Birth and Migration of Scientists: Does Religiosity Matter? Evidence from 19th-Century France *

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Abstract

Can religiosity affect the emergence and migration patterns of scientists? We focus on 19th-century France, a period in which the Catholic Church had embraced a particularly antiscientific attitude, and we exploit variation in intensity of Catholicism. Using data on the places of birth and death of famous individuals from 1790 to 1880, we show that more religious cantons were less likely to give birth to scientists, but religiosity did not play a role for their migration choices. We shed light on the mechanism and suggest that accumulation of scientific human capital earlier in life was key: religious vs. secular secondary education can partly explain the negative relationship between religiosity and the "birth" of scientists. Finally, placebo regressions show that religiosity is not associated with the birth and migration patterns of famous individuals in nonscientific professions—nor is it associated with the emergence of scientific human capital in the pre-1790 period.

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1 Introduction

Clashes between science and religion have been common throughout history and still are today in many countries around the globe (Bénabou, Ticchi, and Vindigni, 2020). Focusing on different religious affiliations and historical periods, a large literature in economics has studied whether religion can hamper the diffusion of new ideas and scientific progress (Mokyr, 2011; Chaney, 2015; Bénabou, Ticchi, and Vindigni, 2015; Bénabou et al., 2020). For instance, Mokyr (2011) argues that the lack of Jewish inventors before 1850 can be attributed to the approach of traditional Judaism, hostile to scientific innovations. In a general theoretical framework, Bénabou et al. (2020) study the interplay between religious doctrines and scientific progress; the stock of religious human capital can be reduced by belief-eroding innovations, and whether these innovations will be blocked depends on political conflicts and coalition formation along religious and income dimensions. The authors also provide cross-sectional evidence of a negative relationship between religiosity and innovation (measured as patents per capita) across countries and within the United States. However, there is hardly any micro-level evidence on how religiosity can hamper scientific progress, and whether it hinders the local emergence of scientists or discourages their inflow from elsewhere.

This paper focuses on France during the 19th century, a period of strong confrontation between science and Catholicism. The Church (after the events of the 1789 French Revolution) had embraced a particularly conservative attitude and opposed the spreading of technological and scientific knowledge. Throughout the century, religion and science found themselves lined up on opposite sides of the battlefield (Minois, 1991). Though 98% of the population was Catholic, there was large variation in religiosity (i.e., intensity of Catholicism) that we exploit in our empirical analysis. As in Squicciarini (2020), our main indicator of religiosity is the share of refractory clergy. This represents the share of clergy who confirmed their loyalty to the Catholic Church, by not swearing the oath of allegiance to the Civil Constitution (and the secular government). Since the religious views of the local community largely determined clergymen's decision about the oath, the share of refractory clergy has been considered a good indicator of religiosity at the local level (Tackett, 1986; Blanc, 2019; Squicciarini, 2020).

We measure scientific knowledge as the density of famous scientists in the 1790-1880 period (de la Croix and Licandro, 2015). As argued in Serafinelli and Tabellini (2020), the presence of famous individuals in scientific activities is more likely to capture the occurrence of innovation and scientific production compared to more general measures of human capital. Thus, we use information on the dates and places of their birth and death to study the relationship between religiosity and accumulation of scientific human capital across almost 3,000 French cantons (metropolitan areas).

First, we focus on the local emergence of scientific knowledge; we find that more religious cantons were less likely to be the birthplaces of famous scientists. In particular, over the entire 1790-1880 period, a one standard deviation increase in religiosity lowers the number of scientists born in a canton by approximately 20% (with an average of 200 scientists per 10,000 inhabitants). As the external environment has a higher impact on human-capital accumulation when individuals are young (Serafinelli and Tabellini, 2020), religiosity in the location of birth should be particularly informative for the emergence of scientists at the local level.

Next, given the extremely high mobility of famous individuals—68% of our scientists migrated from their birthplace—we analyze whether religiosity also determined the attractiveness of a location for scientific elites. Interestingly, we find no significant relationship between a canton's religiosity and the density of scientist immigrants.[1] Thus, our results so far suggest that religiosity "partly" affected scientific production: it played a negative role on the accumulation of scientific human capital by hindering the local emergence of scientific talents. However, once scientists undertook this career path, their migration choices were not affected by the religiosity of the hosting canton.[2]

Finally, we shed light on the mechanism behind the negative relationship between religiosity and the emergence of scientists, and we suggest that early accumulation of scientific human capital played an important role. In particular, we focus on secondary education—which was addressed to a minority of students who could afford studying upon completion of primary education—and distinguish between Catholic and secular schools.[3] Despite the high-quality education offered in many Catholic secondary schools, the scientific training in these schools was weaker than in their public counterparts—and it often represented the main difference between the two schooling curricula (Harrigan, 1973). We show that religiosity is positively associated with the share of Catholic secondary schools and that the type of secondary education partly explains the negative relationship between the share of refractory clergy and the density of scientists.[4] This finding provides further support for our main results: it suggests that the external environment in the place of birth—which includes its religiosity—is particularly important to undertake a career in sciences and that the path of becoming famous scientists is clearly shaped earlier in life.

When interpreting these findings, one key concern is whether other factors related to religiosity

[1] If famous individuals lived in different locations throughout their lifetime, using data on the city of death does not allow us to study all their migration choices. However, it does capture their mobility late in life.

[2] Other factors seem to determine migration patterns of scientists, such as the presence of a university or a *grande école*, the location of the city on the Mediterranean Sea or on the Atlantic Ocean, as well as its closeness to Paris.

[3] Religiosity is also associated with the share of primary Catholic schools in the late 19th century (Squicciarini, 2020). However, we don't focus on primary education for two main reasons: First, this was addressed to the entire population of students—and the large majority of them would stop studying and enter the labor market after completing primary school. Second, the differences between Catholic and secular primary schools became evident in the late 1860s, especially with the 1882 Jules Ferry laws (i.e., at the end of our period of analysis).

[4] The Sobel-Godman mediation test shows that 34% of the negative relationship between religiosity and scientists is mediated *via* the type of secondary education.

are also affecting the presence of famous scientists, thus confounding our results. To deal with this issue, we implement several strategies. First, throughout the analysis, we control for a series of potentially confounding characteristics, such as differences in geographic and institutional factors across cantons. Then, we show that our results are robust to the inclusion of a full set of region and time fixed effects, and when restricting the analysis to alternative subsamples. In addition, if religiosity was correlated with other canton-level characteristics that affected the accumulation of upper-tail knowledge, we would expect more-religious locations to have fewer famous individuals in all fields, not only fewer famous scientists. As a placebo, we construct the density of famous people in fields other than sciences (such as humanities, law, business, and education), and we show that this is not systematically associated with the intensity of Catholicism—suggesting that religiosity did not hamper the accumulation of upper-tail human capital in nonscientific fields. Thus, remaining factors that could confound our results should be correlated with religiosity and affect the emergence of scientists, but not the birth of other famous individuals. If such factors existed, they would also likely hamper scientific progress (via channels other than religiosity) *before* the clash between Catholicism and science had emerged. We address this concern by using data on the number of scientists in the 1700-1780 period, and we show, in line with a rich historical record, that religiosity is not associated with our proxy of scientific knowledge pre-1790. Interestingly, this pattern suggests that more-religious locations experienced lower scientific production only when the confrontation between the Church and science flared, as when Catholicism bagan to strongly oppose scientific progress. As argued in Squicciarini (2020), religiosity determines the importance given to religious values and the resistance to new ideas, if these clash with religious norms. Our findings support this argument and suggest that the relationship between religiosity and scientific progress is not inherently negative. Rather, it can vary over time, and when religious norms become particularly unfavorable toward the sciences, higher religiosity can act as a barrier against the spread of scientific knowledge.

This paper contributes to the literature on the relationship between religion and science (Minois, 1991; Deming, 2010; Mokyr, 2011; Chaney, 2015; Bénabou et al., 2020). While most of these studies take a theoretical or historical approach, we provide micro-level evidence on this relationship, and we further investigate whether religiosity affects the emergence of scientists or their immigration choices.

