levels were available in almost each Sicilian municipality, but their attendance was not compulsory. Our identification strategy relies on the historical heritage of seismic events in shaping mid-19th century land and property distribution, which allowed for the emergence of a class of "wealthy" households. Results of the analysis show that, even in an almost entirely agrarian society, household wealth played a decisive role in educational choices: an increase of 10

Keywords: Wealth; Education; Long-run Development; Institutions; Human Capital

JEL CLassification: I24; O15; N93

Educational Take-off and the Role of Wealth*

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December 19, 2023

Abstract

What is the role of a society's wealth in influencing educational choices? Although the theoretical literature provides several possible answers, from an empirical viewpoint answering question is not straightforward. Indeed, nowadays such an issue cannot be typically inspected before starting the college, due to the compulsory public education laws in force at lower education levels in nearly all countries. We investigate this problem by employing a unique dataset covering Sicilian wealth shares and primary school enrollment in the year 1858 at municipal level. This represents an ideal setting to study our research question as, at that time, schools at the lowest grade levels were available in almost each Sicilian municipality, but their attendance was not compulsory. Our identification strategy relies on the historical heritage of seismic events in shaping mid-19th century land and property distribution, which allowed for the emergence of a class of "wealthy" households. Results of the analysis show that, even in an almost entirely agrarian society, household wealth played a decisive role in educational choices: an increase of 10% in the share of wealthy households implied an increase of approximately 0.6% of the share of students enrolled in primary schools. We discuss the implications of these results for the existing evidence on the nexus between wealth and education, and provide a number of falsification tests that support our main results. In addition, we show that the wealth effect is only triggered beyond a certain threshold of rent and document the long-lasting impacts of early wealth conditions on a series of institutional and economic outcomes.

Keywords: wealth, education, long-run development, institutions, human capital.

JEL Classification: I24, O15, N93.

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1 Introduction

Classic textbook analysis, at least from Becker (1964), generally stresses teh role of monetary and non-monetary opportunity-costs in educational investment decisions. The determinants of education have been widely investigated in the literature (e.g., Haveman and Wolfe, 1995; Boissiere, 2004). There is an aspect, however, which prevents linking empirics with the theory: the current presence of compulsory education in most countries (with the exception of Bhutan, Oman, Papua New Guinea, Solomon Islands and Vatican City; UNESCO, 2015). Firstly implemented by Prussia in 1763, then by Austria, Hungary and the current Czech Republic in 1774, and thereafter spread across the world, compulsory education pushed economists and social scientists towards studying the determinants of educational choice on the intensive margin—i.e., on decisions of pursuing an educational pathway after compulsory education. Compulsory education plays a role also when the focus is on factors leading to primary school enrollment or dropout, as it may distort the individual demand for education through a set of moral and legally binding constraints to the parents of the pupils.

This implies that an ideal setting to understand the economic determinants of school enrollment, and whether this can be welfare improving, would be provided by a non-institutionally constrained demand for education—i.e., a non-compulsory education system, with generally available supply for education. If such a setting only the (indirect) opportunity-costs would be relevant, without demand for schooling being influenced by compulsory education. A wide strand of literature has investigated whether and how wealth/income inequalities drive the educational choices. From a theoretical perspective, the modern approach linking inequality and educational choices, and the implications for economic growth, starts with the seminal paper of Galor and Zeira (1993), which explains how investment in human capital, in presence of credit market restrictions, is ultimately determined by inherited wealth. More specifically, households' decision to enroll their children in school depends on whether the bequest received is above or below a certain threshold, and by the possibility to borrow on the credit market.[1]

In this study, we investigate the effect of household wealth on the decision to enroll children in primary school in the case of Sicily during the mid-19th century. This time period bears significant importance, as it corresponds to the Bourbon Kingdom era in Sicily prior to its annexation to the Kingdom of Sardinia in 1860. Our analysis is based on a newly constructed dataset from both the Bourbon Archive and the Sicilian *Direzione Centrale di Statistica* (Central Direction of Statistics), established in 1832. The mid-19th century Sicilian context presents a range of distinctive attributes that makes it a compelling

[1] Galor *et al.* (2009) show that inequality in the distribution of land ownership implies lower human capital accumulation, due to the delayed emergence of growth-promoting institutions, such as public education and child labor regulations. Our case study, however, is characterized by the same type of institutions in each Sicilian municipality. Hence, in this respect, there is no possibility for a delayed educational take-off due to different institutional frameworks. We might, in any case, note that compulsory education laws were already present in less unequal European countries, as we document in Section 2, providing an indirect confirmation of this intuition put forward by Galor *et al.* (2009).

quasi-experimental case deserving of thorough investigation. First, in the entire South of Italy there was no compulsory education until the end of 1861, while in the Northern regions the Casati Law (*Legge Casati*) of 1859 was already in force. This legislation mandated the compulsory and cost-free provision of the initial two years of primary education, beginning at the age of six (Hörner *et al.*, 2015). Consequently, the findings of our study, being grounded in pre-annexation Sicily to the Kingdom of Sardinia, are not influenced by the legal implications of the Casati Law, as it was not effective during that period. Secondly, in 1817, Ferdinand I, King of the Two Sicilies, decreed that all the municipalities should have ensured the presence of at least one primary school.[2] The extension and application to Sicily occurred with the decree n. 1088 of 28 January 1818.[3] This implies that, in the period under study, children could attend the school in almost all of the Sicilian territory, although without any obligation.[4] Third, within the context of Southern Italy, the Sicilian island represented an *unicum* in several respects. For example, starting from 1505, under the Spanish domination, there have been regular censuses aimed at obtaining knowledge of assets owned and households members, referred to as Registers of Goods and Souls (*Riveli di Beni e Anime*. See Aymard, 1971; Ligresti, 2002).[5]

From the perspective of wealth distribution, the Sicilian fiscal system was remarkably simple and prone to maintain deep inequalities. Land rent taxation was based on a proportional tax rate which, during the 19th century, averaged around 10% (Goodwin, 1842; Dias, 1856; Scaglione, 2016). Furthermore, industrialization was only at the beginning: according to Chilosi and Ciccarelli (2022), before the unification of Italy, the Sicilian labor force participation rate was equal to 55%, with an industrial employment share of 5%.[6] Land rent, therefore, could be considered one of the most important and secure source of wealth (Carano-Donvito, 1910; Dal Lago, 2005; Schneider and Schneider, 1976).[7]

Building on these peculiarities, we gathered historical archive data on property and land rents, primary school enrollment, and other control variables to investigate the role of Sicilian household wealth in the family choice of enrolling children in primary schools. In particular, the analysis relies on the entire

[2] *Collezione delle leggi e decreti reali del Regno delle Due Sicilie*, decree n. 623 of 31 January 1817, *"Decreto portante le disposizioni per l'instruzione ed educazione pubblica dell'uno e dell'altro sesso ne' reali domini al di la del Faro"*, pp. 173-174. See also Raffaele (2011).

[3] *Collezione delle leggi e decreti reali del Regno delle Due Sicilie, "Decreto relativo alla Commessione di pubblica istruzione ne' domini oltre il Faro".*

[4] Franck and Galor (2022) study a similar situation in France, considering data for a period characterized by non-compulsory education, with the aim of explaining heterogeneous industrialization.

[5] At the time of reunification with the Kingdom of Naples, in 1816, 15 censuses in 3 centuries had been held exclusively in Sicily. The last general census, following the reunification with the Kingdom of Naples, was held in 1831 (Ligresti, 2002). Such a structured and well-tested framework to regularly monitoring population characteristics was also employed for a survey of households land properties in 1858 (Direzione Centrale di Statistica, 1864), serving as the basis for the new post-unification Italian cadastre.

[6] In addition, as pointed out by Toniolo (2013), Sicily also lagged behind in terms of other preconditions of industrialization, such as flow rates of rivers, a core factor for potential internal transport and hydroelectric power (3-4 liters *vis-à-vis* 127 liters per second per inhabitant in Central-North regions), as well as a well-developed road network, as a proxy for infrastructure equipment (1.1 km *vis-à-vis* 6.5 km per thousand inhabitants in Lombardy).

[7] With the purpose of giving an insight about the relevance of land rent as primary source of wealth, at that time the revenues generated from landownership provided more than 90% of the tax incomes in several municipalities of the Kingdom of the Two Sicilies (see Storchi, 1981).

land rent distribution at municipal level, rather than on indirect measures of wealth concentration, such as average values or proxies based on the landownership extension (i.e, land concentration, as an indicator of the extent of serfdom) characterizing other contributions in the literature (e.g., Acemoglu *et al.*, 2020; Cinnirella and Hornung, 2016), and take advantage of historical information on school population in a context of non-compulsory attendance.

Recent literature has investigated the link between education and land distribution at the beginning of industrialization. Findings in Cinnirella and Hornung (2016) indicate that large landownership concentration in the (first half of) 19th century Prussia was negatively associated with enrollment rates. Similarly, Tapia and Martinez-Galarraga (2018) point out that Spanish land access inequality, as proxied by the share of farm laborers engaged in agriculture, had detrimental effects on male literacy in 1860. Although the research questions are similar, both studies employ schooling data in contexts where compulsory attendance laws were already in force.[8] Moreover, at that time, in Sicily children were permitted to engage in work activities, in contrast to Prussia, where a law was enacted in 1839 to regulate child labor within industrial areas. This legislation prohibited employment in factories for children under the age of 9 and constrained working hours to a maximum of 10 hours per day for kids under 16 years old (Anderson, 2018).[9]

Differently from the previously mentioned contributions, the analysis presented in this paper exploits a unique set of information on the amount of households with a given rent (i.e., in monetary terms, regardless of land concentration, extension, or access inequality), which is an ideal measure of the level of wealth-generated income in a mostly agrarian society, such as Sicily in mid-19th century. This makes it possible to identify the effect of household wealth on primary school enrollment in the absence of legislation on compulsory education. Emphasizing the importance of having a comprehensive distribution of monetary payments, which accounts for the number of families having properties evaluated for a specific rent, proves significantly more precise than solely considering land size distribution. This holds true for at least two key reasons: i) returns can vary nonlinearly with land size, and ii) there may not necessarily exist a straightforward bivariate relationship between the number of properties and the number of households (as one household may possess multiple properties). In addition, to the best of our knowledge, this is the first empirical work that explores the relationship between the transition from a post-Malthusian to a modern growth regime (Galor, 2011a), and the implied human capital accumulation under the conditions described above.

[8] Schooling became mandatory in Prussia in 1763, when Frederick the Great with his "*Generallandschulreglement*" (General Country School Regulations) decreed that all children between the ages of 5 and 13 had to attend school (Van Horn Melton, 2003). In Spain, the "*Ley de Instrucción Pública*" (Law of Public Instruction) in 1857 established the obligation for all children between the ages of 6 and 9 to attend primary school, and for children between the ages of 9 and 12 to attend either primary or secondary school (Insa-Sánchez and Díez-Minguela, 2022).

[9] Italy had no laws against child labor until 1886, with the passage of the Berti Law (*Legge Berti* n. 3657), which set up the minimum working age to 9 years old (Ruslan *et al.*, 2020).

The identification strategy employed in this study leverages an instrumental variable approach, utilizing the historical impact of seismic events (starting with the catastrophic 1693 *Val di Noto* earthquake) to instrument property and land distribution. The underlying assumption is that the historical heritage of earthquakes played a pivotal role in solidifying the wealth structure of mid-19th century Sicily. To ensure the instrumental variable's validity, the exclusion restriction is paramount, positing that the earthquakes exclusively influence primary school enrollment via land distribution (i.e., seismic phenomena did not impact enrollment through any other potential channel). We test such an assumption through several falsification and robustness exercises, all of which consistently indicate a reliable causal link between the (instrumented) household wealth and the decision to enroll children in schools, proving that other channels were not relevant as the one based on wealth. Another recent work that exploits the seismic events in Sicily as a source of variation is Baccini *et al.* (2023), who find that individual level data on membership of city councils show a strong effect of the 1693 earthquake on democratization. The intensity of the earthquake is also associated with greater turnout in the long term.

The findings from the empirical analysis reveal the existence of a strongly positive correlation between the share of wealthy households and pupils enrolled in primary schools in 1858. In terms of magnitude, a 10% increase in the share of wealthy households is associated with an approximately 0.6% rise in the share of primary school enrollment. In line with the testable predictions provided by Galor (2011a), suggesting that inequality may have a positive role in affecting human capital investment in poorer economies, we also detect heterogeneous effects based on different wealth clusters. According to our estimates, primary school enrollment is only triggered beyond a certain household wealth cut-off point, with estimates indicating the presence of an inverted U-shaped relationship between clustered classes of household rents and children enrolled in primary school. Moreover, we show that early wealth levels are linked to medium- and long-term institutional and economic outcomes encompassing, among others, literacy rates, voting participation, political competition and industrialization levels. Overall, our findings suggest that even in a society characterized by low literacy rates and pre-industrial conditions, wealth positively and significantly affected the accumulation of human capital. This highlights the relevance of socioeconomic factors in shaping the trajectory of human capital development.

The article proceeds as follows: Section 2 illustrates the historical background, focusing on the characteristics of the Sicilian educational, fiscal and land systems during the mid-19th century. Section 3 thoroughly describes the original data collected in the Historical Archive. Section 4 outlines the econometric methodology and sets out the initial results. Section 5 focuses on the identification strategy, discussing the historical and statistical support, as well as the main findings of the empirical investigation. Section 6 presents sensitivity analyses and additional results. Section 7 considers the potential confounding factors and falsification exercises, while Section 8 discusses long-lasting effects of initial wealth on several institutional and economic outcomes. Finally, Section 9 concludes.

2 Historical Background

Before focusing on the empirical part of the study, this section provides a historical overview related to two fundamental aspects characterizing the socio-economic context within which our analysis is carried out. In this regard, Subsection 2.1 offers some insights concerning the educational system and the conditions prevailing around the mid-19th century in Sicily, while Subsection 2.2 discusses the peculiarities of the Sicilian tax system and the functioning of the household wealth assessment organization.

2.1 The Educational System

Compulsory education was not uniformly implemented across Europe in the 18th and 19th centuries. While several European countries had already established compulsory public schooling systems during this period, Italy experienced significant delays and had the lowest enrollment rates compared to its European counterparts (see Buchardt *et al.*, 2013; Guérard, 1914; Van Horn Melton, 2003; Cipolla, 1969; Sandberg, 1982). According to Lindert (2004), in mid-19th century Italy reported 124 students per thousand children of ages 5-14 enrolled in primary schools, compared to 730 in Prussia, 549 in Belgium, 515 in France and 389 in Austria.

At the time of unification, however, there were significant education disparities between the North and South of Italy, with Sicily facing pronounced challenges due to the poor schooling outcomes. In 1861, in particular, Sicily had an illiteracy rate of 90% compared to 57% of Piedmont, 60% of Lombardy and a national average of 78% (Chistolini, 2001). The second census of the Italian Kingdom, conducted in 1871, revealed that the literacy rate in the Southern region of Italy had experienced a marginal increment, reaching 16.1%, yet it remained significantly lower than the North-West, which recorded a literacy rate of 57.6% (Bertola and Sestito, 2011).[10]

One of the first steps towards the implementation of a modern educational system in Sicily can be traced back to the two-year period 1817-18, when Ferdinand I, King of the Two Sicilies, issued a directive introducing free primary schools in every municipality.[11] According to Sindoni (2018), before its annexation to the rest of Italy, around 90% of Sicilian municipalities had primary schools.[12] It is important to note that Ferdinand I's directive, although introducing free primary schools, did not feature compulsory education. This implied that the objective was to enhance educational accessibility (i.e., the supply-side) without specifically addressing the demand side (i.e., the mandatory attendance). The Law No. 357 of November 13th, 1859, commonly referred to as *Legge Casati* (Casati Law), was instrumental

[10] School enrollment exhibited a parallel trajectory, with a percentage of 33.4% in the South as opposed to 67.5% in the North-West.