By focusing on religion's role in hampering scientific progress, this paper also belongs to a growing literature analyzing when conservative religious values hinder human-capital accumulation, and, more broadly, modernity (Berman, 2000; Carvalho, 2013; Carvalho and Koyama, 2016; Carvalho, Koyama, and Sacks, 2017; Rubin, 2017; Iyigun, Rubin, and Seror, 2018). Our paper is related mostly to Squicciarini (2020). Focusing on France during the period of the Second Industrial Revolution (1870-1914), she shows that the conservative approach of Catholicism was largely expressed in the resistance to the adoption of a technical curriculum in primary schools, and in a push for religious education—key for the Church to try to control the mindset of future generations (Kuru, 2009). She thus suggests that religiosity, through its effects on primary schooling, helped hinder the spread of new ideas, for the accumulation of "economically useful" human capital, and for industrial and economic development. This paper extends these findings in three main respects. First, we focus on upper-tail knowledge, specifically on scientific knowledge[5]; while Catholicism exerted a strong influence on several aspects of people's lives (Minois, 1991; Squicciarini, 2020), it is not obvious whether scientists also responded to this conservative attitude. Second, given the particularly high mobility of our famous scientists, we investigate whether a lower religiosity, besides affecting local scientific production, also made some locations more attractive for scientists. Third, we extend the period to earlier decades, covering also the first half of the 19th century.[6]

We also contribute to a large literature—starting with the pioneering work of Max Weber (1905)—that analyzes the role of religion for economic development. In particular, we contribute to those studies examining the relationship between religion and accumulation of human capital; major examples are Becker and Woessmann (2009) and Botticini and Eckstein (2012).[7]

Finally, this paper relates to those works analyzing the importance of upper-tail knowledge (Mokyr, 2002, 2005; Squicciarini and Voigtländer, 2015; Serafinelli and Tabellini, 2020; de la Croix, Docquier, Fabre, and Stelter, 2020). We study a specific subset of upper-tail human capital, famous scientists, and we point to religiosity as a key factor explaining their spatial distribution.

The rest of the article is organized as follows: Section 2 illustrates the historical background. The data are described in Section 3. Section 4 presents the empirical results. Section 5 concludes.

2 Historical Background: Church and Science in 19th-Century France

During the 18th century, Catholicism and science had a complex, but generally positive relationship. Scientific progress was considered in line with God's plans and favorably welcomed in many Catholic milieus. In the decades of the Enlightenment, several clergymen were at the forefront in the promotion of sciences[8]; examples are the Abbé Jean-Antoine Nollet, who conducted experiments with electricity

[5] We adopt a precise definition of upper-tail knowledge and—following the categories of de la Croix and Licandro (2015)—we focus exclusively on "sciences." Other types of upper-tail knowledge (not strictly related to sciences) are used as a placebo, since they did not represent a direct target of the conservative agenda of the Church.

[6] In the first half of the 19th century, the Church largely reestablished its hegemony in primary education; it was not trying to hamper the spreading of technical and scientific knowledge in primary schools—as was the case during the Third Republic (from 1870 onward). On the other hand, Catholicism had already adopted an antagonist approach toward the sciences.

[7] For an overview of the literature on the economics of religion, see Iannaccone (1998) and Iyer (2016).

[8] Even before the Enlightenment, there are exemplary cases of clergymen devoted to science, such as the Minim order monk Marin Mersenne (1588-1648), an important mathematician who made influential contributions in acoustics, and the ordained priest Pierre Gassendi (1592-1655), a mathematician and astronomer who was the first to document Mercury's transit before the sun, as well as several members of the Society of Jesus.

and became a professor of experimental physics, as well as Popes Benedict XIV (1740-1758) and Clement XIV (1769-1774), both known as "friends of science" (Minois, 1991).[9]

The French Revolution (1789) changed these dynamics. The revolutionary government put scientific progress at the top of its agenda, emphasizing its importance especially for secondary education (Williams, 1953).[10] At the same time, though, the Civil Constitution of the Clergy and, even more, the introduction of the "Cult of Reason" were clear attempts to dismantle the role of the Church in French society. In these years, Church lands were expropriated, religious ceremonies banned, and about 3,000 priests were guillotined (Kuru, 2009). Under the flag of the Enlightenment, the Cult of Reason was promoted as an atheistic religion and, in 1795, the first secular French state was declared (Kuru, 2009). With the advent of Napoleon, the emphasis on technological and scientific progress was renewed, the modernization of secondary education was further stimulated, and science became a symbol of the Revolution and the Empire (Minois, 1991). The reaction of the Church was immediate: already in 1791, Pope Pius VI publicly criticized the revolutionary principles, defining freedom of thinking and writing a "monstrous right," and equality a "nonsense" (Minois, 1991). This tension continued throughout the Napoleonic years, and it worsened with the French invasion of Italy (carried out in the name of reason). Thus, by the early 19th century, a unhealable rupture had occurred; the Church and science were now lined up on opposite sides of the battlefield for reasons beyond their intrinsic nature.

The Bourbon Restoration (1815-1830) represented an important opportunity for the Church "to rebuild the moral fibre of the lower classes, leaving behind them the accident [of the Revolution] ... and to restore the principles of stability and subordination, which had been the mark of Catholic and monarchic France" (Furet and Ozouf, 1977, p. 121). At the central level, the Church in Rome promoted an extremely antimodern and antiscientific program covering several aspects of people's lives: all French laws were abolished, the use of electricity and vaccinations prohibited, 700 new cases of heresy were introduced, and imprisonment and executions of liberals increased sharply. This conservative program reached all Catholic countries, including France.[11] In this context, the proscience approach of

[9]Benedict XIV was interested in medicine and studied hysteria and epilepsy. He strongly promoted scientific research at the University of Rome, and he was so popular in the intellectual community all over Europe that Voltaire even wrote the *Mahomet* as an homage to his openness to science. A similar attitude was embraced by Clement XIV, who in one of his letters, regretted not to have had enough time to study physics.

[10]Mechanical arts became central in the secondary school curriculum, and mathematics and physics were considered key to fostering innovative activities. The emphasis on scientific subjects was reflected in the requirement for each school to have "a public library, a natural history cabinet, a cabinet of physics, and a collection of machines or models for arts et métiers" (Jacob, 2014).

[11]While substantial progress was made in medicine, local clergymen strongly opposed medical advices and interventions: for instance, they considered the catastrophic cholera epidemic in 1832 as God's punishment for the 1830 revolution, and they organized religious processions as a remedy; they strongly contrasted with the efforts of public authorities who were trying to introduce vaccinations and of doctors recommending birth control. (Minois, 1991; Squicciarini, 2020)

the previous decades was not spared: scientific and technical education was banned from seminaries, while the production of religious books surged, and the clergy recovered its hegemony in primary education (Minois, 1991; Jacob, 2014).[12]

During the central decades of the 19th century (1833-1870), the confrontation between science and religion—even if without the harsh connotations of the earlier years—remained salient and was felt in political, social, and educational contexts. In the years of the July Monarchy (1833-1848), despite the progressive schooling reforms implemented by minister Guizot and the promotion of the University—finally "freed from the anxiety of its survival that had plagued it for much of the Restoration" (Fox, 2012, p. 28)—religious instruction remained mandatory and the Church kept protecting its role in French society, while opposing sciences and innovative activities. Similarly, during the early years of the Second Empire (1852-1865), Catholic interests were often pleased: one example is the 1850 Falloux Law, allowing all members of religious congregations to teach in primary schools, and the creation of secondary Catholic schools. And, while the decades of the Empire "were not a period devoid of innovations, far from it" (Fox, 2012, p. 95), the Church strongly opposed scientific and technological progress (as reflected in the antiscientific curriculum of its religious schools).

Then, in the last years of the Second Empire (1866-1870), but especially after the advent of the Third Republic (1870), the confrontation between the Church and science worsened. The Republican government promoted a marked anticlerical agenda that had, at its core, the idea of *laïcité* (i.e., secularism). The objective was to weaken and then eliminate the influence of the Church in the public sphere, particularly "target[ing] the school system" (Kuru, 2009, p. 145). Thus, partly reviving the tension of the beginning of the century, France found itself divided into two opposing factions: on the one hand, supporters of religious and conservative values, embodied in the Catholic Church; on the other hand, inheritors of the revolutionary ideals, represented by leftist political parties and progressive groups in society (Kuru, 2009). The process of reforms promoted by the Republican government gradually undermined the role of the Church in French society and culminated in the Jules Ferry Laws—which made education free, mandatory, and secular.[13] How did Catholicism react? The resistance and opposition to scientific progress intensified, and the Church tried to control many aspects of its churchgoers' lives, exemplified in the opposition to the secularization and professionalization of education system, the rejection of vaccinations and birth control, and the proscription of the use of electricity in churches (Minois, 1991; Squicciarini, 2020).

Thus, the history of 19th century France is a history of constant confrontation between the forces

[12]The Bourbon Restoration imposed renewed attention on Catholic education and on the moral probity of French students. Primary schooling, mainly entrusted to the clergy, aimed rechristianize society, following decades of strong anticlericalism.

[13]Other reforms included the abolishment of the prayer in parliamentary sessions (1884), the secularization of hospitals (1885), the secularization of public school personnel (1886), and obligatory military service for the clergy (1889).

of religious and social conservatism, broadly embodied in the Church, and those of secularism and scientific progress.[14] Importantly, "while science was not the cause of the confrontation, it became inextricably involved" (Fox, 2012, p. 138); the religious and conservative forces made science the scapegoat of their battles, trying to hamper its production and diffusion. As discussed in Squicciarini (2020), the large heterogeneity in religiosity determined the importance given to religious norms and, in turn, the local-level resistance to scientific progress, when this clashed with the Catholic precepts.

3 Data

This paper exploits a rich dataset that combines information on famous people in the 18th and 19th centuries with data on religiosity and on geographic, institutional, and economic characteristics.

During the French Revolution, the administrative structure of the country was reformed and the entire French territory was divided into departments, districts, and cantons. Since some territories were being annexed and others lost, we focus on the 83 departments that were part of France throughout our period of study. Districts were administrative units between departments and cantons. There were 523 districts in the 83 departments of our analysis, and they stayed in place for approximately five years (1790-1795). Our main explanatory variable (the share of refractory clergy) is reported at the district level. Finally, cantons generally included a main city and a few smaller towns or villages. In 1801, the French territory was divided into almost 3,000 cantons. Our analysis is conducted at the canton level.[15] We now turn describing the variables we use in the analysis. Table 1 provides descriptive statistics, and Appendix B.2 reports further details.

3.1 Dependent Variable: Density of Famous Scientists

In line with a growing literature that uses information on notable individuals (Xue and Koyama, 2018; Dittmar and Meisenzahl, 2020; Serafinelli and Tabellini, 2020), our main dependent variable is the canton-level density of famous scientists in the 1790-1880 period. Importantly, the presence of famous people in scientific activities is more likely to capture the occurrence of innovation and scientific production, compared to more general measures of human capital (Serafinelli and Tabellini, 2020). The density of famous scientists is defined as the number of famous people in scientific professions born in canton c during decade t (per 10,000 inhabitants). Next, to measure the attractiveness of a location for scientists, we follow Serafinelli and Tabellini (2020) and construct the density of famous

[14]Since the confrontation between the Church and science lasted for the entire 19th century, our analysis abstracts from the potential role of the different political regimes in mitigating/ enhancing this conflict. Other authors have analyzed in details, using a theoretical or historical approach, the interaction between the state and organized religions (see, e.g. Kuran, 2011; Davids, 2013; Rubin, 2017; Johnson and Koyama, 2019; Bénabou et al., 2020).

[15]Even if data on famous individuals are available at the municipal level, conducting the analysis at the canton level is likely more informative about the attractiveness of a location—as small towns would likely enjoy the opportunities offered by the nearby city.

Table 1: Summary Statistics

	(1) Mean	(2) Stand. Dev.	(3) Min	(4) Max	(5) Obs.
Density of Scientists	0.02	0.19	0	11.01	27,195
Density of Nonscientists	0.11	0.51	0	23.58	27,195
Density of Scientist Immigrants	0.01	0.35	0	38.02	27,195
Density of Nonscientist Immigrants	0.06	0.52	0	20	27,195
Share Refractory Clergy	0.45	0.27	0	1	27,135
Population	9,280.8	28,446.9	9	1,851,792	27,195
University- *Grande École* Dummy	0.01	0.10	0	1	27,195
Atlantic Dummy	0.06	0.24	0	1	27,195
Mediterranean Dummy	0.02	0.12	0	1	27,195
Distance to Paris	0.38	0.19	0	0.82	27,195
Distance to Coalfields	0.07	0.05	0	0.21	27,195
Wheat Suitability	3.73	1.16	1	8	26,133

Notes: This Table provides descriptive statistics for the variables used in the analysis, using the full sample of cantons. For descriptive statistics on the restricted samples, see Tables A.1 and A.2.

scientist immigrants as the number of famous people in scientific professions who died in canton c and were born elsewhere in France in decade t (per 10,000 inhabitants). Using the place of death to measure migration patterns provides only an imprecise proxy of migration: if famous individuals lived and worked in different locations throughout their lifetime, information on the city of death does not allow us to study all their migration choices, but it still captures their mobility late in life. Finally, to run placebo regressions, we also construct the density of famous individuals and famous immigrants in professions other than sciences.

Data on the number of famous people are from de la Croix and Licandro (2015). The database contains records from the *Index Bio-bibliographicus Notorum Hominum (IBN)*, which was compiled from approximately 3,000 biographical sources (mainly dictionaries and encyclopedias) published between 1600 and 1980.[16] We keep those individuals for whom information on year and place of birth and death, occupation, and nationality are reported. We further restrict the sample to famous people of French nationality born between 1790 and 1880; finally, we match them with French cantons using information on their places of birth and death.[17] de la Croix and Licandro (2015) also group famous

[16]This dataset is richer than other data sources on famous creatives and, hence, more suited for a within-country analysis. Reassuringly, when we compare famous people in our sample with those reported in Freebase.com (based on Wikipedia entries and used in other scientific works), we find that these are strongly positively correlated.

[17]To attribute individuals to a canton, we first match birth and death locations with the 36,000 French municipalities,

individuals in nine different occupational categories: arts and *métiers*, business, education, humanities, law and government, military, nobility, religion, and science. We specifically focus on famous individuals in the science category—for placebos, we use the other types of upper-tail knowledge, which did not represent a direct target of the conservative Church program.[18] In our sample, there are 6,978 famous people —1,130 of them are in scientific professions.

We source population data from the project *Des villages de Cassini aux communes d'aujourd'hui*, reporting census information for France since 1793.[19] Population data are available at the municipal level, with quinquennial periodicity (usually years 01 and 06). We build the canton-level measure of population by summing the population of all municipalities belonging to the same canton—and using, for each decade, the population data for the earliest year in which it is available.

The average density of famous scientists in our sample is 0.02 (i.e., 200 scientists per 10,000 inhabitants per decade), while the density of famous nonscientists is 0.11 (see Table 1). The fact that both variables have a high standard deviation is due to the large number of locations with no famous people reported (on average, in each decade, only 10% of locations gave birth to at least one famous person). On the one hand, the high number of cantons with no famous people could depend on the fact that the birth of a famous individual is a rare event. On the other hand, this could be because famous people tend to group in clusters and small peripheral cantons never gave birth to any famous individual. Since this high number of zeros may generate noise and influence our results, we perform the analysis on two different samples: the full sample of cantons and a restricted sample of cantons that gave birth to at least one famous individual throughout the 1790-1880 period (Table A.1 in the Appendix reports the summary statistics for the restricted sample).[20] Famous individuals display high geographical mobility—approximately 68% of our scientists and 70% of all our famous individuals migrated from their birthplace. Considering migration destinations, in each decade, 0.9% (4.5%) of all cantons received at least one famous scientist (one famous individual).[21] The average density of scientist immigrants is 0.013, and the average density of nonscientist immigrants is 0.06. Also, when analyzing migration choices, we will use both the sample of all cantons and the restricted sample of cantons where at least one famous individual migrated throughout the sample period (Table A.2 in

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then aggregate these data at the canton level.

[18]We follow the original classification of de la Croix and Licandro (2015). Focusing exclusively on *science* implies that all other categories of upper-tail knowledge (i.e., not only humanities, but also business and arts and *métiers*) are considered *nonscientific*. In addition, famous individuals in the *religion* category are excluded from the analysis.

[19]The original data are available at http://cassini.ehess.fr. The project was a joint effort by several institutions, namely, Ecole des Hautes Études en Sciences Sociales (EHESS); Bibliothèque Nationale (BNF); Centre National de la Recherche Scientifique (CNRS); Institut National d'Études Démographiques (INED).

[20]In Table 3, we further account for the large number of zeros using nonlinear (i.e., Poisson and Negative Binomial) model specifications.

[21]Among the nine occupational categories, *law and government* displays the highest mobility.

Appendix reports the summary statistics for this restricted sample).

3.2 Main Indicator of Religiosity: Share of Refractory Clergy

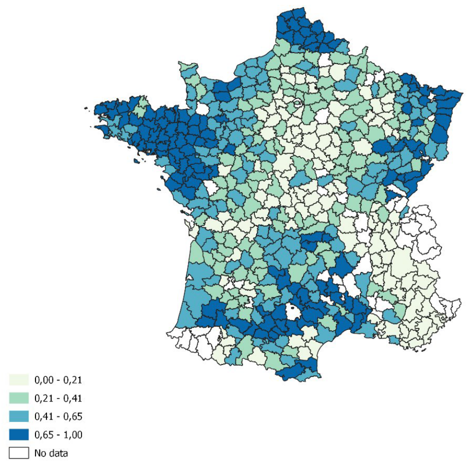

Figure 1: Religiosity in 1791

Note: The figure shows the quartiles of the distribution of the share of refractory clergy in 1791.