[11] These schools were open to both boys and girls and the decree also established the adoption of teaching methods and decided unconditionally on textbooks. The school curriculum included reading and writing, as well as moral instruction (i.e., catechism and the social duties of the citizen). See Crimi (1968).

[12] At the provincial level, the distribution of primary schools in Sicily was the following: Palermo, 87%; Trapani, 86%; Caltanissetta, 97%; Girgenti, 98%; Siracusa (Noto), 89%; Catania, 92%; Messina, 82%.

in bridging Italy's educational divide from the rest of the European countries especially when, after the unification, the law enforcement was extended to encompass the entire Kingdom of Italy through the Royal decree of November 28th, 1861.[13] Subsequently, in 1877 the Coppino Law (*Legge Coppino*) provided higher funds for public schools and extended the period of compulsory education up to 3 years, inflicting sanctions for families contravening the obligation.[14]

From this reconstruction, it emerges that both the Coppino and Casati Laws were implemented after the period under investigation in this article. Therefore, when considering the potential impact of public policies on the outcomes of our research, it should be noted that the extension of the Casati Law to Sicily did not have any effect on the 1858 data regarding school enrollment.[15]

2.2 Wealth and the Fiscal System

In the early 19th century, notwithstanding the regular census of the previous centuries, the Sicilian fiscal system lacked a comprehensive map of property ownership, making it easier for individuals to provide inaccurate declarations and pay lower taxes to the Bourbon state. To address this issue, the monarchy commissioned the creation of the Bourbon Cadastre (*Catasto Borbonico*), aiming at centralizing information on landownership, to standardize the fiscal system and enhance the administration of the island. The land survey and property registry system involved the creation of detailed maps of all lands of the kingdom, including rural farmlands, urban properties, forests and other natural resources.[16] The registry was compiled from a municipal commission, supported by special delegates who scrutinized the notarial contracts and prepared summary reports for both rural and urban areas. Territories were divided into sections and, at lower level, into parcels. Each item in the Cadastre included the "Surname, Name, profession, and residence of the owners" for each parcel, along with the nature and the name of property, the location (i.e., street, floor, or district), the size of the property (e.g., rooms per building, "salme"—i.e. units of measurement in effect during the Bourbon Kingdom—, and fractions of "salme" for rural land),

[13] The Casati Law implemented several important reforms, such as the institution of primary schools for children between the ages of 6 and 10, the introduction of 2 years of compulsory education for all children aged 6 and above, as well as the establishment of teacher training institutes to improve the quality of teaching (Hörner *et al.*, 2015).

[14] In this respect, the monetary sanction amounted to 0.50 Lire and up to a maximum of 10 Lire, which represented a considerable financial penalty, considering that, in 1905, the daily wage in the Sicilian mining sector was 2.14 Lire (Chessa, 1909). From that moment on, the Italian educational system underwent different reforms, designed to increase school attendance and literacy rates - which, however, remained relatively low for several decades -, as well as to enhance the human capital level of the new generations.

[15] Due to the slow implementation process of the Casati Law, it is also plausible to conjecture that its impact on education and enrollment during the early stage of unification was limited. Consequently, it is less likely that the initial census report on the state of education in Italy for the 1862-63 school year was significantly affected, especially for Sicily, which had become part of the Kingdom of Italy only two years before.

[16] The maps were used to record information about ownership, boundaries and value of the lands, which were then recorded in large ledger books known as cadastral maps (*mappe catastali*). Both for the urban and rural rent, the monarchy adopted the average values of the 1820-1830 as reference to estimate the rent values of the properties in the new Cadastre. After an initial period, the realization of the detailed maps appeared too expensive for the kingdom, which then opted for less detailed maps but more precise numerical information, which allowed to complete the work in 1853, with a Cadastre able to provide estimates of the land value per class of land.

and the net rent.[17] Taxation on land rent was proportional, with households subjected to a 10% tax rate (Dias, 1856), following a reduction from the previous level of 12.5% (Historical Archive of Palermo. See also Figure B1 in the Appendix).[18]

Figure 1 summarizes the relevant historical events of the present study. Since our analysis relies on data referring to 1858 (i.e., about 2 years before annexation and 4 years prior to the extension and application of the Casati Law to the South of Italy), compulsory education was not in place in Sicily, despite the presence of primary schools in almost every municipality, following the decrees of Ferdinand I (1817-18).

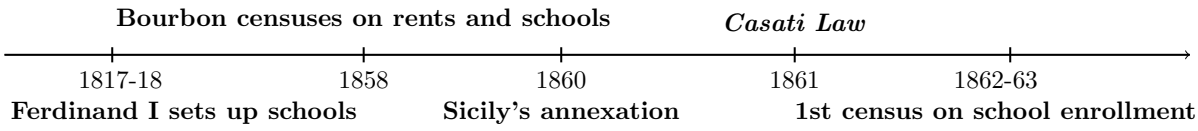

Figure 1: Events timeline.

In the next section, we describe the dataset.

3 Data

The analysis focuses on a unique cross-sectional dataset that was obtained by collecting, coding and merging historical data sources at the municipality level for Sicily. Most of the indicators used in this study were built from information extracted for the first time in an empirical analysis. This information was retrieved from the National Historical Archive of Palermo.[19] The majority of the indicators in this analysis comes from the fund created with the documents from the *Direzione Centrale di Statistica*. This was one of the first European statistical institutes, founded under the Bourbon Kingdom in 1832 with the aim of gathering information on the socio-economic profile of the Sicilian population (Galvani, 1927). The fund is divided into binders (*faldoni*), which contain all the information on certain topics, such as schools, cadastre, donations and industries, during the time of operation of the *Direzione Centrale di Statistica* (i.e., approximately 1832-1864).[20]

[17] The Marquis of Villarena, Vincenzo Mortillaro, was the main architect of the success of the initiative, being able to overcome the resistance of many municipalities to send a map of the possessions. He completed the work in 1853 (Mortillaro, 1854).

[18] According to Zamagni (2011), before the Italian unification wealth concentration in Sicily was supported by the lack of taxation on trade, professions, financial income and inheritance. This implied significant differences in terms of tax contribution across regions. Consistent with this remark, in 1860-61 the tax revenues in the Kingdom of Sardinia and Lombardy were approximately three times higher than those of Sicily (respectively, 35.8, 27.5 and 10.3 Lire per-capita).

[19] The Archive operates under the Directorate General of Archives and belongs to the Ministry of Culture. The Archive is responsible for conserving documents of all public and private entities that have been recognized as having particular historical interest. It is organized into funds and collections based on the data source, historical timing and subject matter.

[20] Basile (2020) has indexed the full list of documents and binders, which can be accessed through the following link: *Archivio di Stato di Palermo, Direzione Centrale di Statistica*. Additional details on the data collection process and variables construction are reported in Section A of the Appendix.

We collected data on household property rents in 348 Sicilian municipalities to construct our main explanatory variable.[21] In the *Direzione Centrale di Statistica* fund, these data are available at municipality level and clustered across 21 classes, ranging from 0 to more than 20,000 *Ducati*, the local currency in force during the Bourbon Reign, arranged by intervals of contribution size (e.g., from 5 to 10, 20 to 30, ..., 10,000 to 15,000 *Ducati*). Within each class, the documents provide the number of contributing households for that given rent category.[22] The Bourbon administration assessed the validity of these amounts by cross-checking the self-declarations reported in the Registers of Goods and Souls with the newly created Bourbon Cadastre.[23] Our main explanatory variable is the share of population that owns properties with rents exceeding 30 Ducati in a given municipality (henceforth referred to as *share of wealthy households*).[24] The threshold has been selected as a value that could represent a relatively upper-middle class. Scaglione (2016) suggests that productive buildings, such as shops (*botteghe*) and mills (*mulini*) were associated with rents higher than 30 ducati, together with apartments (*quartini*).[25] From a descriptive viewpoint, through this threshold we are able to identify, on average, about 10% of the total population with cadastral properties within sampled municipalities.[26] The kernel density plot depicted in Figure 2 illustrates the distribution of wealth (in logarithmic scale) for all households in the dataset. This graph also includes the threshold value, as well as reference points denoting properties of varying value. The visual representation aligns with the concept of a dynamic growth process driven by human capital within a disadvantaged economy, wherein only a limited number of households can surpass the threshold and invest in human capital (see, in particular, Figure 6 in Galor, 2011a).[27]

[21] In 1853, there were multiple municipalities that later merged with others to create larger cities. For instance, Sorrentini joined the municipality of Patti (Messina province) after the Italian Unification of 1861. To ensure consistency with other data sources, we applied a merging procedure whenever needed, as described in Acemoglu *et al.* (2020), p. 546.

[22] As an example, Figure B2 in the Appendix shows the original summary table of land rents for the municipality of Cerda (Palermo province), preserved at the Historical Archive of Palermo.

[23] The archive comprises 427 documents, broken down in 286 maps of municipal territories and 138 planimetries of Sicilian urban centers.

[24] While the logic of the Galor and Zeira (1993) model is often associated with the Gini index in reduced form estimations, inequality is not the proper way to consider the share of people surpassing the critical threshold necessary to afford human capital investment. As shown in Esteban *et al.* (2004), inequality provides limited information on polarization (even less in case of not unimodal distributions), which instead represents a key aspect of the distribution for our purposes. Results of estimations using the Gini index in place of the share of wealthy households as dependent variable are available upon request.

[25] Scaglione (2016) analyzed the value of different ecclesiastical properties, by typology, in Catania in 1843, reported in Table D1 of the Appendix. The level of rent is increasing according to different characteristics of the property declared, such as land size, typology of building and destination purpose. In particular, the commercial nature of the property itself appears to drive rents.

[26] For reference, the class immediately below our selected threshold includes individuals declaring rents between 20 and 30 Ducati, while the class above it comprises individuals declaring rents between 50 and 100 Ducati. Using these two classes as a basis for the threshold implies population shares of 13.8% and 6%, respectively. Our main findings remain unchanged when selecting these adjacent thresholds, as discussed in Section 6.

[27] Mid-19th century Sicilian municipalities were also characterized by a set of common structural features deemed relevant by Galor (2011a), such as institutions, production technologies, the cost of education, and the level of imperfections in the credit market.

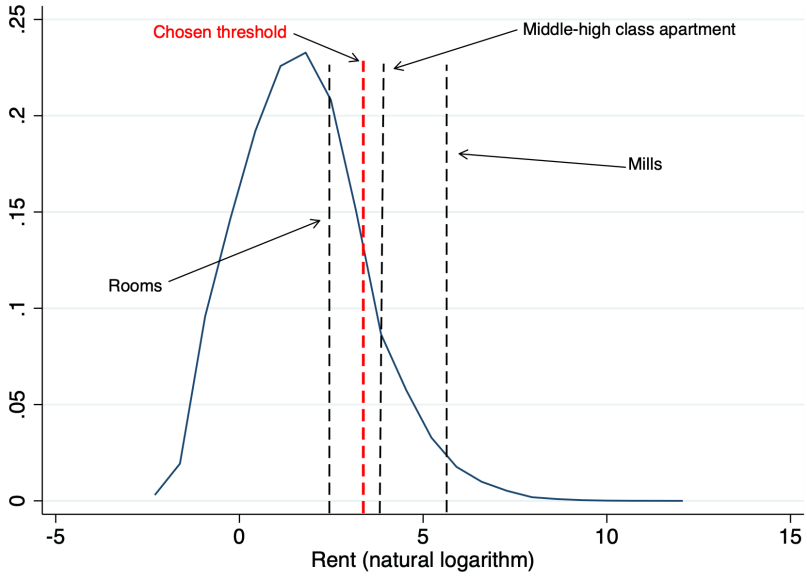

Figure 2: Rent distribution of population of Sicily, 1858.

To build our dependent variable, we gathered original information on school population. The National Historical Archive documents report data for all available schools within each Sicilian municipality in 1858 by gender, grade, and subject, following the scholastic organizational structure of that period. For boys, the distinction is between primary, secondary, literary, religious and art schools, while for girls, data cover the "College of Mary" (*Collegio di Maria*) and the "Educandarium" (*Educandario*), comprising in turn several teaching courses (e.g., literary, arts, moral and religious). Students are further classified by age group. Since the present analysis focuses on primary school enrollment, we only kept information on the number of male pupils enrolled in private primary schools (*Scuole private per fanciulli*)[28] and the number of female students enrolled in schools for girls (*Scuole per fanciulle*). These data have been complemented with municipal information on male pupils enrolled in public primary schools (*Scuole pubbliche per fanciulli*) drawn from Agresta and Sindoni (2012).[29] The choice to include schools of different nature, besides aiming to represent the entire student population, is driven by the intention to consider the importance of Catholic education (Squicciarini, 2020), which was prevalent within private schools. In this regard, our data reveal that in the 111 municipalities with either public of private schools, the students enrolled in the latter institutions accounted for 65% of the overall schooling population.

[28] These institutions were commonly funded through donations from private citizens, who made them available to municipalities where local governments were unable to cover management and operating expenses, such as teachers' salaries and classroom furniture. Private schools were authorized by royal decree on 23 September 1823, and could be established by teachers. Classes were to be conducted with open doors to allow for potential inspections to examine the status of schools' performance, as stipulated on November 13, 1821 (see *Regolamenti per le scuole comunali e per le scuole private voluti dalla Commissione della Istruzione pubblica* in Giornale degli Atti dell'Intendenza del Valle di Catania, 1821, n. 81, pp. 291-301).

[29] This is substantially due to the lack of comprehensive data on public primary schools, for some provinces or municipalities, at the Historical Archive of Palermo. The documents also contain information on high schools, colleges, boarding schools and seminaries. As these institutions are not in line with the objectives of our analysis, we excluded them from the sample.

However, at the island-wide level, the proportion of students enrolled in private schools dropped at 37%.

By merging these two sources we obtain a dataset on 294 Sicilian municipalities.[30] Figure 3 shows the map of Sicilian municipalities emphasizing the percentage of students enrolled in primary schools.

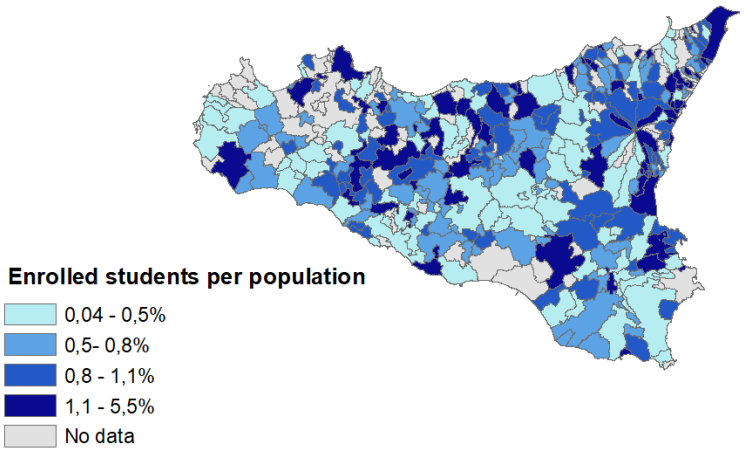

Figure 3: Students enrolled in primary schools, by municipality (% of population).

For reference, only in 35% of the municipalities the percentage of students enrolled in primary schools ranged between 1.1% and 5.5% (i.e., the top quartile) of the population, while the rest of the island was largely below these values. When comparing our original primary school enrollment data with those stemming from the national census on the state of education for the school year 1862-63, we did not find any significant discrepancies. The proportion of students enrolled in the total Sicilian population was, on average 0.9% in 1858 and 1.6% in 1862-63, with peaks of 5.5% and 6.9%, respectively. This juxtaposition instills confidence in the reliability of our historical source of data.[31]

To account for the municipality-level factors that could affect primary school enrollment, we consider a range of demographic, geographical, agricultural and economic characteristics. Specifically, we gather data on the total population in 1858 and the duration of the cholera outbreak in 1837 from the Direzione Centrale di Statistica (1840). The latter is included hypothesizing that the epidemic might have had long-lasting and inter-generational effects on school enrollment in 1858. As for the agricultural controls, we consider the share of total cultivated land in 1853 (Mortillaro, 1854) and, as in Acemoglu *et al.*

[30] A comparison of our sample with that of Acemoglu *et al.* (2020), encompassing 333 out of 348 Sicilian municipalities surveyed at that time, shows that share of population we cover, due to the unavailability of information on students enrolled in primary schools, accounts for approximately 90% of citizens surveyed in the first Italian census of 1861.

[31] We make use of data on primary school enrollment from the national census on the state of education for the school year 1862-63 as an extended analysis, in Section 8. Insofar as such an indicator may have been weakly influenced by the application of the Casati Law on compulsory school attendance in Sicily, we have considered it outside of a setting that investigates the phenomenon where there is no-compulsory school attendance. For comparative purposes with enrollment data in 1858, the map depicting the municipal distribution of primary school enrollment in 1862-63 is reported in Figure C1 of the Appendix.

(2020), a dummy variable indicating whether the municipality was a rural center. This is slightly posterior to our dependent variable as it is based on data from the first Italian census, conducted in 1861, and takes a value of 1 when more than 40% of agricultural land is devoted to cereal cultivation and at least 4,000 inhabitants reside in the city center. However, given the nature of the variable, we do not expect that this will substantially vary over short time periods, so we assume that we can safely use it as control without hindering the analysis. These cities had a concentrated landownership structure, which attracted peasants and farmers seeking work, particularly in the cereal sector. To take into consideration geographical characteristics, relying on data from the Direzione Centrale di Statistica (1859), we include the postal distance from Palermo (the region capital), as a proxy for the availability of road infrastructures (originally organized by Lo Jacono, 1856). The specification also accounts for the altitude of the town center and the average altitude of the municipality (from the 1929 Agrarian Cadastre).[32] A higher altitude is correlated with greater difficulty in cereal cultivation and/or a higher likelihood of a harvest failure, thus playing an additional potential role in the decision-making process to invest in education (Parry, 1975; Santiago-Caballero, 2013). Finally, the set of controls includes the average rural rent per hectare in 1853, obtained from Mortillaro (1854), as a proxy for the economic peculiarities of the territory.

Table 1 provides descriptive statistics of the main variables used throughout the empirical analysis.[33]

Table 1: Main variables descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
Share of students enrolled in primary school	294	0.01	0.008	0	0.055
Share of wealthy households (rent >30 Ducati)	294	0.093	0.086	0.003	1
No. of Earthquakes	294	1.95	1.53	1	16
Population in 1858	294	6,914.25	13,593.16	279	187,182
Duration of Cholera epidemic in 1837 (days)	294	23.93	32.52	0	145
Altitude of the town centre	294	419.02	281.02	3	1265
Distance from Palermo	294	113.31	57.25	0	229
Average altitude of the town	294	394.077	284.4	10	1,627
Rural centre	294	0.37	0.484	0	1
Share of cultivated land in 1853	294	0.97	0.09	0.17	1
Rural rent per hectare in 1853	294	6.79	4.89	1.17	35.15

Notes: The descriptive statistics include the number of observations (Obs), the average (Mean), the standard deviations (SD), the minimum (Min) and the maximum value (Max) for the entire sample of municipalities. See text for variables definitions and sources.

[32] As before, these variables do not vary across time and will not be affected by education, thus can safely enter among the list of controls.

[33] Sections A and C in the Appendix provide a detailed description of the original information collected, a thorough explanation of how some of the variables used in this paper were constructed, and additional statistics on indicators entering in the robustness, falsification tests, as well as medium- and long-term impact sections.

4 Empirical Framework and Baseline Results

To test the impact of wealth on primary school enrollment, we start by an Ordinary Least Squares (OLS) regression as the baseline specification, which includes a set of observable characteristics, as described in Section 3, along with a series of district/province dummies. The latter are useful for capturing cross-sectional differences at a higher geographical level, such as district/province cultural and historical factors, institutional capacity, or other unobserved heterogeneity. Thus, the empirical specification is formally expressed as follows:

$$h_i = \alpha_{OLS} + \beta_{OLS} SW_i + \gamma_{OLS} \mathbf{X}_i + \delta_{OLS} D_i + \epsilon_i. \tag{1}$$

The model specification includes the variable h, which represents the share of students enrolled in primary school relative to the population in 1858, in municipality i. The variable SW measures the share of wealthy households, with β_{OLS} being the coefficient of interest. The vector $\mathbf{X}$ denotes a set of municipality-level controls, with γ_{OLS} representing the corresponding vector of coefficients. D consists of district/province level dummies, depending on the estimated specification. The error component is denoted by ϵ_i and is clustered at the district level.[34]

Results of the OLS estimation of Eq. (1) are reported in Table 2 and arranged on the basis of district fixed effects (Panel A) or province fixed effects (Panel B). Overall, these indicate a consistently positive and strongly significant relationship between the share of wealthy households and primary school enrollment. The correlation remains stable when controlling for demographic, agricultural, geographical and economic factors (columns (2)-(5)) in the baseline specifications (column (1)). Adding province or district fixed effects to the set of controls does not alter the sign, significance or magnitude of the coefficient of interest. The R^2 value exceeds 0.24 when at least one set of controls is included.

If we interpret this coefficient as a clue of a causal relation, it implies that a 10% increase in the share of households over the wealth threshold in a municipality would result, on average, in around 0.2% increase in primary school enrollment. Finally, in column (6) of Table 2, we incorporate the per-capita number of schools from the 1862-63 census on the state of Italian education to address the supply-side aspect of schooling. Regrettably, we lack a variable capturing such information for the pre-unification period, yet it is reasonable to assume that there were no significant alterations in school infrastructure during the years 1858-1862. Notably, this factor does not substantially affect the coefficient of the household wealth variable, with R^2 raising to 0.30 when district fixed effects are included in the model specification.

[34] The main findings are robust when clustering is at the provincial level. Results are available upon request.

Table 2: OLS regression results: Share of wealthy households and primary school enrollment in 1858.

Dependent variable: Share of students enrolled in primary school						
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: With district fixed effects						
Share of wealthy households	0.011**	0.020***	0.021***	0.022***	0.020***	0.020***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.006)	(0.005)
R^2	0.11	0.264	0.279	0.285	0.295	0.302
Panel B: With province fixed effects						
Share of wealthy households	0.011**	0.020***	0.021***	0.022***	0.020***	0.020***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.006)	(0.005)
R^2	0.082	0.247	0.266	0.268	0.273	0.279
Demographic controls		✓	✓	✓	✓	✓
Agricultural controls			✓	✓	✓	✓
Geographic controls				✓	✓	✓
Economic controls					✓	✓
Other education determinants						✓
Observations	294	294	294	294	294	293

Notes: The table reports OLS estimates for the relationship between primary school enrollment in 1858 and the share of wealthy households. In Panel A (B) district (province) fixed effects are included in the model specification of Eq. (1). Column (1) does not include any additional control variable. Column (2) includes population (in logs) in 1858 and days of duration (in logs) of 1837 cholera epidemic as demographic controls. Column (3) also includes the share of cultivated land in 1853 and the rural centre dummy variable as agricultural controls. In Column (4), we add the postal distance from Palermo, the average altitudes of the municipality and town center, to account for geographical characteristics. Column (5) includes the average rural rent per hectare in 1853 to control for local economic characteristics. Finally, Column (6) includes the number of schools per-capita. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

The theoretical framework developed by Galor and Zeira (1993) suggests that wealth should play a role in a largely agrarian society where: i) a substantial wage discrepancy exists between jobs requiring education (particularly in terms of literacy) and those that do not, and ii) credit market constraints are present, hindering the possibility to borrow to finance education.

In the light of these remarks, therefore, which incentives of investing in education existed at that time? Among them, one would have been legitimately related to the expectations of families to obtain higher wages and social recognition for their children—especially if they had been engaged in a sector other than agriculture. The relevance of education clearly raises when different wages are paid for different jobs, notably for occupations requiring literacy in Sicily's nascent manufacturing industry. To take this aspect into account, we collected historical data on 230 Sicilian-based firms operating in 1855 from the Direzione Centrale di Statistica (1857). This allowed us to compare the average daily wages of men employed in occupations that required literacy to those that did not. For instance, in Palermo, the manufacture of hats, organs, pianos and furniture paid an average daily wage of over 2 Ducati.

Conversely, for the manufacture of salt, paper and rags the average daily wage was about 0.4 Ducati. In general, literate employees in the island were engaged by 15% of firms and enjoyed a relative wage that was about 60% higher than their illiterate counterparts. Although stemming from a still backward context of industrialization, the presence of a strong wage differential could have provided an additional stimulus for (relatively affluent) families of that time in evaluating the decision to enroll their children in schools.[35]

Regarding credit constraints, the banking system in Sicily exhibited notable underdevelopment as late as 1877, prompting Vergara-Bertocci (1877) to suggest the transformation of the traditional institutions, known as *Monti Frumentari* (Grain Centres). These institutions provided loans and wheat to peasants, and the proposition was to convert them into private consumer banks. However, their quantity remained restricted. As pointed out by Vergara-Bertocci (1877), there were only 101 of such institutions in 1877, and even less in 1857 (77) according to Direzione Centrale di Statistica (1860). Our data collection, encompassing budgetary information for only 66 of these entities due to data unavailability, unveiled their absence even in major urban centers like Palermo. In fact, merely three *Monti Frumentari* were operational across the entire province, while approximately half of these institutions were concentrated within the province of Messina. The average interest paid on loans was 11.2%. Given their limited distribution and specific operational scope, it can be inferred that the opportunity to secure loans for educational purposes was nearly nonexistent during this historical period.

However, with respect to the results in Table 2, it is important to note that the relationship between wealthy household and primary school enrollment cannot be interpreted as causal, insofar as there are potential issues of reverse causality and omitted variable biases that may influence the OLS regression coefficients of Eq. 1. For example, a downward bias of the effect of wealth can be due to the fact that parents with higher education may be more likely to enroll their children in school, thus contributing to higher levels of wealth in areas where education is prioritized. A similar bias affecting OLS estimated coefficients could be implied by measurement errors (e.g., Card, 1999). On the other hand, we may run into sources of upward bias—for example, if more educated individuals were better able to extract rents from properties or land, resulting in larger tax payments to the State. Furthermore, the results may suffer from omitted variable bias due to the complex interconnections between wealth/income from land and education. Indeed, wealth may be associated with ability, which is transmitted across generations, influencing in turn children educational outcomes. Ultimately, as suggested by Cameron and Heckman (2001), the OLS *share of wealthy household* estimated coefficient may be biased by long-term hidden

[35] For international comparison purposes, Clark (2001) analyzed historical data for the UK's farms sector in the 1830s, estimating an annual wage of 29.1 pounds in 1833. On the other end, Sanderson (1972) found that mechanics (i.e., the occupation with the higher literacy rate, 67%, in the 1830s) received a monthly wage of 5.19 pounds, matching an annual wage of approximately 60 pounds. This implies that the wage gap between these ancient skilled *vis-à-vis* unskilled occupations was close to more than 100%, i.e. it was larger than the recent college premium (70%) observed by Autor *et al.* (2020).

factors, such as intergenerational income or good levels of education that are linked with household wealth/income. To establish causality and reduce the likelihood of bias, it is necessary to design a quasi-experimental strategy that allows to capture the unidirectional variation of enrollment due to a change in household wealth. To this end, the next sections report the results from an instrumental variable approach and a battery of falsification tests.

5 Identification Strategy: Earthquakes and Landownership Redistribution

To identify the causal linkage between wealth and school enrollment, we utilize a two-stage least squares (2SLS) approach which will provide us with the local average treatment effect. The first stage equation takes the following form:

$$SW_i = \iota_0 + \phi EQ_i + \iota \mathbf{X}_i + \lambda D_i + \mu_i, \tag{2}$$

while the second stage equation is specified as follows:

$$h_i = \alpha_{IV} + \beta_{IV} S\hat{W}_i + \gamma_{IV} \mathbf{X}_i + \delta_{IV} D_i + \epsilon_i, \tag{3}$$

where $S\hat{W}_i$ is the predicted variable from the first stage regression in Eq. (2).

In the first stage, the dependent variable, SW_i, denotes the share of wealthy households in municipality i, and the instrumental variable is the number of earthquakes, EQ_i, that hit municipality i during the previous 150 years, while the other explanatory variables remain the same as in Eq. (1).[36] The earthquakes are measured from 1693, the year of the Val di Noto earthquake, representing the first devastating seismic phenomenon in Italian history.[37] The Val di Noto earthquake was characterized by two seismic episodes occurred on January 9th and 11th, resulting in the destruction of 60 towns, over 50,000 fatalities and thousands more displaced (Sirovich and Pettenati, 2001; Puleo, 2010). According to Condorelli (2010), following the two close earthquakes, the mortality rate for Catania, the third-largest city on the island at that time, was around 55%, and above 15% for 28 neighboring municipalities. Given the precarious healthy conditions, this seismic swarm was accompanied by the upsurge of pandemics and

[36] Information on the number (and intensity, employed in a robustness check in Section 6) of earthquakes at the municipal level have been retrieved from the National Institute of Geophysics and Volcanology (*Istituto Nazionale di Geofisica e Vulcanologia, INGV*) (Historical Seismology and Macro-Seismology section, Catalogue of Strong Earthquakes in Italy (461 b.C.-1997) and Mediterranean Area (760 b.C.-1500). See Guidoboni *et al.*, 2018, 2019).

[37] The AHEAD (European Archive of Historical Earthquake Data) database contains 6,205 earthquake events that occurred between the years 1000 and 1857. Of these events, only 49 were classified as "extra-large". When we focus on the two centuries before our period of interest, we find that only 6 earthquakes in the entire Mediterranean area registered higher intensity than the Val di Noto earthquake, with a moment magnitude of up to 7.5 on the Richter scale (see Albini *et al.*, 2013).

occurrence of other significant shocks (Rodriguez de la Torre, 1995). Nearly a century later, on February 5th and 7th 1783, a second powerful seismic phenomenon took place, with epicenter in southern Calabria, known as the Reggio and Messina earthquake.[38] The event significantly impacted the North-Easstern part of Sicily and caused several tsunamis. The city of Messina was almost razed to the ground and, although the number of casualties was limited to less than 1,000 inhabitants, the earthquake left around 30,000 survivors homeless (e.g., Jacques *et al.*, 2001).

Numerically, our earthquakes frequency variable is based on data covering 21 seismic phenomena that occurred between 1693 and 1854.[39] The distribution of earthquakes is reported in the upper map of Figure 5, which highlights a concentration of events in the Eastern-Central areas of Sicily.

5.1 Historical Evidence Supporting the Exclusion Restriction

The earthquake indicator is a suitable instrument only if the exclusion restriction holds—i.e., if the seismic phenomena are likely to influence the enrollment in school only through their impact on the land rent. In this respect, recent literature has shown that natural disasters can lead to a decrease in income inequality, resulting in lower levels of wealth inequality, due to new opportunities for poorer households (see, for instance, Abdullah *et al.*, 2016; Mendoza and Jara, 2022; Keerthiratne and Tol, 2018). Although income data before and after these events are not available, we expect that certain institutional policies implemented to respond to major earthquakes may have provided new opportunities and increased social mobility for the less affluent segments the population, increasing in this way the size of the wealthy household share of the population. For example, the correspondence of Spanish viceroy Juan Francisco Pacheco, Duke of Uzeda, points out that, after the earthquakes of 1693, new jobs were needed to rebuild the destroyed cities, churches and infrastructures (e.g., Pacheco, 1693a,b). In addition, a free trade zone and tax exemption (which, in a proportional tax system such as the one holding at the time, would have been particularly relevant) were requested to encourage the economic recovery of earthquake-hit areas (see, for instance, Deputati del Regno di Sicilia, 1693; Consiglio patrimoniale, 1693). In pursuit of reconstruction efforts, substantial funds were allocated to local governments, as Tedesco *et al.* (2007) pointed out. These initiatives drew in the island's many highly skilled workers, whose contributions were

[38] Historically, this seismic event was the third most intense, following the devastating Messina earthquake of 1908. Between February and March of 1783, numerous earthquakes continued to occur, with another peak recorded on March 28th, reaching a moment magnitude of 7.0. The number of casualties was estimated at around 50,000 people, and the damages were unmeasurable. Von Goethe, who visited Messina in 1787, described the condition of the city four years after the devastating earthquakes and tsunamis in his *Italian Journey* as follows: *"Most of the buildings had collapsed and the cracked walls of the rest made them unsafe. So a barrack town was hastily erected in a large meadow north of the city"* (Von Goethe, 1992).