Following the approach of Squicciarini (2020), our indicator of religiosity is the share of refractory clergy in 1791 (Tackett, 1986). During the French Revolution, the National Constituent Assembly, passed the 1790 Civil Constitution of the Clergy with the objective of deeply restructuring the French Church. The Civil Constitution included several reforms, such as the abolition of tithes and the conversion of clergymen into functionaries of the state, as well as the election of bishops and parish priests by the citizens and a drastic reduction in the number of religious corps. Following delays in its implementation, the National Assembly required the clergy to take an oath of allegiance to the Constitution. Importantly, "the regional reactions of clergymen in 1791 can be revealing of the attitudes and religious options of the lay population with which the clergymen lived" (Tackett, 1986, p. xvi), suggesting that the decision to accept or reject the oath was not a clergyman's personal choice, but a community-level one – and that this would capture local-level religiosity (Tackett, 1986; Murphy, 2015; Franck and Johnson, 2016; Blanc, 2019; Squicciarini, 2020). In January 1791, the French clergy split into refractory (*nonjurors*) and constitutional (*jurors*). Our indicator of religiosity is the share of refractory clergy, i.e., the share of clergy who did not swear the oath in support of the Constitution but remained loyal to the Catholic Church.[22] Figure 1 shows the spatial distribution of the share of refractory clergy at the district level. On average, 45% of French clergy stayed loyal to the Church.

Our measure of religiosity is positively associated with other indicators of Catholic intensity throughout the 19th century and until the mid-20th century (such as the share of readers of *La Croix* in 1893, the main Catholic newspaper of the time, and Sunday Church attendance in the 1950s)—see Table A.3. This further validates the use of the share of refractory clergy as a measure of religiosity at the local level.

3.3 Control Variables

Our analysis accounts for a large set of potentially confounding characteristics, such as geographic factors, higher-education institutions, and measures of early economic development. In particular, we control for canton-level population, and we include dummies for cantons hosting a university or a *grande école*, for those located on the Mediterranean Sea, and for those located on the Atlantic Ocean. Moreover, to account for the potentially confounding role of industrial vs. agricultural activities, we compute each canton's distance (in 1,000 km) from the nearest coalfield, and we control for wheat suitability.[23] We also account for differences in the reach of the central government. Contrary to cross-country studies, our results are unlikely to be confounded by institutional heterogeneity, since, throughout the 19th century, France was a centralized state. However, to proxy for local differences in the influence of central institutions, we control for distance from Paris (in 1,000 km).

3.4 Empirical Strategy

To test our central hypothesis, namely that, *ceteris paribus*, higher religiosity hindered the formation of scientific human capital in the 19th century, we estimate linear models of the following form:

$$Y_{c,d,r,t} = \beta_1 \cdot \mathrm{Sh.\,Refractory}_d + \beta_2 \cdot \mathrm{lnpop}_{c,t} + \beta_3 \cdot \mathrm{Higher\,Educ.}_{c,t} + \beta_4' \mathbf{X}_c + \delta_r + \gamma_t + \varepsilon_{c,d,r,t}\,, \quad (1)$$

where $Y_{c,d,r,t}$ represents the density of famous scientists that either were born in or migrated to canton c of district d of region r in decade t. $\mathrm{Sh.\,Refractory}_d$ is the share of refractory clergy measured at the district level at the beginning of the sample period (1791); $\mathrm{lnpop}_{c,t}$ denotes the natural logarithm of the population of canton c measured at the beginning of each decade t; $\mathrm{Higher\,Educ.}_{c,t}$ is a time-varying indicator for the presence of a higher-education institution (university or *grande école*) in

[22] As argued in Squicciarini (2020), there were not particularly strong consequences for the clergy not taking the oath. Later, during the Reign of Terror (1792-1793), which promoted the complete dechristianization of the country and established the Cult of Reason, stronger punishments were implemented, but they were addressed to both the refractory and the constitutional clergy.

[23] Data on distance from the nearest coalfield are from Juhász, Squicciarini, and Voigtländer (2020), while data on wheat suitability are from Finley, Franck, and Johnson (2020). The latter is measured at the district level.

canton c in decade t; $\mathbf{X}_c$ is the vector of time-invariant geographical and economic controls measured at the canton level; and δ_r and γ_t are a set of region and time fixed effects. Throughout the analysis, standard errors are clustered at the district level to allow for residual correlation across all cantons of the same district and through time. The main coefficient of interest is β_1, representing the effect of religiosity on the density of famous scientists. We expect β_1 to be negative and significantly different from zero, indicating that—conditional on our controls—higher religiosity in a location reduces the emergence (or inflow) of upper-tail human capital in sciences.

Our identification exploits cross-sectional variation in presample levels of religiosity and relies on the absence of correlation between our measure of religiosity and the error term, conditional on all controls. Specifically, the identification of β_1 requires that other characteristics correlated with the presence of famous scientists did not influence religiosity at the local level. We address this potential concern by running a set of placebo regressions. First, if religiosity reduced local opportunity for human-capital accumulation, thus affecting all forms of upper-tail knowledge, we would observe that more religious cantons have fewer famous individuals—and not only fewer scientists. We construct the density of famous individuals in nonscientific fields and provide evidence that their birth and migration patterns are not related with religiosity. Second, if there were other canton-level characteristics affecting only the presence of scientists (but not other form of upper-tail knowledge), we would likely observe a negative relationship between religiosity and scientific progress also in earlier years, i.e., before the clash between Catholicism and science had prominently emerged. We use data on the number of scientists in the 1700-1780 period and show that religiosity is not associated with our proxy of scientific knowledge pre-1790. This also speaks to reverse-causality concerns, as religiosity could itself be affected by the presence of famous scientists who were more willing to embrace secular values. Showing that early scientific progress is not related to religiosity mitigates such concerns.

4 Empirical Results

We now turn to the results of the empirical analysis. In Section 4.1, we study the relationship between religiosity and the emergence of scientific elites, and we analyze whether religiosity also affects migration decisions of famous individuals. In Section 4.2, we present the placebo regressions discussed above. In Section 4.3, we investigate one channel that may mediate the impact of religiosity on the emergence of scientific elites and focus on the role of secondary education.

4.1 Main Results

We start by plotting the unconditional correlation between the share of refractory clergy and the density of scientists born in a canton, both for the full sample (Figure 2a) and for the restricted sample of cantons where at least one famous individual was born in the 1790-1880 period (Figure 2b). In both

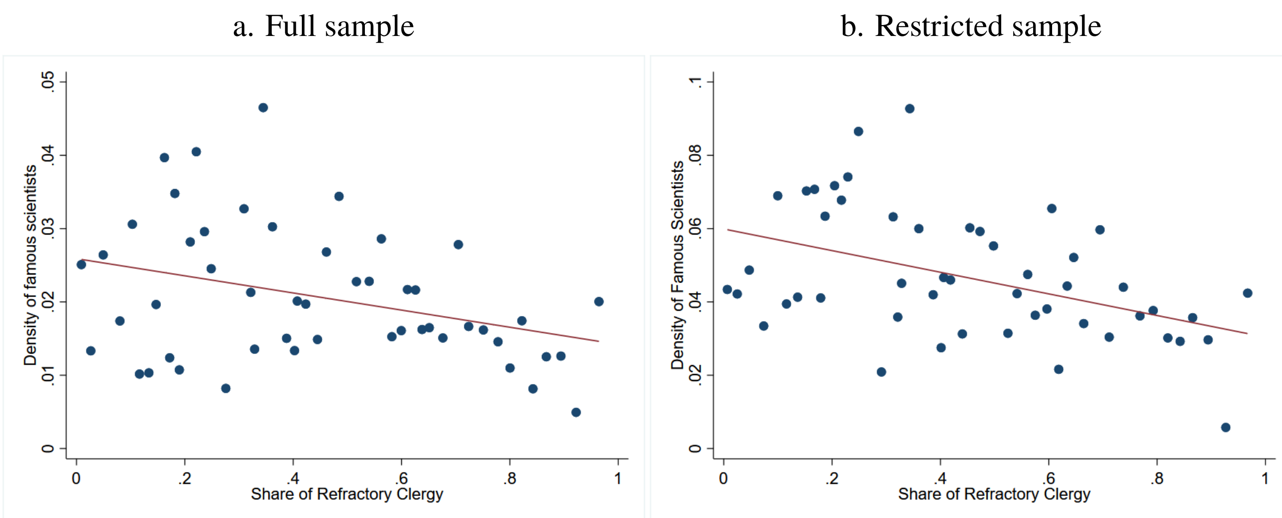

Figure 2: Scatter Plots of Density of Famous Scientists on Share of Refractory Clergy

Notes: Panel (a) shows the correlation between the share of refractory clergy and scientist density in the full sample using a bin-scatter plot with 50 bins. Panel (b) shows the correlation between the share of refractory clergy and scientist density in the restricted sample using a bin-scatter plot with 50 bins

cases, we observe a negative relationship between religiosity and the formation of upper-tail scientific human capital.