[39] In this period, the dataset reveals that 242 municipalities were hit by at least 1 earthquake. Since a seismic phenomenon is a spatially correlated event, the number of earthquakes in the remaining municipalities has been imputed using the province's average. The imputation process is also necessary due to the fact that, within the historical earthquakes database of INGV, the nomenclature of municipalities follows contemporary conventions. Therefore, in cases where certain mid-19th-century towns were abolished or merged to form larger cities, the number of earthquakes has been assigned using the same criterion.

crucial to the emergence of the cultural, artistic and architectural phenomenon recognized as "*Sicilian Baroque*" (Dufour and Raymond, 1994; Puleo, 2014).

Moreover, a number of policies were implemented with the aim of facilitating a less uneven distribution of wealth and properties in territories most affected by the devastation of the Val di Noto earthquake (Ligresti, 1993; Giarrizzo, 1997).[40] For instance, as documented by Condorelli (2006), in situations where properties remained unreconstructed, the municipal authority of the city of Catania, represented by the senate, had the mandate to intervene and facilitate their transfer to individuals willing to undertake the reconstruction efforts. Further specific and more drastic measures were carried out, reflecting the severity of the catastrophe. Notably, property prices were reduced by one third, mortgages on sold buildings were abolished, and the pricing of urban land was standardized.

Ultimately, the effects of natural disasters and the consequent policy interventions impacted on agricultural productivity and therefore on the income and wealth distributions across the entire island. As remarked by Alexis De Toqueville, during his Sicilian journey in 1826: "*The land round Etna being subject to frightful ravages, the nobles and the monks grew disgusted with it, and the people became the proprietors. It is now sub-divided almost without any limit. Each cultivator has an interest, however small, in the soil. This is the only part of Sicily where the peasant is a proprietor*" (De Tocqueville, 1862).

5.2 Statistical Support to the Exclusion Restriction

The historical anecdotal claims on the linkage between seismic events and land fragmentation is further supported by at least two statistical evidences that we extracted from the Historical Archive. First, we examined episodes of re-allocation of land over a period of about 10 years spanning the two most destructive seismic events in our sample: the 1693 Val di Noto earthquake, and the 1783 earthquake in Reggio and Messina. This was achieved by collecting and geo-localizing information from the Kingdom of Sicily's protonotary "Directory of Feudal Investiture Processes from 1452 to 1812" (*Protonotaro del Regno di Sicilia, Repertorio dei Processi di Investiture Feudali dal 1452 al 1812 n. 122*).[41] We identified a total of 722 feudal land assignments made over the years 1687-1697 and 1778-1788 (341 in the period around the Val di Noto earthquake; 381 for the Reggio and Messina earthquake) in the 24 Sicilian districts.[42] To investigate the existence of significant differences in land redistribution induced by the

[40] Similar actions were taken after the Reggio and Messina earthquake of 1783 (Ruggieri, 2017; Parrinello, 2022).

[41] Between 1693 and 1812, thousands of official land assignments and feudal investitures were recorded. In addition to this, names of towns changed frequently making hard identification and localization. Therefore, the analysis of these assignments before and after the most intense seismic phenomena is limited to the most destructive ones. The document can be accessed through the following link: Directory of Feudal Investiture Processes from 1452 to 1812.

[42] We were unable to match the districts where other 70 additional assignments took place.

earthquakes, we classified the districts according to the average intensities of the two seismic events.[43] Subsequently, we computed the ratios of land re-assignments in the most and least affected districts considering three intervals: 5 years before the event, the periods immediately following the event and, finally, a period of additional 3 years. As shown in Figure 4, the (relative) feudal assignments and land allocations remarkably increased in the years immediately after the seismic events (i.e., 1693-1694, and 1783-1785). Specifically, these variations amount to approximately 50% for the Val di Noto earthquake and over 135% for the 1783 Reggio and Messina earthquake—in line with the historical reconstruction of the policy interventions aimed at redistributing the land to prevent the depopulation of those territories. Notably, the trend in the ratios of land allocations reverts to levels comparable to those before the occurrence of two seismic phenomena in the later years (i.e., after 1694 and 1785).

Figure 4: Differences in land assignments between the most and least affected districts by the 1693 Val di Noto earthquake (1687-1697) and the 1783 Reggio & Messina (1778-1788) earthquake.

As complementary evidence, we considered the effect of seismic events on land fragmentation and agricultural production in the medium- and long-term. For example, the effect of earthquakes on land distribution does not appear to pass through the typology of crop cultivated in the different municipalities. Indeed, as highlighted in Table 3, at the time of the analysis all provinces predominantly cultivated wheat, with an overall average share of about 0.5 and province average shares of land devoted to grains ranging between 0.31 and 0.71 of total cultivated land. However, from historical data on wheat harvests in 1854

[43] In this regard, Caltagirone, Catania, Modica, Noto and Siracusa were the districts most severely affected by the 1693 Val di Noto earthquake, in which the moment magnitude exceeded the average of 6.5. In the case of the 1783 Reggio and Messina seismic event, the districts of Acireale, Castroreale, Messina and Patti, where the moment magnitude was higher than the average of 6.2, resulted as the most impacted areas.

(see Appendix A for details), significant East-West differences emerge, as emphasized by De Tocqueville (1862). Despite reserving a lower share of land cultivated with wheat than the regional average, the province of Catania - among the Eastern territories most affected by earthquakes (see Figure 5) exhibited a crop yield and a per-capita value added that exceeded the Sicilian average by 68% (0.53 tonnes per-capita and 4.7 Ducati per-capita, respectively), as opposed to the Palermo and Trapani Western provinces where, although having wheat cultivation shares in line with the regional average, per-capita crop yields and value added were close to the Sicilian average (about 0.32 tonnes per-capita and 2.8 Ducati per-capita, respectively).[44] Overall, this evidence suggests that after the seismic events institutional interventions aimed at redistributing land (and properties) encouraged individuals who received the land to make it more productive through the adoption of new technologies and higher investment in capital-intensive production, achieving in this way higher yields from their land (on this point, see for instance di Gregorio, 2007; Drago, 2004). As a result, an "upper-middle" class emerged, composed of new wealthy households. By contrast, territories that experienced fewer earthquakes underwent a less profound process of land redistribution (even despite the abolition of Feudalism), resulting in the perpetuation of both an extensive type of agricultural production and greater social viscosity.

Table 3: Shares of land devoted to grain cultivation, per-capita wheat yield and value added (average values by province) in 1854.

	Share of land cultivated with grains	Per-capita wheat yield (tons/population)	Per-capita wheat VA (Ducati/population)
Caltanissetta	0.698	0.299	2.656
Catania	0.435	0.529	4.694
Girgenti	0.714	0.305	2.702
Messina	0.312	0.108	0.96
Noto	0.642	0.238	2.112
Palermo	0.528	0.332	2.949
Trapani	0.582	0.315	2.798
Overall mean	0.503	0.315	2.794

Source: Author's calculations based on Direzione Centrale di Statistica (1864), Mortillaro (1854) and Corriere della Sera (1909).

The impact of these processes are reflected in the Sicilian allocation of cadastral properties as of 1858. As illustrated in the lower map of Figure 5, the municipal distribution of per capita land closely traces

[44] Significant heterogeneities also persisted between similar municipalities in different provinces. For instance, when comparing territories at the district level, it can be noticed that, while reserving almost the same share of land devoted to wheat cultivation, the municipalities falling within the district of Nicosia (Catania province) had average per-capita values of crop wheat three times higher than those of Corleone (Palermo province). Detailed information on crop wheat at the district level are provided in Table C3 of the Appendix.

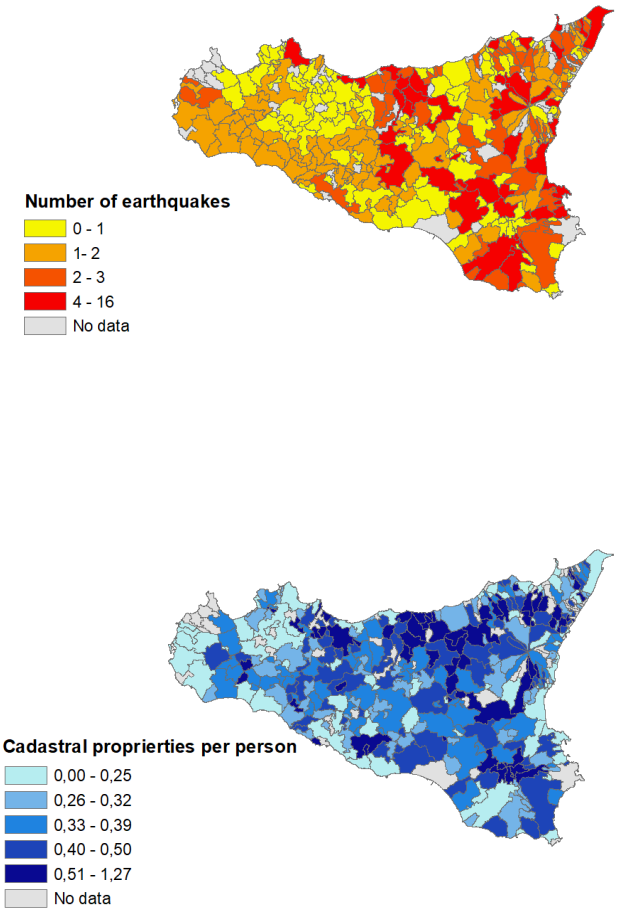

Figure 5: Earthquakes (1693-1854) and Cadastral properties by municipality in 1858.

that of earthquake occurrences (upper map).

In the next subsection, we present the results of the 2SLS estimations.

5.3 IV Estimation Results

Results from 2SLS estimates of Eqq. (2) and (3) are reported in Table 4. As in Table 2, we distinguish the results with district or province fixed effects. In both cases, the first stage of all the estimations confirms a positive and statistically significant correlation between the number of earthquakes and the share of wealthy households (defined as those with a rent exceeding 30 Ducati), as soon as a first set of controls (i.e. demographic) is intoduced. In terms of magnitude, an additional earthquake in the past is linked, on average, to an increase of 1.6-2% in the share of wealthy households, depending on the specification.

Table 4: 2SLS regressions results: Share of wealthy households and primary school enrollment in 1858.

Dependent variable: Share of students enrolled in primary school					
Panel A: With district fixed effects	(1)	(2)	(3)	(4)	(5)
First stage					
No. of Earthquakes 1693-1854	0.020***	0.020***	0.020***	0.019***	0.019***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)
R^2	0.244	0.245	0.248	0.268	0.285
Second stage					
Share of wealthy households	-0.018	0.058***	0.063**	0.066***	0.065***
	(0.013)	(0.023)	(0.026)	(0.026)	(0.025)
F-test	12.19	10.81	11.25	11.97	11.41
Panel B: With province fixed effects	(6)	(7)	(8)	(9)	(10)
First stage					
No. of Earthquakes 1693-1854	0.019***	0.017***	0.016***	0.017***	0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
R^2	0.123	0.137	0.143	0.196	0.221
Second stage					
Share of wealthy households	-0.016	0.057***	0.060**	0.061**	0.061**
	(0.012)	(0.022)	(0.026)	(0.025)	(0.026)
F-test	12.55	11.89	10.29	11.74	10.64
Demographic controls		✓	✓	✓	✓
Agricultural controls			✓	✓	✓
Geographic controls				✓	✓
Economic controls					✓
Observations	294	294	294	294	294

Notes: The table reports 2SLS estimates for the relationship between the share of wealthy households and primary school enrollment in 1858, using the number of earthquakes occurred in the years 1693-1854 as IV in the first stage. In Panel A (B) district (province) fixed effects are included in the model specification of Eqs. 2-3. Column (1) does not include any additional control variable. Column (2) includes population (in logs) in 1858 and days of duration (in logs) of 1837 cholera epidemic as demographic controls. Column (3) also includes the share of cultivated land in 1853 and the rural centre dummy variable as agricultural controls. In Column (4), we add the postal distance from Palermo, the average altitudes of the municipality and town center, to account for geographical characteristics. Finally, column (5) includes the average rural rent per hectare in 1853 to control for local economic characteristics. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

These findings support the hypothesis that historical seismic events have played a crucial role in the emergence of a new "upper-middle" class.

The second stage estimates confirm the positive relationship between the share of wealthy households and primary school enrollment. In terms of magnitude, an increase of 10% in the share of wealthy households leads to an increment of about 0.6% in the share of students enrolled in primary school. The

coefficient remains positive and statistically significant when additional control variables are included in the estimated models (i.e., agricultural, geographic and economic), as shown in columns (2)-(5) and (7)-(10) of Table 4. In addition, the statistical diagnostic checks allow to exclude the hypothesis of weak instruments, with F-test statistics always above 10 (Stock and Yogo, 2005).

Note that the second stage coefficients are approximately three times larger that those obtained from the OLS regressions (outlined in Table 2), suggesting that the latter were downward biased.[45] When comparing our findings to previous analyses conducted under conditions of compulsory education (see, for example, Cinnirella and Hornung, 2016), we note that our 2SLS estimated coefficients are approximately 2-3 times larger than those typically documented in the existing literature. This divergence implies that the presence of compulsory education can lead to severely downward-biased estimates. With the imposition for parents to ensure their children's attendance in school it follows that, on average, a larger proportion of children from less affluent households are enrolled. As a consequence, the coefficient linking wealth and enrollment is lower in terms of magnitude.

6 Robustness, Wealth thresholds and Class Clustering

In this section, we assess the robustness of results presented above and provide an heterogeneity analysis. In subsection 6.1 we make use of alternative IVs for the 2SLS estimates and a method for adjusting standard errors to account for spatial correlation, while in subsection 6.2 we evaluate whether adjacent thresholds for defining the share of wealthy households affect our core findings, as well as to what extent proprietors falling within specific clusters of rent influence primary school enrollment.

6.1 Sensitivity Analysis

This subsection presents the results of a set of tests conducted to evaluate the reliability of the main findings, which are reported in Table 5. To rule out any selection bias on the number/typologies of earthquakes included in the instruments, we have varied the time-window used for calculating the indicator. Column (1) shows the results obtained by considering only earthquakes that occurred between 1800 and 1854 (i.e., in the 19th century), while column (2) reports the results obtained with the 1693-1799 period. The remaining columns of Table 5 provide 2SLS estimates obtained by employing the cumulative intensity of earthquakes between 1693 and 1854 (columns (3) and (4)), as an instrument alternative to the frequency. In all cases, the positive and statistically significant impact of household wealth on primary school enrollment is confirmed, with a range of coefficient magnitudes extremely similar to the one from the IV regressions of Eq. (3).

[45] In terms of bias of the OLS estimated coefficients, the ratio between our 2SLS and OLS estimates is in line with those of Easterly (2007), Ramcharan (2010) and Acemoglu *et al.* (2020).

Finally, we address the possibility that seismic events in a municipality - as well as our other control variables - might be spatially correlated with neighboring municipalities. To account for this correlation, in columns (5)-(6) of Table 5 we report the 2SLS estimates of Eqq. (2) and (3) with the full set of controls (i.e., columns (5) and (10) of Table 4) and bootstrapped standard errors allowing for two-way clustering, proposed by Cameron *et al.* (2008, 2011), and applied in Acemoglu *et al.* (2020). Specifically, we adopt the two-way clustering procedure conditional on the district to which the municipality belongs and the average distance (in logs) to the epicenters of the earthquakes. Also in this case, the main results remain consistent as the use of this standard errors correction technique does not alter the significance of our main explanatory variable in the second stage equation.

Table 5: Sensitivity analysis:
2SLS regression results with alternative earthquakes variables and standard errors adjustment.

Second Stage Dependent Variable: Share of students enrolled in primary school						
	(1)	(2)	(3)	(4)	(5)	(6)
First stage	No. of EQs	No. of EQs	EQs Cumulative	EQs Cumulative	No. of EQs	No. of EQs
	in 19th Century	1693-1798	Intensity 1693-1854	Intensity 1693-1854	1693-1854	1693-1854
	0.042***	0.020***	0.003***	0.002***	0.019***	0.016***
	(0.012)	(0.006)	(0.000)	(0.000)	(0.006)	(0.005)
R^2	0.281	0.257	0.271	0.21	0.285	0.221
Second stage						
Share of wealthy households	0.046**	0.095***	0.067***	0.060**	0.065***	0.061***
	(0.023)	(0.024)	(0.025)	(0.023)	(0.022)	(0.019)
F-test	11.69	11.41	11.47	10.79	11.41	10.64
District fixed effects	✓		✓		✓	
Province fixed effects		✓		✓		✓
Bootstrapped S.E.					✓	✓
Full set of controls	✓	✓	✓	✓	✓	✓
Observations	294	294	294	294	294	294

Notes: The table reports 2SLS estimates for the relationship between the shares of wealthy household and primary school enrollment in 1858, based on the model specification of Eqs. 2-3, but employing different IVs and standard errors correction techniques. Columns (1)-(2) make use of district fixed effects and the number of earthquakes occurred, respectively, in 19th century and in the 1693-1798 period as IVs for the share of wealthy households in 1858. Columns (3)-(4) consider the cumulative intensity of earthquakes as alternative IV and district/province fixed effects, respectively. Columns (5)-(6) report 2SLS estimates (as shown in columns (5) and (10) of Table 4), with bootstrapped standard errors allowing for two-way clustering conditional on the district to which the municipality belongs and the average distance (in logs) to the epicenters of the earthquakes, and district/province fixed effects, respectively. All the estimates include demographic, agricultural, geographic and economic controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors for the estimates in columns (1)-(4) are clustered at the district level.

6.2 Rent Thresholds and Rent Classes

To exclude that our results are driven by the chosen threshold, we conducted a set of additional exercises to test whether different wealth thresholds affect the key findings. The results of these tests are presented in Table C4 in Appendix C and indicate that minor changes to the threshold (i.e., starting with rent above 20 or 50 Ducati, respectively) do not significantly affect the findings. This suggests that the positive

relationship between household wealth and primary school enrollment has been accurately captured.[46]

As an additional exercise, we considered the proportion of proprietors falling within specific rent intervals to re-assess the consistency of the relationship with the opportunity cost of sending children to school. Specifically, we created five rent intervals: 1 to 20 Ducati, 20 to 30 Ducati, 30 to 50 Ducati, 50 to 100 Ducati, and 100 to 300 Ducati. The results of this supplementary analysis are displayed in Figure 6.[47] Notably, these estimates identify an inverted U-shaped relationship between household wealth and primary school enrollment.

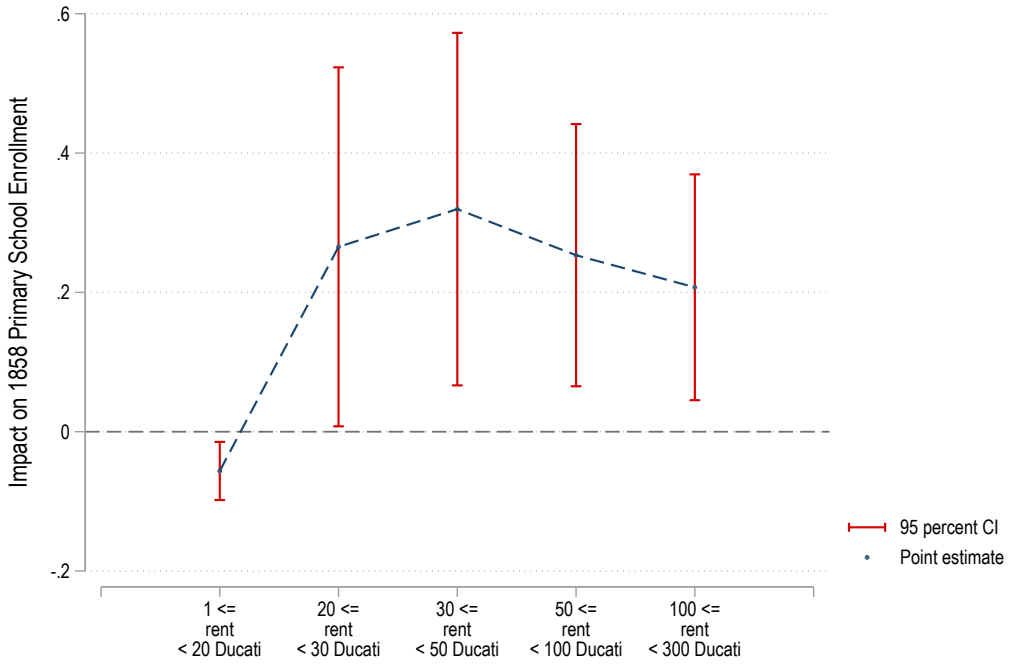

Figure 6: Heterogeneity: effects of different rent classes on primary school enrollment.

For poorer households (i.e., with rent below 20 Ducati), such as those owning small properties like rooms (*camere*), small farm houses (*casaleni*), cultivated land (*terreni coltivati*), or low-level apartments (*bassi*), we detect a negative and significant association with school enrollment. This may be due to high opportunity costs for the poorer families of enrolling children to school, especially if these were credit-constrained and relatively large. In fact, it may have been more economically rational for them to employ their children in activities that did not require education as a crucial prerequisite.

Conversely, as the rent class increases, we observe a rising and positive impact on primary school enrollment, which peaks at rents between 30 and 50 Ducati. The effect then gradually diminishes at higher rent classes. The growing and declining segments of the positive effect of wealth on schooling, can be explained by taking into account two contrasting motivations. On the one hand, families with rents

[46] We have also taken into account lower classes to calculate the proportion of households with specific initial rents (excluding only the first category, which includes property-less households). The core results are consistently confirmed by these additional analyses and are available upon request.

[47] Detailed results are reported in Table C5 of Appendix C.

falling within specific classes may have viewed enrolling their children in school as a sound economic investment, as it would have allowed to improve household economic conditions. On the other hand, families with significantly higher levels of wealth might not have considered sending their children to school as a fundamental priority, as they could rely on an already considerable level of household assets or could provide to the education of their children through private tutors. This would explain the lower impact on enrollment rate observed for rent classes higher than 50 Ducati.

7 Falsification Exercises

In the previous section, we provided support to the idea that earthquakes affected the wealth distribution in Sicily as they implied targeted policy interventions, giving new opportunities for economically disadvantaged households. In this section, we present the outcomes of a comprehensive array of falsification tests designed to assess the validity of the exclusion restriction—i.e., to determine whether the influence of earthquakes on school enrollment could be attributed to factors distinct from land (and consequently) wealth distribution. Specifically, the next subsections discuss the following plausible different transmission mechanisms: demography (Subsection 7.1), infrastructures (Subsection 7.2), social capital (Subsection 7.3), and religion (Subsection 7.4). Figure 7 graphically illustrates this set of alternative pathways potentially affecting schooling, alternative to the channel represented by land and wealth distribution. In addition, Table 6 contains the complete set of results of the falsification tests, including province fixed effects, while those obtained utilizing district fixed effects are reported in Table C6 of Appendix C.

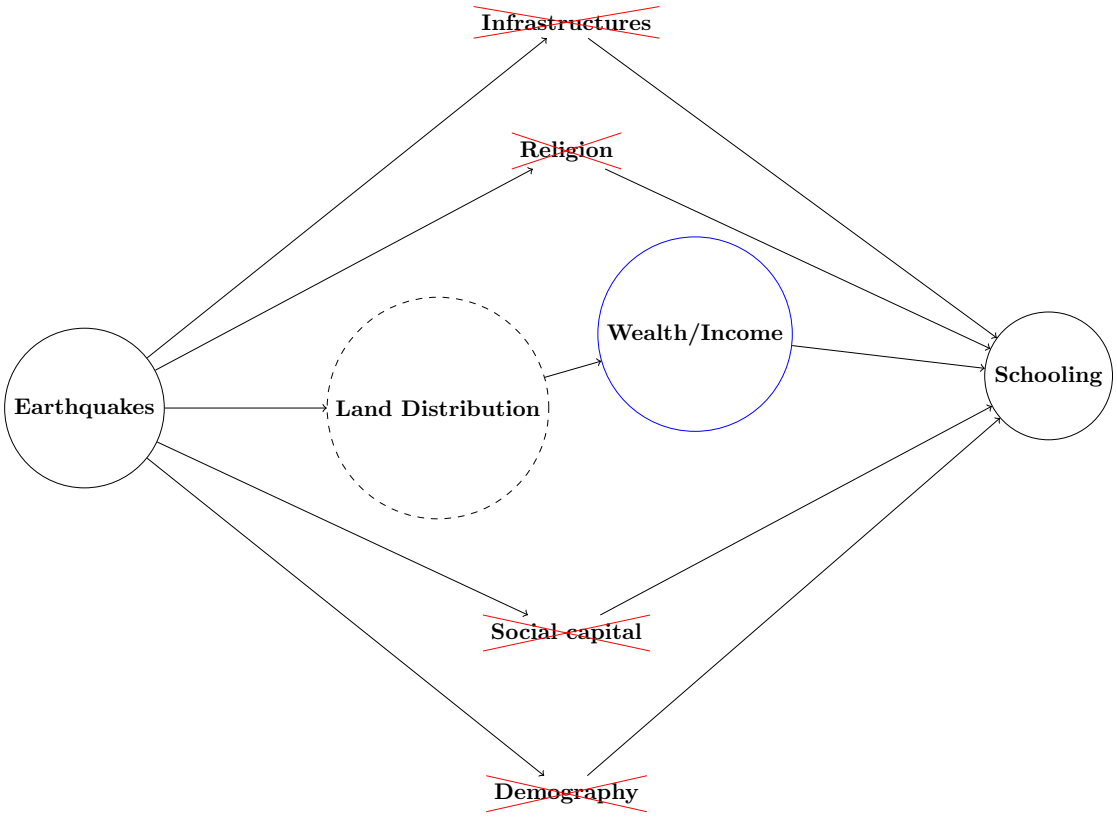

Figure 7: Tests on alternative channels connecting earthquakes and educational choices.

7.1 Demography

Earthquakes might influence the demographic composition of affected areas. In fact, migration may represent a response to earthquakes involving out-migration towards safer territories or inflows of population for the reconstruction, and represents a plausible way through which primary school enrollment may have been affected. In fact, seismic events could have pushed people to leave municipalities that were at greater risk, potentially altering the demographic profiles of seismic-distressed territories and making them distinct from those that were not impacted by the earthquakes. Dustmann and Glitz (2011) propose several channels for migration influencing human capital accumulation, some of them in a positive way, such as less credit constraints due to remittances, others negative, including less parental inputs or cash shortages.[48] These, in turn, may have determined a divide in terms of demand for education, with places where more youths remained (moved) displaying higher (lower) demand for education. Unfortunately, we do not have data on population by age cohort for all the relevant period. However, it is still possible to estimate the impact of earthquakes on population growth between 1798 and 1858 relying on information from the Direzione Centrale di Statistica (1837, 1864). To this aim, in the first-stage of the econometric analysis we regress the changes in population on the earthquake frequency variable, together

[48] McKenzie and Rapoport (2011) find an overall negative effect of migration on schooling attendance and attainment.

with the full set of controls, including the wealth indicator as a (non-instrumented) control variable. The results from this exercise are reported in columns (1)-(3) of Table 6, where it can be observed that the total number of earthquakes and those occurring solely in the 19th century, respectively, have no effect on population growth (the corresponding F-tests have very low values). On the contrary, a positive and significant impact is detected due to seismic events that took place between 1693 and 1798 (column (2)). In any case, the second-stage estimates do not show any evidence of an impact of population growth on primary schooling enrollment, while our household wealth variable consistently enters with a positive and statistically significant coefficient at the 1% and 5% levels (as in our baseline scenario in Table 2), depending on the specification.

Taken together, these findings exclude significant associations between earthquakes and population growth, and do not undermine our main results. Furthermore, considering the potential positive impact on population growth, it can be inferred that the overall population—which represents the denominator of our dependent variable—experienced more rapid expansion in comparison to the enrolled students population (i.e., the numerator of our dependent variable), consistent with the emergence of a post-Malthusian phase of development (Galor, 2011b). Notably, it also implies that if earthquakes indeed prompted more individuals to migrate away from those territories, the wealth coefficient we derived can be viewed as a cautiously conservative lower estimate.

7.2 Infrastructures

Earthquakes can also impact on private and public infrastructures, which in turn can affect the school enrollment. In fact, seismic phenomena can lead to destruction and damaging of buildings, implying the need of subsequent reconstruction. This can result in higher opportunity costs of education, as individuals may be required to divert their time and resources towards rebuilding efforts. Earthquakes can also affect the physical capital of a municipality, thereby impacting on its economic structure and influencing both the demand and supply of education.[49] Following a seismic event, it is reasonable to assume that the subsequent reconstruction efforts had two effects. On one hand, such efforts may have led to newer or more efficient infrastructures in areas that were hit harder by the earthquakes, making access to schools easier. Alternatively, when reconstruction did not occur or was not efficiently

[49] While, in principle, earthquakes may also be responsible for the destruction of schools, it is worth noting that, following the 1817-1818 Ferdinand I's decrees, only 5 seismic episodes occurred across the island. The average moment magnitude of earthquakes was approximately 4.5. This suggests a relatively low probability of earthquakes significantly impacting enrollment in 1858 due to potential damage to school buildings. In fact, as pointed out by Sindoni (2018), primary schools were actually operating in Sicily prior its annexation to the Kingdom of Sardinia. Furthermore, concerns related to self-selecting individuals residing in territories with significant seismic risk, driven by factors such as strong social or cultural ties, affordable housing or job opportunities, can be mitigated as well. Considering the average life expectancy at birth in Italy being approximately 32 years in 1861 (see Felice *et al.*, 2016), it is reasonable to assume that location choices during that era were influenced by factors unrelated to experience or direct memory of devastating earthquakes. If we evaluate the combination of this element with the low literacy rate, it becomes challenging to believe that self-selective location choices could significantly characterize such an environment.

implemented, people living in these areas may have faced increased transportation costs. Moreover, families would have been more hesitant to send their children to school for the possible lack of access to school infrastructure in their municipality. The validity of this potential channel is further supported by the fact that both the proximity to school and the quality of school infrastructures represent relevant determinants of school attendance (Branham, 2004; Fafchamps and Wahba, 2006).

To rule out the effects of this alternative channel on school enrollment, we analyzed data on the municipality distance from the district capital before 1861, gathered from the *Direzione Centrale di Statistica* in the National Historical Archive of Palermo. The falsification test, in this case, is aimed at assessing whether the occurrence of earthquakes is related to the accessibility to the main city in the district, which is likely to be where the larger labor and good markets are located. As shown in column (4) of Table 6, the analysis reveals a negative correlation between the number of earthquakes and the distance from the district capital, suggesting that the historical post-earthquake reconstructions resulted in an overall improvement in the infrastructure quality of that time—for example, in terms of practicability. When employing the same instrumented variable to assess its impact on school enrollment in the second stage equation, the associated coefficient does not exhibit statistical significance. By contrast, our wealth coefficient remains consistent in both magnitude and sign, maintaining its statistically significance level of 1%.