Table 2 studies this relationship more systematically. Column (1) presents the simple correlation between the density of famous scientists in the 1790-1880 period and religiosity; it shows a negative and significant coefficient on the share of refractory clergy. In the following columns, we progressively enrich the specification until we estimate our baseline model in columns (4) - (5). Column (2) includes the set of canton-level controls described above.[24] Column (3) introduces a set of decade fixed effects, and column (4) completes the specification by adding region fixed effects. To rule out that our findings are driven by the high number of cantons with zero famous individuals, in column (5) we restrict the sample to cantons that gave birth to at least one famous person over the entire 1790-1880 period. In all specifications, the coefficient of interest, β_1, is negative and statistically significant, thus pointing to a negative relationship between religiosity and the density of scientists in the population. When considering the baseline model (column 4), a one standard deviation increase in the share of refractory clergy lowers by 0.004 the density of scientists—a reduction of approximately 20% compared to the sample average (0.02). In other words, moving from the 25th to the 75th percentile of the religiosity distribution (i.e., from a share of refractory clergy of 0.22 to a share of refractory clergy of 0.66) would

[24]The number of observations decreases, since wheat suitability is not available for all districts in our sample.

Table 2: Lower Density of Famous Scientists in More Religious Cantons

Dependent Variable: Density of Famous Scientists, 1790-1880

	(1)	(2)	(3)	(4)	(5)
Share Refractory Clergy	-0.012***	-0.019***	-0.019***	-0.014**	-0.033**
	(0.004)	(0.004)	(0.004)	(0.006)	(0.014)
Population		0.006***	0.007***	0.007***	-0.015
		(0.002)	(0.002)	(0.002)	(0.011)
Distance to Paris		-0.020***	-0.020***	-0.018	-0.029
		(0.007)	(0.007)	(0.017)	(0.038)
University-*Grande École* Dummy		0.134***	0.133***	0.134***	0.154***
		(0.019)	(0.019)	(0.019)	(0.023)
Atlantic Dummy		0.011**	0.011**	0.011**	0.021**
		(0.005)	(0.005)	(0.005)	(0.010)
Mediterranean Dummy		0.020**	0.021**	0.022**	0.030*
		(0.009)	(0.009)	(0.009)	(0.017)
Distance to Coalfields		-0.029	-0.027	-0.035	-0.057
		(0.030)	(0.030)	(0.037)	(0.073)
Wheat Suitability		-0.003**	-0.002**	-0.002	-0.003
		(0.001)	(0.001)	(0.001)	(0.003)
Time FE			✓	✓	✓
Region FE				✓	✓
R^2	0.00	0.01	0.01	0.01	0.01
Observations	27,195	26,133	26,133	26,133	11,675
Sample	Full	Full	Full	Full	Restricted

Notes: All regressions are run at the canton level. The dependent variable is the density of famous scientists in the 1790-1880 period. Controls: *Population* represents the (log) total canton population measured at the beginning of each decade. *Distance to Paris* measures the distance to Paris (in 1,000 km). *University-Grande École Dummy* is a time-varying dummy that equals one for cantons hosting a university or a *grande école* in time *t*. *Atlantic Dummy* is a dummy equal to one for cantons located on the Atlantic Ocean. *Mediterranean Dummy* is a dummy equal to one for cantons located on the Mediterranean Sea. *Distance to Coalfield* measures a canton's distance to the nearest coalfield (in 1,000 km). *Wheat Suitability* is wheat soil suitability. The restricted sample corresponds to cantons where at least one famous individual was born throughout the sample period (1790-1880). Standard errors (clustered at the district level) in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

lead to a decrease in 60 scientists per 10,000 inhabitants. A simple back-of-the-envelope calculation—although abstracting from any general equilibrium effect—suggests that if all the cantons in France displayed the minimum level of religiosity (i.e., a share of refractory clergy equal to 0), the country would give birth to approximately 20 extra scientists each decade—a rather large increase, considering that the average number of famous scientists per decade is 115.[25] Interestingly, focusing on the restricted sample (column 5), a one standard deviation increase in the share of refractory clergy leads to additional 80 scientists per 10,000 inhabitants; this effect corresponds to an increase of approximately 18% compared to the average of this sample and it is extremely similar to the effect estimated on the full sample. Among the other controls, the presence of higher-education institutions displays a positive and significant coefficient, suggesting that the availability of universities or *grandes écoles* is positively correlated with the presence of famous scientists. In addition, in line with the argument that port cities—thanks to their favorable geographic location—may be more exposed to new ideas and innovations, we find that cantons located on the Atlantic Ocean and Mediterranean Sea are more likely to be the birthplace of scientific elites.

Table 3: Robustness Checks – Different Aggregation Levels and Models

Dependent Variable: Density of Famous Scientists, 1790-1880

	(1)	(2)	(3)	(4)
Share Refractory Clergy	-0.018***	-0.015**	-0.620**	-0.620**
	(0.006)	(0.006)	(0.294)	(0.294)
Time FE	✓		✓	✓
Controls	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
R^2	0.03	0.07		
Observations	4,176	2,910	26,133	26,133
Model	OLS District-Level	OLS Cross-Section	Zero-Inflated Poisson	Zero-Inflated Neg. Binomial
Sample	Full	Full	Full	Full

Notes: Regressions are run at the district level (col. 1) and at the canton level (cols. 2-4). The dependent variable is the density of famous scientists in the 1790-1880 period. Controls are those listed in Table 2. Standard errors (clustered at the district level in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Next, we investigate the robustness of our empirical strategy using alternative model specifications

[25]To calculate the effect for the entire country, we (i) compute the fitted values of the baseline model (column 4 of Table 2) with the imposition that the share of refractory clergy is equal to its minimum value in the sample, (ii) compute the difference between this predicted value and the actual value of the density of scientists, and (iii) multiply this difference by the French population (approximately 28 million in 1793).

(Table 3). Specifically, since the share of refractory clergy is measured at the district level, we redefine all our variables and estimate the baseline model at this higher level of aggregation. The result is reported in column (1). Similarly, as the religiosity measure is time-invariant, column (2) removes the time dimension and uses long-term averages for all time-varying variables (e.g., we compute the average of scientist density over the 1790-1880 period). Finally, to account for the large number of zeros in the dependent variable and the skewness of its distribution, in columns (3) and (4) we perform our analysis estimating both zero-inflated Poisson and zero-inflated Negative Binomial models.[26] The estimated coefficients remain similar in magnitude and strongly significant to those of the baseline specification (for the nonlinear models, the marginal effect of a unitary increase in the share refractory clergy, estimated at the mean of the share refractory variable, is -0.016).

In Section A.2 of the Appendix, we perform an extensive sensitivity analysis. In particular, Table A.4 controls for distance to the closest *grande école* and to the closest university, it accounts for possible persistence in the birthplaces of famous scientists (by including lags of our dependent variable), as well as for number of famous people born in the 1660-1780 period (separately for each category), and for a (department-level) proxy for pre-industrial activities. Table A.5 shows that the results hold when considering alternative subsamples (i.e., sequentially excluding from the analysis cantons with more than 50,000 inhabitants in 1793, cantons located in non-French-speaking departments and in Brittany, and cantons in the lowest and highest 5% of the religiosity distribution). Next, Figure A.2 shows the robustness of the findings to different standard error corrections. In particular, we (i) allow for heteroskedasticity in the variance-covariance matrix, (ii) cluster at district$\times$time level, (iii) use two-way clustering, (iv) cluster at the department level or (v) at the region level, (vi) correct standard errors for spatial correlation using Conley (1999) with different distance cutoffs, and (vii) use the heteroskedasticity and autocorrelation consistent estimator to account for serial autocorrelation. The results on religiosity hold in all specifications.

So far, we have shown that the intensity of Catholicism can differentially affect the number of scientists born in a canton. We now investigate whether religiosity can impact accumulation of scientific knowledge also by fostering or discouraging migration of famous scientists from elsewhere. When focusing on upper-tail human capital, the analysis of migration patterns is indeed relevant, since famous individuals display high geographical mobility (in our sample, for instance, approximately 70% of famous people migrated). To trace migration patterns, we now use data on both the city of birth and the city of death of famous individuals. Our main dependent variable is the density of scientist

[26] To interpret β_1 as the effect on the density of famous scientists when using nonlinear count models, the specification uses the (integer) number of famous scientists born in a canton as the dependent variable, and forces the coefficient of the log transformed population to be equal to one. We use the total number of famous people presample (1660-1780) to predict the excessive number of zeros.

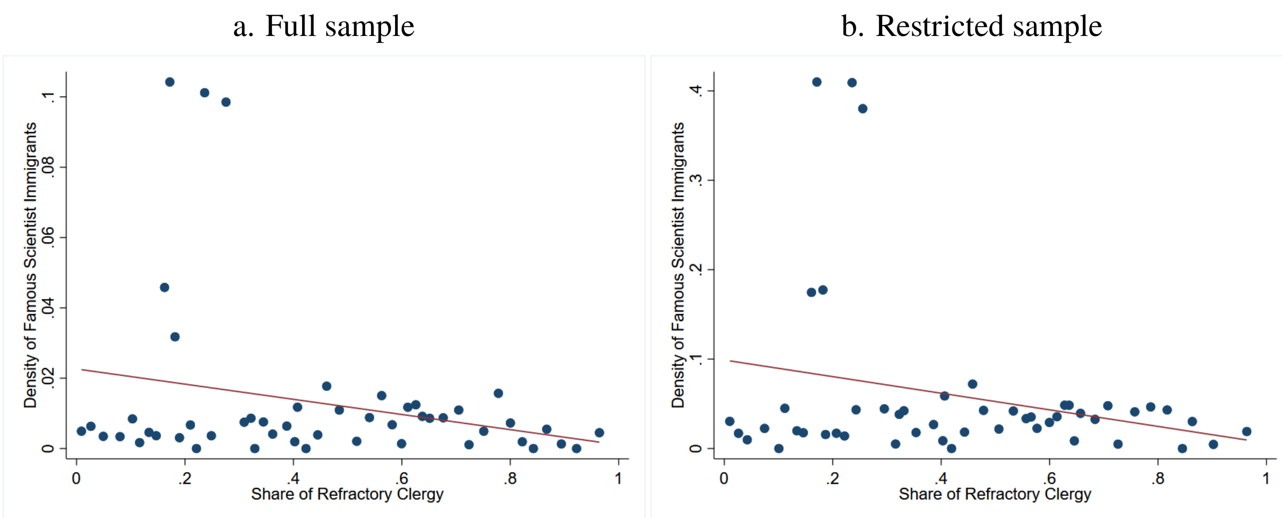

Figure 3: Scatter Plots of Density of Famous Scientist Immigrants on Share of Refractory Clergy

Notes: Panel (a) shows the correlation between the share of refractory clergy and the density of famous scientist immigrants in the full sample using a bin-scatter plot with 50 bins. Panel (b) shows the correlation between the share of refractory clergy and the density of famous scientist immigrants in the restricted sample using a bin-scatter plot with 50 bins.

immigrants in the 1790-1880 period.

We first plot the unconditional correlations between the share of refractory clergy and the density of scientist immigrants using the full sample (Figure 3a) and the restricted sample of cantons where at least one famous individual migrated into (Figure 3b). We observe a negative correlation between religiosity and scientists' migration patterns, which, however, seems to be driven by a few cantons with high immigration levels and low religiosity (e.g., cantons located in the districts of Aix, Corbeil, and Versailles). Table 4 reports the regression results, using (for comparability purposes) the same specifications of Table 2.[27]

When we look at the unconditional correlation, the estimated coefficient on the share of refractory clergy is negative and significant (column 1). However, as we add canton-level controls, the relationship between religiosity and the density of scientist immigrants disappears (column 2)—remaining insignificant also in the following specifications (columns 3-5). This confirms the visual pattern of Figure 3, suggesting that religiosity was not a key driver of scientists' migration decisions. This result is particularly interesting, given the high-mobility of famous scientists: it suggests that the choice of place where scientists migrated—and where they likely spent a large part of their active life—was not affected by local-level religiosity. Which factors, then, attracted scientists to move to a location? Our

[27] In this case, the restricted sample corresponds to cantons where at least one famous individual migrated into during the 1790-1880 period.

Table 4: Religiosity and Density of Famous Scientist Immigrants

Dependent Variable: Density of Famous Scientists (Migrants), 1790-1880

	(1)	(2)	(3)	(4)	(5)
Share Refractory Clergy	-0.022**	-0.007	-0.007	-0.006	-0.021
	(0.010)	(0.006)	(0.006)	(0.013)	(0.048)
Population		-0.017*	-0.017*	-0.013	-0.131**
		(0.010)	(0.010)	(0.009)	(0.062)
Distance to Paris		-0.039***	-0.038***	-0.028*	-0.028
		(0.013)	(0.012)	(0.015)	(0.065)
University-*Grande École* Dummy		0.083***	0.084***	0.077***	0.237***
		(0.021)	(0.021)	(0.021)	(0.086)
Atlantic Dummy		0.008*	0.008**	0.007*	0.025
		(0.004)	(0.004)	(0.004)	(0.016)
Mediterranean Dummy		0.036*	0.036*	0.039**	0.109*
		(0.019)	(0.020)	(0.019)	(0.059)
Distance to Coalfields		0.084	0.083	0.047	-0.127
		(0.068)	(0.067)	(0.044)	(0.235)
Wheat Suitability		0.002	0.002	-0.002	-0.015
		(0.002)	(0.002)	(0.003)	(0.014)
Time FE			✓	✓	✓
Region FE				✓	✓
R^2	0.00	0.00	0.00	0.01	0.02
Observations	27,195	26,133	26,133	26,133	5,798
Sample	Full	Full	Full	Full	Restricted

Notes: All regressions are run at the canton level. The dependent variable is the density of famous scientists immigrants in the 1790-1880 period. Controls are those listed in Table 2. The restricted sample corresponds to cantons where at least one famous individual migrated throughout the sample period (1790-1880). Standard errors (clustered at the district level) in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

findings show that they were more likely to move to cantons hosting a university or a *grande école*, as well as to cantons located on the sea or on the ocean, and to those closer to Paris.

Thus, the results so far suggest that, during the 19th century, higher religiosity hindered scientific progress by discouraging young, talented individuals from undertaking scientific activities, while it did not seem to reduce the attractiveness of a location for famous scientists.[28]

4.2 Placebo

One key concern regarding the results presented thus far is that other factors related to religiosity could make some cantons more likely to give birth to famous people—for instance, by providing more opportunities for accumulation of upper-tail human capital. While including the geographic, institutional, and economic controls partly addresses this issue, unobserved canton-level characteristics could still be driving the observed patterns. If this were the case, we would expect cantons with higher religiosity to host fewer famous people in all fields, and not only in sciences. Table 5 deals with this concern. We compute the density of famous individuals in the seven residual categories not related to sciences[29] and use it as dependent variable in our placebo regressions. Columns (1) - (5) reproduce the specifications of Table 2 and show that the determinants of the emergence of upper-tail nonscientific human capital are in line with those affecting scientific human capital—population size, access to the sea, and the presence of higher-education institutions all display significant coefficients. Interestingly, the striking exception is religiosity: the coefficient on the share of refractory clergy is not systematically associated with the density of famous people in nonscientific fields. This result suggests that religiosity hampered the emergence of scientific knowledge, while it did not affect the formation of upper-tail human capital in fields other than sciences.[30] Table A.6 in the Appendix reports the results of the specification in column (4) of Table 5 using as the dependent variable the density of famous people, separately for each occupational category. Table A.7 replicates Table 5 using the density of famous nonscientist immigrants. The nonrelationship between religiosity and both the presence of upper-tail knowledge in nonscientific fields and the migration of nonscientists confirms the previous results.

Thus, remaining canton-level characteristics that could still confound our results should be correlated with religiosity and affect only the presence of scientists, but not the birth of other famous individuals. If this were the case, these factors would likely hamper scientific progress (via channels

[28]This latter result should be interpreted with caution since, given the nature of our data, we are not able to study all migration choices of famous individuals, but we can still capture their mobility late in life (for details, see Section 3).