As an alternative approach, we considered the ratio between the distance from the district capital in 1854 and the present-day distance (in 2023), which we obtained from the Italian National Institute of Statistics (ISTAT). This indicator serves as a proxy for infrastructure quality, based on the assumption that the current distance between two locations should ideally be no greater than the past distance. Therefore, the resulting ratio should fall in the range (0, 1). A ratio close to 1 implies that municipalities were better connected in 1854. If the number of earthquakes positively correlates with this measure, it would suggest that seismic events during the 17th-19th centuries led to efficient reconstruction, aligning with the discussion of Section 5. Also in this case, the results (available upon request) are consistent with our benchmark analysis.

7.3 Social Capital

Earthquakes might influence enrollment rates through their effects on social capital. The recurrent incidence of seismic events could potentially shape individual and societal levels of trust, a dynamics that can also be affected by the adoption of welfare-centered policies (e.g., Aldrich, 2011; Mathbor, 2007; Skoufias, 2003). An illustrative case is provided by Goldin and Katz (1999), who identified complementarities between social and human capital. In the aftermath of a natural disaster, therefore, one could expect variations in social capital that may affect decisions on human capital investments. Building upon this premise, Guriev and Melnikov (2016) employed the internet search term “adoption” in conflict

zones as a proxy for social capital. If seismic-distressed areas experience the development of community solidarity, cooperative efforts and/or targeted public interventions focused on supporting vulnerable segments of the population, particularly children, such dynamics could exert an influence on educational outcomes. To explore this possibility, we collected data on the number of foundlings ("*projetti*"), placed under the care of dedicated institutions, between 1836 and 1840, sourced from the *Direzione Centrale di Statistica*. Our estimated coefficients, reported in column (5) of Table 6, allows us to rule out the eventuality of seismic events operating on primary school enrollment through the social capital channel. In the first stage equation, we do not detect a statistically significant correlation between earthquakes and the share of foundlings on the population. Likewise, the coefficient associated with foundlings is not significant in the second stage equation. Conversely, the share of wealthy household variable enters with a positive and statistically significant coefficient, even though there is a notable decrease in the number of observations, and the first stage F-test value turns out to be rather low.

7.4 Religion

While a substantial body of literature has extensively examined the intricate relationship between religion and socio-economic outcomes (e.g., Grier *et al.*, 1997; Barro and McCleary, 2003; McCleary and Barro, 2006; Iyer, 2016), the existing works on the impact of religion on education present a mixed evidence (Berman, 2000; Malik and Mihm, 2022). The impact of natural disasters on societal attitudes toward religion can be observed through their influence on the evolution of the institutional framework, or on the genesis of religious beliefs (Bentzen and Force, 2023). For example, Belloc *et al.* (2016) show that earthquakes in Middle-age Italy contributed to transitions towards formal, municipal-level institutions (i.e., *Comuni*). This should imply a potential negative correlation between religious practice and the incidence of earthquakes, as well as a corresponding negative association between the former and educational outcomes—particularly within Catholic communities (Lenski, 1961). However, this argument does not always hold true. A historical example emerges from the correspondence of viceroy Pacheco, Duke of Uzeda, with the Spanish Crown in the aftermath of the 1693 Val di Noto earthquake (see, for instance, the correspondence dated February 19th, 1693, in Guidoboni *et al.*, 2019), revealing that the reconstruction of churches was at the top of priorities for Spanish ruling institutions. In this scenario, earthquakes might have sustained or strengthened religious attitudes, as long as they implied priority to churches in the reconstruction. This, in turn, may have translated into positive effects on educational attainments over the long term.[50]

To investigate which of the two theoretical implications aligns with the data from mid-19th century Sicily and, consequently, whether an effect of the religious channel on our school enrollment variable

[50] For a review of studies on the positive effects of religion on various adolescent outcomes, including education, see Regnerus (2003).

exists, we gathered information on the number of churches at the municipal level from the Historical Archive of Palermo in 1833 (Direzione Centrale di Statistica, 1859). Subsequently, we constructed two indicators aimed at capturing the extent of religious practitioners per municipality: the number of churches per-capita and per square kilometer. The outcomes of the falsification tests, performed using these two proxies, are reported in columns (6) and (7) of Table 6, respectively. While, on the one hand, earthquakes do not significantly correlate with the number of churches per-capita (in the first stage equation), and the latter with enrollment (in the second stage), on the other hand, we find a positive and statistically significant relationship between seismic phenomena and the number of churches per square kilometer (column (7)). This is consistent with findings in Bentzen and Force (2023), who pointed out that the continued occurrence of earthquake events appears to be correlated with the persistent level of religiosity worldwide. As such, seismic phenomena should be positively correlated with religious practice. Finally, the sign of the second stage coefficient is in line with that of Belloc *et al.* (2016), although it turns out to be not statistically significant. In contrast, the inclusion of this additional proxy for the intensity of religious practitioners has no impact on the sign and magnitude of the share of wealthy households coefficient, which remains statistically significant at the 1% level.

Table 6: Falsification exercises (with province fixed effects).

				First-stage (OLS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st-stage dep. var.:	Population growth in 1798-1858	Population growth in 1798-1858	Population growth in 1798-1858	Distance from the district capital in 1858 (logs)	Share of foundlings in 1836-1840 (%)	No. of churches per-capita (1833)	No. of churches per sq. km (1833)
No. of EQs 1693-1854	0.010			-0.161***			
	(0.017)			(0.038)			
No. of EQs 1693-1798		0.042***			0.020	0.000	0.001***
		(0.013)			(0.038)	(0.000)	(0.000)
No. of EQs in 19th century			-0.003				
			(0.028)				
Province fixed effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓
R-squared	0.175	0.186	0.173	0.491	0.382	0.154	0.540
F-test	0.328	11.30	4.969	18.31	0.266	2.230	30.22
				Second-stage (IV)			
2nd-stage dep. var.:				Share of students enrolled in primary school			
Population growth in 1798-1858	-0.013	0.002	-0.016				
	(0.041)	(0.007)	(0.015)				
Distance from the district capital in 1858 (logs)				0.001			
				(0.002)			
Share of foundlings in 1836-1840 (%)					-0.009		
					(0.023)		
No. of churches per-capita (1833)						-0.711	
						(1.340)	
No. of churches per sq. km (1833)							-0.131
							(0.213)
Share of wealthy households	**0.022****	**0.018*****	**0.018*****	**0.021*****	**0.028***	**0.020*****	**0.019*****
	(0.010)	(0.004)	(0.004)	(0.005)	(0.017)	(0.006)	(0.004)
Province fixed effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓
Observations	279	279	279	294	211	222	222

Notes: The table presents OLS estimates (upper part) for the relationships between earthquakes and other potential channels that could influence education. Columns (1)-(3) report the results concerning the effects of earthquakes on population growth in 1798-1858, as a proxy for migration. Column (4) reports the result concerning the effects of earthquakes on the distance from the district capital in 1858, as a proxy for infrastructure availability. Column (5) reports the result concerning the effects of earthquakes on the number of foundlings per population in 1836-1840, as a proxy for social capital. Columns (6)-(7) report the results concerning the effects of earthquakes on the number of churches per-capita and the number of churches per square kilometer, respectively, as proxies for the religious channel. The lower part of the table shows the results of 2SLS estimates in which the alternative channels potentially influenced by earthquakes, and consequently affecting education, are considered endogenous and instrumented using the number of earthquakes.

8 Medium- and Long-term Impacts of Wealth

In this section, we assess the lasting effects of the wealthy households shares in 1858 on a set of institutional and economic outcomes throughout the rest of 19th-century and up to mid-20th century.

To this end, we run cross-sectional estimates of the following form:

$$y_i = \alpha_{IV} + \beta_{IV} S\hat{W}_i + \gamma_{IV} \mathbf{X}_i + \delta_{IV} D_i + \epsilon_d, \tag{4}$$

where y_i denotes a series of medium- and long-term outcome variables in municipality i. All the specifications are estimated through 2SLS using Eq. (2) as first stage, in which the earthquakes frequency variable over the period 1693-1854 represents the excluded instrument. The two sets of results are discussed in the following subsections. Specifically, Subsection 8.1 considers the impacts of household wealth in 1858 on several institutional indicators, while Subsection 8.2 discusses the effects on a number of economic outcomes.

8.1 Institutional Effects

Did household wealth distribution in 1858 have a long-lasting effect on institutional outcomes, such as voting and political competition, even after the unification of Italy? Thereafter, we present the results of a series of estimates aimed at answering this question. As for voting outcomes, we collected information from the Ministero dell'Agricoltura, Industria e Commercio (1867) to build a number of municipality measures related to both general and local elections held in 1865. Beyond the percentages of voters in relation to the total municipal population, these data allow the construction of additional indicators at various levels of disaggregation. In particular, it is possible to test the effect of initial wealth conditions on the shares of voters by census status (i.e., wealthiest voters), as well as by qualifications and skills. Finally, information on the maximum number of votes obtained by elected candidates enables the creation of a proxy for political competition in the elections held in 1865. As shown in Panel A of Table 7, our estimates reveal that household wealth is positively associated with voter turnout with respect to the total population (columns (1)-(2)).[51] However, this correlation is negative when we consider the wealthiest voters (*per censo*, column (3)). While this may appear counter-intuitive, it needs to be considered together with the significant and positive relationship detected between wealthy households and the share of voters attributed to qualifications and skills (columns (4)-(5)). In this regard,

[51] The electoral laws in force required citizens to satisfy a range of conditions to be allowed to vote, among which: i) being able to read and write; ii) paying direct annual contributions ranging from 5 to 25 Lire (equivalent to roughly 1.15 and 5.8 Ducati, respectively, based on the 1861 exchange rate) for those residing in municipalities with less than 3,000 or more than 60,000 inhabitants, and raised to 40 Lire (about 9.25 Ducati) for national elections. The electoral law for general elections can be accessed through the following link: Legge elettorale del Regno d'Italia - 17 Dicembre 1864, while the electoral law for local elections is available at: Legge 20 marzo 1865, n. 2248 - Per l'unificazione amministrativa del Regno d'Italia.

in fact, the electoral laws stipulated that individuals who were ineligible to vote due to tax contribution reasons could still be recognized as voters if they were members of academies, chambers of agriculture and commerce (subject to the King's approval), professors and teachers, as well as belonging to a professional category (including notaries, accountants, surveyors, and pharmacists). While the wealthy household measure accurately captures the "upper-middle" class segment, it could also potentially account for the representation of these professional groups within the electorate (and consequently explaining the positive effect on the share of voters by qualifications and skills), rather than merely impacting the portion of the population eligible to vote based on census status.

In column (6) of Table 7, we do not detect any effect on the ratio of maximum votes obtained by the elected to total voters, as a proxy for political competition in 1865. Conversely, by using several Hirschman-Herfindahl concentration indexes (HHI), from Corbetta and Piretti (2009) and Acemoglu *et al.* (2020), at the municipal level spanning the years 1909-1963, in Panel B of Table 7 we observe negative correlations with the share of wealthy households (columns (7)-(12)). These findings suggest that the political competition was encouraged by the share of wealthy households, for instance as it might have implied more possibilities for local political parties to campaign (Lipset, 1959; Boix, 2003; Ansell and Samuels, 2014).

8.2 Economic Effects

In what follows, we investigate whether and to what extent the initial household wealth had medium- and long-term effects on educational outcomes, development expenditure, taxation and 1911 industrialization.[52] As for the effects on primary school enrollment, we examine whether the introduction and application of compulsory education has weakened the influence of initial household wealth, relying on data on the share of students enrolled in primary school from the first census on the state of Italian education for the school year 1862-1863 (Ministero della Pubblica Istruzione, 1865). In this regard, column (1) in Panel A of Table 8 reveals that this is not the case, as a significant and positive correlation between wealthy households in 1858 and primary school enrollment is still detected. Moreover, the impact of household wealth seems to produce long-lasting positive effects on a series of literacy rate indicators, retrieved from several censuses (as in Acemoglu *et al.*, 2020), spanning the years 1911-1961 (columns (2)-(5)) and high-school completion rate in 1961 (column (6)). However, the magnitude of coefficients mostly diminishes over time so that, even within a long-lasting legacy, the influence weakens through the development process.

In Panel B of Table 8, we report the outcomes of additional estimates on proxies of public expen-

[52] The underlying logic behind these medium- and long-term economic effects stems from the joint contribution of initial wealth conditions and the experience of an educational take-off. In this regard, an extensive literature focuses on the long-term economic consequences of human capital accumulation, in line with growth theories *à la* Nelson and Phelps (1966). See, among others, Botticini and Eckstein (2007) and Valencia Caicedo (2019).

diture. These are constructed by aggregating data on local administration items of spending (such as infrastructure, education and justice) from the Direzione Generale della Statistica (1887, 1914) for the years 1884 and 1912. Specifically, columns (7)-(8) indicate that household wealth is positively associated with local development expenditure (defined, according to Acemoglu *et al.* 2020, as "[...] *all spending under the discretion of the local administration directed at economic development or improvement of local infrastructure, education, security, and justice*"). In addition, the initial wealth conditions tend to increase the per-capita level of local indirect taxation over population, as well as the ratio of indirect over direct tax collection in 1884 (columns (9)-(10)). These findings suggest that the presence of wealthy households in the municipality fostered the capacity of local governments both in terms of spending for development purposes and tax collections, probably due to the contribution of wealthy households in determining more complex and dynamic economic systems.

Lastly, we collected municipal information on 1911 industrialization from Ministero di Agricoltura, Industria e Commercio (1911) to determine the extent and nature of the impact of household wealth on Sicilian industrialization. In particular, columns (11)-(12) in Panel C of Table 8 document positive effects on the use of motor power both in all industries and on the share of non-agricultural industries. Moreover, wealthy households in 1858 are positively associated with employment-to-population ratios in agricultural and non-agricultural industries.[53] By and large, these outcomes show that the existence of wealthy households in the municipalities may have contributed to the rise of a fresh entrepreneurial class. This might have promoted investments in new technologies within both the agricultural sector and the nascent manufacturing industry. Consequently, there could have been a surge in the demand for (more productive) labor.

Overall, the results presented in this subsection support the testable predictions of Galor (2011a), which suggest that a certain level of inequality in a low-income economy, proxied in our case by an emerging share of wealthy households, leads to higher investments in human capital. These, in turn, prove to be beneficial for the economic development process in the medium- and long-run.

[53] Data on 1911 population at the municipal level are retrieved from the Ministero di Agricoltura, Industria e Commercio (1914).

Table 7: Medium- and long-term effects of wealthy households in 1858 on voting and political competition.

Panel A: 1865 voting	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Vars.:	Share of voters in general elections	Share of voters in local elections	Share of wealthiest voters	Share of voters by qualifications and skills (general elections)	Share of voters by qualifications and skills (local elections)	Ratio of maximum votes obtained by the elected to total voters
Share of wealthy households	0.056***	0.113**	-1.206***	0.635**	0.978***	1.039
	(0.016)	(0.045)	(0.418)	(0.316)	(0.235)	(1.016)
Full set of controls	✓	✓	✓	✓	✓	✓
Observations	289	291	289	289	291	291
Panel B: political competition	(7)	(8)	(9)	(10)	(11)	(12)
Dep. Vars.:	HHI in 1909	HHI in 1946	HHI in 1948	HHI in 1953	HHI in 1958	HHI in 1963
Share of wealthy households	-1.217**	-0.458*	-0.500***	-0.283***	-0.465***	-0.389***
	(0.549)	(0.269)	(0.166)	(0.102)	(0.144)	(0.101)
Full set of controls	✓	✓	✓	✓	✓	✓
Observations	279	294	294	294	294	294

Notes: The table reports 2SLS estimates of the impact of the share of wealthy households in 1858, instrumented by the number of earthquakes occurred in the years 1693-1854, on 1865 voting outcomes (Panel A) and proxies for political competition (Panel B). In columns (1)-(2) the dependent variables are the shares of voters in 1864 general and local elections. In column (3) the dependent variable is the share of wealthiest voters in 1865 elections. In columns (4)-(5) the dependent variables are the shares of voters by qualification and skills in 1865 general and local elections. In column (6) the dependent variable is the ratio of maximum votes obtained by the elected to the total voters in 1865 elections. In columns (7)-(12) the dependent variables are the Hirschman-Herfindahl concentration indexes (HHI) in 1909, 1946, 1948, 1953, 1958 and 1963. All the estimated models include province fixed effects, demographic, agricultural, geographic and economic controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

Table 8: Medium- and long-term effects of wealthy households in 1858
on education, development expenditure, taxation and 1911 industrialization.