[29]As mentioned in Section 3, since the Church explicitly targeted sciences, but not other types of upper-tail knowledge, we adopt a precise definition of *sciences*—and include only those individuals that de la Croix and Licandro (2015) have grouped into scientific fields. This implies that all remaining fields of upper-tail knowledge (e.g., humanities, arts and *métiers*, and business) belong to the nonscientific categories. For details on the other categories, see Section 3.1.

[30]The nonrelationship between religion/religiosity and broader categories of upper-tail knowledge (not strictly related to sciences) is also documented in Squicciarini (2020) and Serafinelli and Tabellini (2020).

Table 5: Religiosity and Density of Famous Individuals in Nonscientific Fields

Dependent Variable: Density of Famous Individuals in Nonscientific Fields, 1790-1880					
	(1)	(2)	(3)	(4)	(5)
Share Refractory	-0.003	-0.020	-0.020	0.016	0.045
	(0.015)	(0.017)	(0.017)	(0.020)	(0.038)
Population		0.028***	0.029***	0.034***	-0.126***
		(0.008)	(0.008)	(0.007)	(0.034)
Distance to Paris		-0.073***	-0.073***	-0.034	-0.078
		(0.026)	(0.027)	(0.058)	(0.105)
University-*Grande École* Dummy		0.593***	0.591***	0.582***	0.705***
		(0.073)	(0.072)	(0.073)	(0.086)
Atlantic Dummy		0.057***	0.056***	0.043**	0.075**
		(0.021)	(0.021)	(0.021)	(0.036)
Mediterranean Dummy		0.179***	0.180***	0.153***	0.171***
		(0.043)	(0.043)	(0.042)	(0.045)
Distance to Coalfields		0.038	0.042	-0.110	-0.125
		(0.080)	(0.081)	(0.123)	(0.214)
Wheat Suitability		-0.007*	-0.007*	-0.005	-0.005
		(0.004)	(0.004)	(0.004)	(0.009)
Time FE			✓	✓	✓
Region FE				✓	✓
R^2	0.00	0.02	0.02	0.03	0.03
Observations	27,195	26,133	26,133	26,133	11,675
Sample	Full	Full	Full	Full	Restricted

Notes: All regressions are run at the canton level. The dependent variable is the density of famous individuals in fields other than sciences in the 1790-1880 period. Controls are those listed in Table 2. The restricted sample corresponds to cantons where at least one famous individual was born throughout the sample period (1790-1880). Standard errors (clustered at the district level) in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

other than religiosity) also in the years of the Enlightenment, i.e., before the Church prominently turned against sciences. To deal with this potential issue, we construct two measures for the density of scientists in the Enlightenment period (1700-1780) and we investigate whether the negative relationship between religiosity and scientific progress is detectable before 1790.

Table 6: Religiosity and Density of Famous Scientists Before 1780

Dependent Variable:	Density of Famous Scientists, 1700-1780					
	[using population estimates]			[using 1793 population]		
	(1)	(2)	(3)	(4)	(5)	(6)
Share Refractory Clergy	-0.001	-0.009	-0.032	-0.002	-0.005	-0.017
	(0.008)	(0.019)	(0.051)	(0.004)	(0.007)	(0.023)
Controls		✓	✓		✓	✓
Time FE		✓	✓		✓	✓
Region FE		✓	✓		✓	✓
R^2	0.00	0.00	0.01	0.00	0.01	0.02
Observations	22,452	21,597	6,429	24,147	23,204	6,812
Sample	Full	Full	Restricted	Full	Full	Restricted

Notes: All regressions are run at the canton level. The dependent variable in columns (1) - (3) is the number of famous scientists in each decade between 1700-1780 divided by estimates of the decade population. The dependent variable in columns (4) - (6) is the number of famous scientists in each decade between 1700-1780 normalized by the first available census population of 1793. Controls are those listed in Table 2 – except for *Population* which is measured as the (log) total canton population estimated at the beginning of each decade in columns (2) - (3) and as the (log) total canton population reported by the first available census population of 1793 in columns (5) - (6). The restricted sample corresponds to cantons where at least one famous individual was born throughout the sample period (1700-1780). Standard errors (clustered at the district level) in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Our first measure is the number of famous scientists in each decade between 1700 and 1780 divided by estimates of the decade population (expressed in 10,000s).[31] Our second measure is the number of famous scientists in each decade between 1700 and 1780 normalized by the first available census population of 1793 (expressed in 10,000s).[32] Table 6 shows the results. Columns (1) - (3) use, as the dependent variable, our first measure of the density of famous scientists. In column (1), we report the simple correlation with the share of refractory clergy. In column (2), we replicate our baseline

[31]Since population data at the canton level are not available before 1793, we extrapolate population measures back to 1700 using data from Bairoch, Batou, and Chèvre (1988). We compute decennial population growth rate at the department level and use those figures to project the population from the first available census of 1793 back in time.

[32]As a robustness check, Table A.8 in the Appendix also reports the results of cross-sectional regressions that use both the total number of scientists over the entire period and the same number normalized by the 1793 population as the dependent variable.

regression (column 4 of Table 2), and in column (3), we restrict the sample to those cantons with at least one famous person born in the 1700-1780 period. In columns (4) - (6), we use as the dependent variable our second measure for the density of famous scientists and replicate the specifications of columns (1) - (3). The coefficient of share of refractory clergy is imprecisely estimated throughout, suggesting no detectable relationship between the presence of famous scientists and religiosity before the French Revolution.[33] These findings also speak to reverse-causality concerns, as the presence of scientists could potentially be a determinant of religiosity.[34] Showing that early scientific progress is not related to religiosity makes reverse causality unlikely.

4.3 Potential Mechanism

The results thus far suggest that religiosity played a negative role on scientific progress by hindering the formation of upper-tail human capital in science. This section explores one possible channel through which religiosity may act: secondary education.[35]

France was one of the first countries with a national public system of secondary schooling; it was set up during the Napoleonic period. Contrary to primary education, in the 19th century, secondary schooling was still the appanage of a few: the proportion of the total population enrolled in secondary schools was extremely small, reaching only 5% by the turn of the 20th century.[36] In addition, secondary education was provided only by the public system. Schools were divided into *lycées*—few and typically devoted to prepare students for the *grandes écoles*—and municipal colleges. After years of intense debate, the 1850 Falloux Law allowed the creation of Catholic secondary schools.[37] Their number increased rapidly, and they educated an average of one-third of all male (secondary schools) students between 1850 and 1880. Many Catholic schools were competing with secular schools in terms of teaching quality, and the richest strata of society (landed nobility and the ambitious bourgeoisie) often

[33] Besides representing a turning point in the relationship between science and religion, the French Revolution likely impacted several other aspects of French society. While we have to exercise some caution when interpreting these results, it is reassuring that, in line with our interpretation, we do not find a significant relationship between religiosity and scientific progress in the pre-1790 period.

[34] This could be particularly relevant if, as shown in Serafinelli and Tabellini (2020), creativity clusters are persistent over time. Their findings suggest that cities that are at the frontier of creativity in one period retain an advantage that persists for a while but not indefinitely.

[35] As already mentioned, religiosity is also associated with the share of primary Catholic schools in the late 19th century (Squicciarini, 2020). However, we don't focus on primary education since (a) this was addressed to the entire population of students, the large majority of whom would stop studying and enter the labor market after completing primary school; (b) the differences between Catholic and secular primary schools became evident in the late 1860s, especially with the 1882 Jules Ferry Laws (which is beyond our period of analysis).

[36] Official estimates were 1 in 35 of the age group in 1842, and 1 in 20 in 1865; even under the Third Republic, the proportion was very small—3.4% in 1901 and 5% in 1912 (Anderson, 1971).

[37] The Falloux Law permitted any qualified individual to conduct a secondary school. This led to the foundation of several private lay schools, as well as of Catholic schools (Harrigan, 1975).

opted for Catholic education because of its conservative orientation and its focus on classical studies.[38]

For our analysis, we are particularly interested in the differences in the curricula of Catholic vs. secular schools. Harrigan (1973) notes that these were minor, especially for those subjects aimed at preparing students for the *baccalauréat* examination and for the entrance to the *grandes écoles*.[39] The only notable exception was science, considered with extreme disfavor in Catholic schools, both because of philosophical concerns and for organizational reasons. Catholics claimed that scientific knowledge trained only one part of the mind and could promote a materialistic philosophy. Also, a more practical restriction in the teaching of science was that the vast majority of Catholic teachers were priests who had received little scientific training.[40]

The prevalence of Catholic schools in regions with high religiosity combined with their hostility toward scientific subjects could be one of the mechanisms through which religiosity affected the emergence of scientific elites. To test this channel, we use data on secondary education from *La Statistique Générale de la France*, providing department-level information on both the number of secondary schools by type (public, private religious, and private nonreligious) and the number of students enrolled in secondary education. We exploit information for 1865 (the only year available that falls in our sample period),[41] using the share of Catholic schools to measure the local-level training of students on a traditional (as opposed to a more scientific) track.