Panel A: Schooling	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Vars.:	Enrollment in 1862-63	Literacy in 1911	Literacy in 1921	Literacy in 1931	Literacy in 1961	High School in 1961
Share of wealthy households	0.057**	0.597***	0.673***	0.303**	0.323***	0.282***
	(0.028)	(0.151)	(0.154)	(0.147)	(0.089)	(0.053)
Full set of controls	✓	✓	✓	✓	✓	✓
Observations	293	294	294	294	294	294

Panel B: Development Expenditure and Taxation	(7)	(8)	(9)	(10)
Dep. Vars.:	Development Expenditure in 1884	Development Expenditure in 1912	Per-Capita Indirect Tax in 1884	Ratio of Indirect Over Direct Taxes in 1884
Share of wealthy households	4.918**	19.159***	50.238***	82.006**
	(2.409)	(5.233)	(10.699)	(39.467)
Full set of ontrols	✓	✓	✓	✓
Observations	294	294	294	291

Panel C: Industrialization in 1911	(11)	(12)	(13)	(14)
Dep. Vars.:	Motor Power in All Industries (logs)	Share of Motor Power in Non-Agr. Ind.	Emp-to-Pop Ratio in Agr. Ind.	Emp-to-Pop Ratio in Non-Agr. Ind.
Share of wealthy households	7.340**	1.833***	1.360***	2.052***
	(3.581)	(0.817)	(0.344)	(0.726)
Full set of controls	✓	✓	✓	✓
Observations	216	206	255	255

Notes: The table reports 2SLS estimates of the impact of the share of wealthy households in 1858, instrumented by the number of earthquakes occurred in the years 1693-1854, on education outcomes (Panel A) development expenditure and taxation indicators (Panel B), and proxies for 1911 industrialization (Panel C). In column (1) the dependent variable is the share of primary school enrollment in the years 1862-1863. In columns (2)-(5) the dependent variables are the literacy rates in 1911, 1921, 1931 and 1961.In column (6) the dependent variable is the high school completion rate. In columns (7)-(8) the dependent variables are the per-capita development expenditure of municipalities (in logs) in 1884 and 1912. In column (7)-(8) the dependent variables are, respectively, the level of local per-capita indirect taxation over population in 1884 and the ratio of indirect over direct taxation in 1884. In columns (11)-(12) the dependent variables are the motor power use in all industries (in logs) and the share of motor power use in non-agricultural industries, respectively, for the year 1911. In columns (13)-(14) the dependent variables are the employment-to-population ratios in agricultural and non-agricultural industries, respectively, for the year 1911. All the estimated models include province fixed effects, demographic, agricultural, geographic and economic controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

9 Conclusions

Understanding the relationship between education and household income/wealth is a key empirical question in fields such as labor and development economics. However, with the advent of universal compulsory schooling laws in nearly all countries, such questions are typically limited to marginal increases in the amount of education—particularly in tertiary or post-tertiary education.

To investigate this interplay in a setting freed from compulsory education, we created a historical database encompassing, among others, comprehensive information on primary school enrollment, property and land rent distribution, at the municipal level, from the mid-19th century Sicily. At that time, the island was part of the Bourbon Kingdom, before being annexed to the Kingdom of Sardinia in 1860. Importantly, primary schools were present in almost all municipalities, but attendance was not compulsory. In such an ideal setup, we can effectively mitigate potential downward bias effects in the empirically estimated coefficients related to enrollment rates, characterizing previous studies within the existing literature.

The outcomes of our empirical analysis document a robust, positive correlation between household income/wealth and primary school enrollment. This exhibits its greatest strength at a medium-to-high wealth threshold. Although the magnitude of the effect might not be substantial, it highlights the presence of a trend toward human capital accumulation that positively correlates with wealth in an agrarian society experiencing the early phases of industrialization.

To address endogeneity concerns, we leverage the considerable variation in the frequency of natural disasters across municipalities on the island. Specifically, we rely on the incidence of historical earthquakes that occurred over a span of more than one hundred and fifty years prior to 1858, the reference year for the analysis. Our findings reveal a positive association between past seismic events and the emergence of an "upper-middle" class, in terms of new wealthy households. A series of falsification exercises designed to validate our conclusions demonstrates that the seismic events influence primary school enrollment only through the wealth channel. Importantly, our findings maintain their robustness across various model specifications.

In the last section of our study, we investigate the potential medium- and long-term consequences of the emergence an "upper-middle" class at municipal level. These supplementary results reveal that the early presence of wealthy households have a lasting impact, extending up to a century in their effect on education outcomes—including enrollment and literacy rates. In addition, higher proportions of wealthy households are correlated with various indicators, encompassing heightened levels of institutional engagement such as voting participation and political competition, as well as higher development expenditure and improved tax collection. Finally, the presence of wealthy households in 1858 turns out to be associated with advancements in subsequent Sicilian industrialization, including increased utilization of motor

power within industries, as well as employment growth.

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Appendix

A Data Collection and Construction of the Indicators

One noteworthy aspect of this study pertains to the sources utilized for data mining and variables' construction. Consequently, we initiated a thorough survey and analysis of the archival "funds" housed at the Historical Archive of Palermo, which preserves unpublished data and original documents from the Bourbon era.

Our approach involved systematic steps. In accordance with the Italian legal system outlined in the Legislative Decree n. 42/2004, which establishes the code for cultural heritage and landscape preservation (*Codice dei beni culturali e del paesaggio*), historical documents comprising correspondence or records produced by government and territorial administrative authorities, public officials, judicial, political, and military institutions or bodies, as well as private cases (such as notarial acts), are mandated to be "deposited" (*versati*) into specific archival "funds" thirty years after their creation. These are retained in the State Historical Archives and made accessible to the public for consultation and research purposes. In Palermo alone, there are multiple offices of the State Historical Archives.

The data employed in this study primarily originate from the fund named "Direzione Centrale di Statistica per la Sicilia - 1827-1862" (*Central Directorate of Statistics for Sicily 1827-1862*), which is located in Palermo and preserved in the "Gancia" archive.

The fund comprises approximately 181 envelopes (*buste*, referring to large paper files), primarily containing three types of materials:

- Institutional documents on the establishment and operation of the central Bourbon statistics department exclusively for the Sicilian territory.
- Correspondence related to data collection requests forwarded by the central management to all Sicilian municipalities.
- Summary tables containing aggregated data provided by municipalities, categorized by subject, provinces, and districts.

Furthermore, the aforementioned fund is divided into *series* covering broad topics such as general affairs, budget, staff, population, and *sub-series* focusing on specific areas and subjects (e.g., agriculture, trade, etc.).

Meanwhile, the *Direzione Centrale di Statistica* regularly published the *Giornale di statistica compilato nella direzione centrale della statistica di Sicilia* (Journal of statistics compiled in the Central Statistics Directorate of Sicily). This can be considered as one of the earliest publications in Southern

Italy and Europe to catalog and analyze quantitative and qualitative data. Within the journal, information collected from various municipalities are aggregated by district and province and accompanied by comprehensive comments written by officials and statisticians from the *Direzione Centrale*.

The data collected and analyzed in the Statistical Journals span a period from 1836 to 1864 and are categorized into two series. The first series comprises 8 volumes, encompassing data from 1836 to 1857, while the second series consists of 2 volumes, covering the years 1858 to 1864. Each volume is further divided into individual files. The first series contains a total of 24 files, while the second series consists of 5 files. Generally, each file focuses on no more than 3 topics (e.g., population variation, cereal production data, cadastral registries).

A.1 List of Variables and Data Sources

Each "historical" indicator employed in this paper relies on information specific to individual municipalities, as available within the archive files. Our data collection covered approximately 348 municipalities (as of 1858), distributed across 7 provinces and 24 districts (i.e., counties) in Sicily. The following data or variables mainly originate from the "Direzione Centrale di Statistica per la Sicilia" fund, preserved at Historical Archive of Palermo, "Gancia" office, with the exception of number 8.

1. *Male students enrolled in private primary schools and female students enrolled in schools for girls*: "Sottoserie II/7: Istruzione pubblica (1832-1860)", envelopes numbered 126 to 134, titled "Intendenza di: Palermo, Messina, Catania, Girgenti, Siracusa, Trapani e Caltanissetta".

2. *Share of wealthy households*: "Sottoserie II/15: Catasto fondiario (1856-1858)", envelopes numbered 164 to 170, titled "Quadri Statistici [...], 1857 - 1858".

3. *Population in 1858*: Data for this variable is obtained from the "Giornale di Statistica Compilato dalla Direzione Centrale della Statistica di Sicilia, Serie 2, fascicolo n. 5 fascicolo segregato ed ultimo, 1864", pages 55–63.

4. *Distance from Palermo and Distance from the district capital*: "Sottoserie II/10: Topografia (1834-1860)", Gancia office, envelope number 15, titled "Distanze intercomunali (1836-1859)".

5. *Wheat yield in 1854*: "Sottoserie II/3: Agricoltura (1831-1860)", envelopes numbered 93 to 96 and 103 to 108, titled "Intendenza di - Palermo, Messina, Catania, Girgenti, Siracusa, Trapani e Caltanissetta - Cereali e altri prodotti agricoli (1833-1859)".

6. *Foundlings in 1836-1840*: "Sottoserie II/8: Beneficenza pubblica (1833-1860)", envelopes numbered 140 to 149, titled "Projezione." Intendenza di: Palermo, Messina, Catania, Girgenti, Siracusa, Trapani e Caltanissetta (1835-1858)".

7. *Sicilian-based firms in 1855*: "Sottoserie II/14: Manifatture e industrie (1854-1857)", envelope number 163, titled "Sicilia e intendenza di Palermo (1854-1857)".

8. *Land assignments in Sicily during 1687-1697*: Data obtained from the Historical Archive of Palermo, "Protonotaro del Regno di Sicilia Repertorio dei processi di investiture feudali dal 1452 al 1812 n. 122" fond (edited by S. Fazio, 2020), pages 361 to 381.

9. *Number of churches by municipality*: Gancia office, "Sottoserie II/5: Statistica ecclesiastica (1832-1852)", envelops numbered 111 to 118.

    - 111. Intendenza di Palermo. Diocesi di Palermo, Monreale e Cefalù (1832-1838);
    - 112. Intendenza di Palermo. Diocesi di Palermo, Monreale e Cefalù (1832-1838);
    - 113. Intendenza di Messina. Diocesi di Messina, Lipari e Patti, Archimandritato, Abbazia di Santa Lucia (1832-1838);
    - 114. Intendenza di Catania. Diocesi di Catania, Caltagirone e Nicosia (1832-1838);
    - 115. Intendenza di Girgenti. Diocesi di Girgenti (1832-1838);
    - 116. Intendenza di Siracusa. Diocesi di Siracusa (1832-1833);
    - 117. Intendenza di Trapani. Diocesi di Mazzara (1832-1838);
    - 118. Intendenza di Caltanissetta. Diocesi di Piazza (1832-1833).

10. *Monti frumentari* (Grain Centres): Gancia office, "Sottoserie II/8: Beneficenza pubblica (1833-1860)", envelops numbered. 137, 144 to 149.

    - 137. Intendenza di Palermo - Monti di prestito e monti frumentari (1833-1856);
    - 144. Intendenza di Messina (1833-1858);
    - 145. Intendenza di Catania (1833-1860);
    - 146. Intendenza di Girgenti (1833-1858);
    - 147. Intendenza di Siracusa (1833-1858);
    - 148. Intendenza di Trapani (1833-1858);
    - 149. Intendenza di Caltanissetta (1833-1856).

A.2 Data on Wheat Harvests in 1854

The Journal of Statistics, as discussed in the previous subsection, provides information on the wheat harvest for 198 Sicilian municipalities in 1854. In order to construct the two indicators related to the per-capita wheat production (tons/population) and per-capita wheat value added (Ducati/population), as shown in Table 3 of the main text, we proceeded according to the following steps. Firstly, since the

harvest was originally measured in "salme" (the unit of weight measurement in effect during the Bourbon Kingdom), we converted it to tons (with 1 "salma" equivalent to 0.224 tons). Secondly, to calculate the per-capita value added of the harvest, we utilized the average price of wheat, which in 1854 averaged around 32 Lire per quintal in the Milan market (approximately 8.9 Ducati according to the exchange rate of 1861), retrieved from Corriere della Sera (1909).

B Historical archive figures

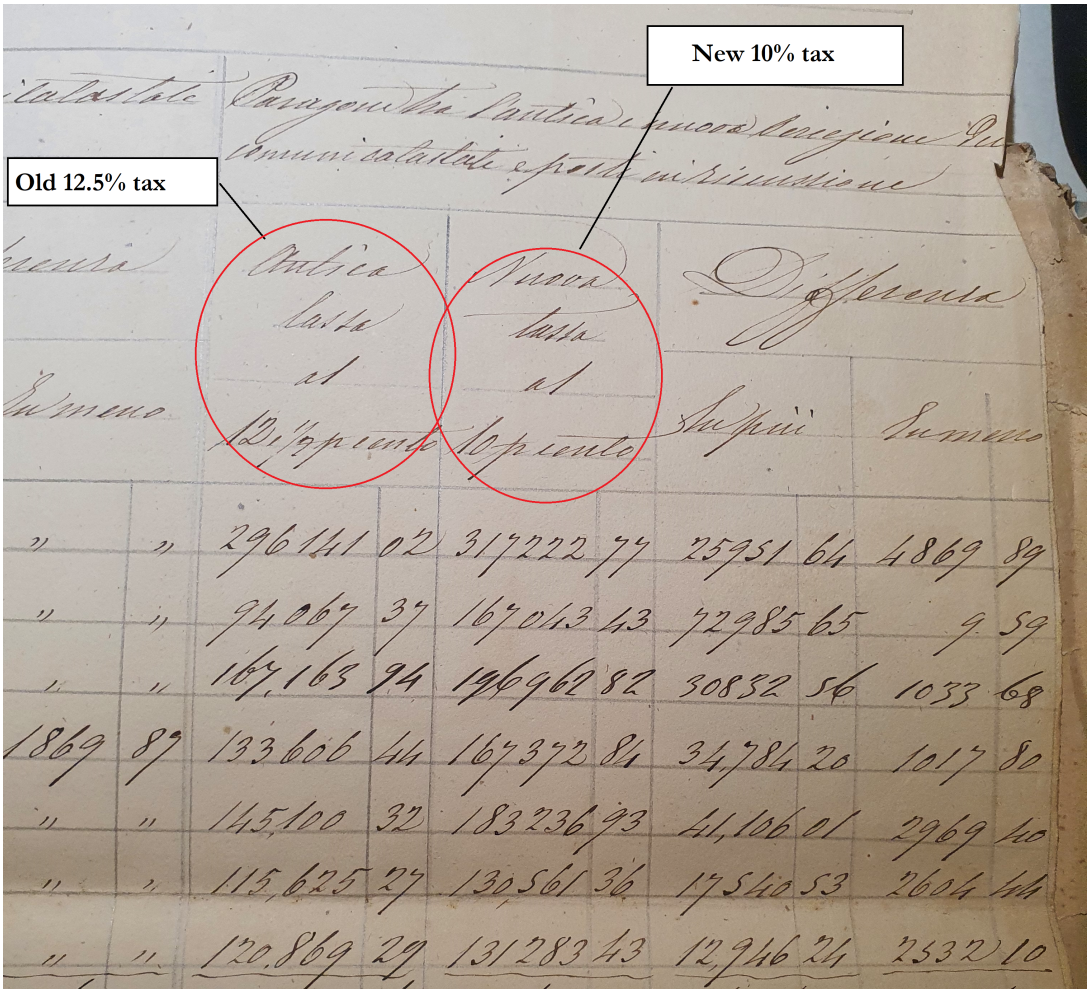

Figure B1: Extract of the table on land rent tax.
Source: Historical Archive of Palermo.