To perform the analysis, we consider only famous individuals born after 1840 (these are individuals who had the opportunity to attend a Catholic school) and build forty-year averages of the density of scientists born in a given department.[42] Table 7 shows the results. Column (1) reports a negative correlation between the share of refractory clergy and the density of scientists, confirming that the baseline results also hold in the cross-sectional setting at the department level. Column (2) shows a positive relationship between our measure of religiosity and the share of Catholic schools. This is not surprising, since Catholic education thrived in those regions particularly devoted to the Roman Catholic religion (i.e., in academies such as Rennes, Douai, and parts of Toulouse), and many Frenchmen chose Catholic secondary schools primarily because of their religious identity (Harrigan, 1975). Next, we study the relationship between the share of Catholic schools and the density of scientists. Column (3) presents the simple correlation, and column (4) includes the control variables used in the baseline model. Both specifications provide evidence of a negative relationship between the pres-

[38] For a detailed discussion on the appeal of Catholic secondary education, see Harrigan (1975) and Anderson (1982).

[39] Public and Catholic schools often adopted the same textbooks (Harrigan, 1973).

[40] A good example of the resistance of Catholic schools to the teaching of science is the firm opposition to the bifurcation system (introduced in 1852 in state schools) aiming to place scientific studies on the same level as classical studies.

[41] The only other period for which information on the affiliation of schools is available at the department level is 1887.

[42] In particular, we consider individuals born after 1840 and before 1880. We do this because students had the opportunity to attend a school different from the public, state-managed, ones only after the 1850 Falloux Law.

ence of a traditional secondary education track (embodied in the lack of scientific teaching in Catholic schools) and the accumulation of scientific upper-tail human capital. We then regress the density of scientists born in a department on both our religiosity measure and the share of Catholic schools with and without controls (columns 5 and 6, respectively). Interestingly, comparing columns 1 and 5, the coefficient on religiosity becomes smaller in magnitude and insignificant, while the share of Catholic schools is still negatively and significantly associated with the density of scientists. This suggests that the negative effect of religiosity on the density of scientists is partially mediated by the presence of Catholic secondary schools.[43]

Table 7: Religiosity, Scientist Density, and Secondary Education

Dependent Variable	Density of Scientists	Share Sec. Cath. Schools	Density of Scientists			
	(1)	(2)	(3)	(4)	(5)	(6)
Share Refractory Clergy	-0.053*	0.145*			-0.035	-0.060
	(0.031)	(0.073)			(0.030)	(0.043)
Share Second. Catholic Schools			-0.133***	-0.098**	-0.123**	-0.093*
			(0.050)	(0.045)	(0.050)	(0.047)
Controls				✓		✓
R^2	0.02	0.04	0.06	0.18	0.07	0.20
Observations	83	83	83	74	83	74

Notes: All regressions are run at the department level. Controls are those listed in Table 2. Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

One potential concern is that other dimensions of secondary education—different from the religious affiliation of the school and its emphasis on sciences—might both affect the emergence of scientists and be correlated with religiosity at the local level. Table 8 studies different aspects of secondary education and tests whether these are correlated with the share of refractory clergy. A first issue could be that the lower density of scientists in more religious places is driven by a lower *quantity* of secondary education. Thus, we check whether religiosity is associated with the number of secondary schools (column 1), with the number of students enrolled in secondary schools (column 2), and with the share of people attending secondary education (column 3). None of these additional dimensions of secondary education is significantly associated with religiosity. A second concern could be that more religious areas were facing lower public investment and a scarcer availability of *lycées* and public

[43] We can analyze this relationship more systematically, by looking at the Sobel-Goodman mediation test. Its ratio shows the proportion of the total effect of religiosity on the density of scientists transmitted via type of secondary education. It suggests that approximately 34% of the relationship between the share of refractory clergy and the density of scientists is mediated via the share of Catholic secondary schools.

colleges—which, in turn, gave rise to the emergence of Catholic schools. Column 4 suggests that this was not the case: there is a positive (albeit insignificant) relationship between the share of refractory clergy and the share of public schools in the department.

Table 8: Religiosity and Other Dimensions of Secondary Education

Dependent Variable	Num. Schools (log)	Num. Students (log)	Share of Population with Secondary Education	Share of Public Schools
	(1)	(2)	(3)	(4)
Share Refractory Clergy	-0.030	0.317	-0.000	0.074
	(0.324)	(0.313)	(0.001)	(0.100)
R^2	0.00	0.01	0.00	0.01
Observations	83	83	83	83

Notes: All regressions are run at the department level. Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 9: Placebo: Secondary Education, Scientist Immigrants, and Nonscientists

Dependent Variable	Density of Nonscientists		Density of Scientist Migrants	
	(1)	(2)	(3)	(4)
Share Second. Catholic Schools	-0.055	0.007	-0.015	0.008
	(0.047)	(0.054)	(0.016)	(0.011)
Controls		✓		✓
R^2	0.01	0.32	0.01	0.30
Observations	82	77	82	77

Notes: All regressions are run at the department level. Controls are those listed in Table 2. Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Finally, we show that the relative abundance of Catholic schools is not related to either the accumulation of other categories of upper-tail human capital or the migration of scientists. Again, we build forty-year averages of the density of famous nonscientists born into a department and the density of famous scientists who migrated into a department. We then correlate these measures with the share of Catholic schools. Column (1) of Table 9 reports the simple correlation between the density of nonscientists and the share of Catholic schools, while column (2) runs a more complete specification that includes all controls used in the baseline model. Reassuringly, there is no statistically significant relationship between the share of Catholic secondary schools and the emergence of famous people in fields other than sciences. Columns (3) and (4) repeat the analysis using the density of scientist migrants as the dependent variable and show that, as expected, it is uncorrelated with the share of Catholic secondary schools.

These results, together with a rich historical record, corroborate the idea that Catholic schools, and their antiscientific curriculum, could partly explain the negative relationship between religiosity and the emergence of scientists. Importantly, although we cannot formally test whether the type of secondary education affected the training of famous scientists also in the first half of the 19th century,[44] we could easily assume that more Catholic places preferred a more conservative and religious education even in this earlier period. This finding on secondary education, more broadly interpreted as *early* accumulation of scientific human capital, provides further support for our main results: it suggests that the external environment in the place of birth, which includes its religiosity, is particularly important when individuals are young. The path of becoming famous scientists is shaped earlier in life (when scholars were in secondary schools); this further points to the importance of local initial religiosity in affecting long-term accumulation of scientific human capital.

5 Conclusions

Science and religion have experienced several clashes throughout history, and their relationship remains complex in many countries today (Bénabou et al., 2020). This paper investigates the conditions under which religiosity hampers scientific progress, and whether it hinders the local emergence of scientists or discourages their inflow from elsewhere.

We focus on a historical setting and study France during the 19th century, a period in which (after the events of the 1789 French Revolution) the Church had embraced a particularly antiscientific attitude. While almost the entire French population was Catholic, the intensity of Catholicism (i.e., religiosity) varied widely—we exploit this in our empirical analysis. Using data on the place and date of birth and death of famous individuals from 1790 to 1880, we measure scientific progress as the density of famous scientists in the population. We find that, throughout the 19th century, more-religious cantons were less likely to give birth to scientists, but that, once these young talented individuals had undertaken the scientific path, their migration decisions were not affected by the religiosity of the hosting canton. In addition, placebo regressions show that religiosity is not associated with (i) the emergence and migration patterns of famous people in professions other than sciences, or (ii) the density of scientists in the 1700-1780 period.

These findings suggest that the intensity of Catholicism did not affect the accumulation of upper-tail human capital in nonscientific fields and that it started to hamper scientific progress only once the clash between Catholicism and science had prominently emerged. In addition, we shed light on a potential mechanism, focusing on the role of secondary education. We find that the type of secondary

[44] As mentioned earlier, Catholic secondary schools emerged after 1850.

education (Catholic vs. secular) can partly explain the negative relationship between religiosity and the emergence of scientists.

Our analysis has important implications for many countries today, since religion still plays a central role in the daily life of billions of people across the globe. Our findings suggest that the relationship between religiosity and scientific progress is not inherently negative—rather, it can vary over time. The intensity of religion determines the importance given to religious norms; when the latter are unfavorable toward sciences, higher religiosity will translate into greater resistance to the production and spreading of scientific knowledge.

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