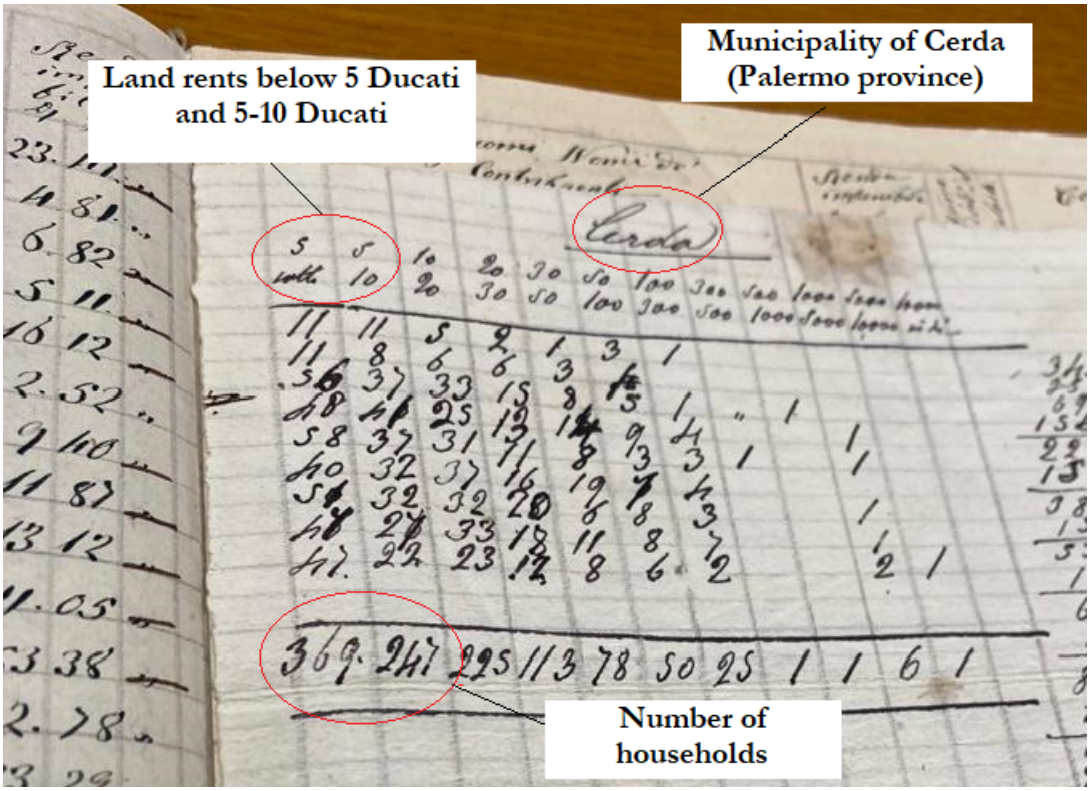

Figure B2: Table of land rents for the municipality of Cerda (Palermo province).
Source: Historical Archive of Palermo.

C Additional descriptive statistics, results and robustness

C.1 Tables and Graphs

Table C1: Additional variables descriptive statistics (Part 1).

	Obs	Mean	SD	Min	Max
Share of population with rent >20 Ducati	294	0.134	0.099	0.003	1
Share of population with rent >50 Ducati	294	0.058	0.074	0.003	1
Share of population with 1 <= rent <20 Ducati	294	0.754	9.127	0	0.997
Share of population with 20 <= rent <30 Ducati	294	0.146	0.06	0	0.383
Share of population with 30 <= rent <50 Ducati	294	0.027	0.022	0	0.166
Share of population with 50 <= rent <100 Ducati	294	0.034	0.021	0	0.136
Share of population with 100 <= rent <300 Ducati	294	0.02	0.034	0	0.5
No. of Earthquakes in 1693-1798	294	1.347	0.921	1	10
No. of Earthquakes in 19th century	294	1.248	0.673	1	6
Earthquakes Cumulative Intensity	294	13.085	8.767	0	79
Distance from district capital	294	33.459	22.272	0	111
Growth rate of population 1798-1858	279	.296	0.304	-0.569	1.593
High school rate 1961	294	0.03	0.015	0.01	0.098
Primary school enrollment in 1862-63	293	0.016	0.011	0	0.069
Literacy rate 1911	294	0.364	0.1	0.108	0.729
Literacy rate 1921	294	0.473	0.092	0.226	0.804
Literacy rate 1931	294	0.586	0.082	0.369	0.789
Literacy rate 1961	294	0.825	0.043	0.685	0.928
Development Expenditure 1884	294	0.821	0.864	-2.152	3.278
Development Expenditure 1912	294	-1.607	2.509	-10.034	5.226
Motor power in all industries in 1911 (logs)	216	4.066	1.481	0	9.257
Share of motor power in non-agricultural industries (1911)	206	0.150	0.258	0	0.998
Employment-to-population ratio in agricultural industries (1911)	255	0.0436	0.113	0.001	1.224
Employment-to-population ratio in non-agricultural industries (1911)	255	0.064	0.196	0	1.458

Notes: The descriptive statistics include the number of observations (Obs), the average (Mean), the standard deviations (SD), the minimum (Min) and the maximum value (Max) for the entire sample of municipalities. See text for variables definitions and sources.

Table C2: Additional variables descriptive statistics (Part 2).

	Obs	Mean	SD	Min	Max
Share of voters in general elections (1865)	289	0.012	0.006	0.001	0.0382
Share of voters in local elections (1865)	291	0.023	0.011	0.008	0.104
Share of wealthiest voters (1865)	289	0.599	0.207	0	1
Share of voters by qualifications and skills (1865 general elections)	289	0.278	0.179	0	1
Share of voters by qualifications and skills (1865 local elections)	291	0.154	0.120	0	0.674
Ratio of max votes obtained by the elected (1865 local elections)	291	0.754	0.380	0	5.269
HHI 1909	279	0.780	0.220	0.335	1
HHI 1946	294	0.405	0.148	0.164	1.183
HHI 1948	294	0.459	0.139	0.195	1.286
HHI 1953	294	0.295	0.086	0.169	0.880
HHI 1958	294	0.335	0.080	0.173	0.678
HHI 1963	294	0.31	0.072	0.168	0.592
Per-capita indirect tax 1885	294	2.057	4.118	0	50.469
Indirect/Direct taxes 1885	291	2.539	7.089	0	62.507
Share of foundlings (1836-1840) (%)	211	0.6	0.4	0	2.1
No. of churches per-capita (1833)	222	0.003	0.003	0.000	0.036
No. of churches per sq. km (1833)	222	0.004	0.006	0.000	0.040

Notes: The descriptive statistics include the number of observations (Obs), the average (Mean), the standard deviations (SD), the minimum (Min) and the maximum value (Max) for the entire sample of municipalities. See text for variables definitions and sources.

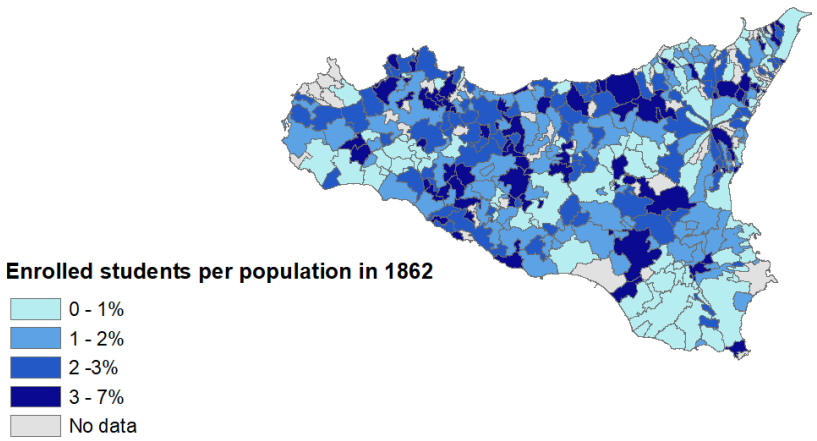

Figure C1: Students enrolled in primary schools in 1862-63, by municipality (% of population). Source: National census on the state of education for the school year 1862-63.

Table C3: Shares of land devoted to grain cultivation,
per-capita wheat yield and value added (average values by district) in 1854.

	Share of land cultivated with grains	Per-capita wheat yield (tons/population)	Per-capita wheat VA (Ducati/population)
Acireale (Catania)	0.264	0.035	0.31
Alcamo (Girgenti)	0.674	0.258	2.286
Bivona (Girgenti)	0.699	0.29	2.568
Caltagirone (Catania)	0.663	0.293	2.599
Caltanissetta	0.724	0.28	2.48
Castroreale (Messina)	0.358	0.126	1.119
Catania	0.335	0.145	1.282
Cefalù (Palermo)	0.497	0.289	2.562
Corleone (Palermo)	0.67	0.431	3.825
Girgenti	0.749	0.21	1.862
Mazzara (Trapani)	0.571	0.463	4.103
Messina	0.192	0.016	0.141
Mistretta (Messina)	0.336	0.088	.779
Modica (Noto)	0.651	0.272	2.413
Nicosia (Catania)	0.641	1.129	10.018
Noto	0.607	0.179	1.591
Palermo	0.399	0.102	.904
Patti (Messina)	0.364	0.163	1.448
Piazza (Caltanissetta)	0.705	0.244	2.165
Sciacca (Girgenti)	0.626	0.59	5.229
Siracusa (Noto)	0.662	0.246	2.182
Termini (Palermo)	0.622	0.453	4.018
Terranova (Caltanissetta)	0.609	0.452	4.006
Trapani	0.485	0.27	2.392
Overall mean	0.503	0.315	2.794

Source: Author's calculations based on Direzione Centrale di Statistica (1864), Mortillaro (1854) and Corriere della Sera (1909).
Notes: Provinces in parentheses.

C.2 Robustness Checks, Rent Classes and Falsification Exercises

Table C4: Sensitivity analysis: Different Wealth Thresholds.

Dependent Variable: Share of students enrolled in primary school								
	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of wealthy households (rent >20 Ducati)	0.019***	0.019***			0.057***	0.054**		
	(0.005)	(0.005)			(0.021)	(0.022)		
Share of wealthy households (rent >50 Ducati)			0.021***	0.021***			0.084**	0.078**
			(0.007)	(0.007)			(0.033)	(0.033)
District fixed effects	✓		✓		✓		✓	
Province fixed effects		✓		✓		✓		✓
Full set of controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	294	294	294	294	294	294	294	294
R^2	0.298	0.275	0.291	0.269				
F-test					13.11	11.98	9.457	9.083

Notes: The table report OLS (columns (1)-(4)) and 2SLS (columns (5)-(8)) estimates of the impact of different constructed shares of wealthy households on primary school enrollment in 1858. In columns (1)-(2) and (5)-(6) the share of wealthy households considers rent above 20 Ducati and district/province fixed effects, respectively. In columns (3)-(4) and (7)-(8) the share of healthy household considers rent above 50 Ducati and district/province fixed effects, respectively. The 2SLS regressions make use of the number of earthquakes occurred in the years 1693-1854 as an IV for the share of wealthy households measures. All the estimated models include demographic, agricultural, geographic and economic controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

Table C5: 2SLS regression results: Effects of different rent classes on primary school enrollment.

Dependent Variable: Share of students enrolled in primary school					
	(1)	(2)	(3)	(4)	(5)
Share of households with 1 <= rent <20 Ducati	-0.056***				
	(0.021)				
Share of households with 20 <= rent <30 Ducati		0.265**			
		(0.131)			
Share of households with 30 <= rent <50 Ducati			0.319**		
			(0.129)		
Share of households with 50 <= rent <100 Ducati				0.253***	
				(0.096)	
Share of households with 100 <= rent <300 Ducati					0.207**
					(0.083)
Full set of controls	✓	✓	✓	✓	✓
Observations	294	294	294	294	294

Notes: The table reports 2SLS estimates of the impact of clustered household wealth and primary school enrollment (see Figure 6 in the main text). The 2SLS regressions make use of the number of earthquakes occurred over the years 1693-1854 as an IV for the share of wealthy households. All the estimated models include district fixed effects, demographic, agricultural, geographic and economic controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at the district level and reported in parentheses below each coefficient.

Table C6: Falsification exercises (with district fixed effects).

				First-stage (OLS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st-stage dep. var.:	Population growth in 1798-1858	Population growth in 1798-1858	Population growth in 1798-1858	Distance from the district capital in 1858 (logs)	Share of foundlings in 1836-1840 (%)	No. of churches per-capita (1833)	No. of churches per sq. km (1833)
No. of EQs 1693-1854	0.011			-0.129***			
	(0.019)			(0.033)			
No. of EQs 1693-1798		0.033*			0.053	0.000	0.001***
		(0.017)			(0.043)	(0.000)	(0.000)
No. of EQs in 19th century			0.006				
			(0.035)				
District fixed effects	✓	✓	✓	✓	✓	✓	✓
Full set of ontrols	✓	✓	✓	✓	✓	✓	✓
R-squared	0.216	0.221	0.215	0.689	0.459	0.238	0.592
F-test	0.323	3.796	3.966	15.27	1.542	2.154	38.69
				Second-stage (IV)			
2nd-stage dep. var.:	Share of students enrolled in primary school						
Population growth in 1798-1858	-0.015	0.010	-0.018				
	(0.045)	(0.011)	(0.017)				
Distance from the district capital in 1858 (logs)				0.002			
				(0.002)			
Share of foundlings in 1836-1840 (%)					-0.006		
					(0.008)		
No. of churches per-capita (1833)						0.079	
						(1.326)	
No. of churches per sq. km (1833)							0.015
							(0.256)
Share of wealthy households	**0.022****	**0.017*****	**0.017*****	**0.021*****	**0.033***	**0.019*****	**0.019*****
	(0.009)	(0.005)	(0.003)	(0.006)	(0.019)	(0.004)	(0.004)
District fixed effects	✓	✓	✓	✓	✓	✓	✓
Full set of controls	✓	✓	✓	✓	✓	✓	✓
Observations	279	279	279	294	211	222	222

Notes: The table presents OLS estimates (upper part) for the relationships between earthquakes and other potential channels that could influence education. Columns (1)-(3) report the results concerning the effects of earthquakes on population growth in 1798-1858, as a proxy for migration. Column (4) reports the result concerning the effects of earthquakes on the distance from the district capital in 1858, as a proxy for infrastructure availability. Column (5) reports the result concerning the effects of earthquakes on the number of foundlings per population in 1836-1840, as a proxy for social capital. Columns (6)-(7) report the results concerning the effects of earthquakes on the number of churches per-capita and the number of churches per square kilometer, respectively, as proxies for the religious channel. The lower part of the table shows the results of 2SLS estimates in which the alternative channels potentially influenced by earthquakes, and consequently affecting education, are considered endogenous and instrumented using the number of earthquakes.

D Miscellanea

Table D1: Ecclesiastic property rents by typology in Scaglione (2016).

Tipology	Numbers	Rent	Avg. Rent.
terranei	493	2288.75	4.64
bassi	383	2954.04	7.71
botteghe	189	4961.07	26.25
quartini terranei o superiori, piani superiori	164	7313.12	44.59
camere	109	903.66	8.29
chiesa	99	0	0.00
magazzino	52	1147.94	22.08
chiostro, cortile, parlatorio, sotterraneo, cucina, dormitorio	51	599.6	11.76
terreni coltivati	48	423.45	8.82
cantina, riposto	22	412.12	18.73
stalla, cavallerizza, rimessa, pagliera	13	145.25	11.17
mulino	8	1951.18	243.90
casa	5	22.91	4.58
casaleno	5	0	0
tettoja	4	17.93	4.48
sciara	3	0.19	0.06

Source: Fondo Cessato Catasto Terreni, summary schedules of the land contribution of the city of Catania in 1843.