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SCIENCE UNDER INQUISITION: THE ALLOCATION OF TALENT IN EARLY MODERN EUROPE

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Abstract

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JEL Classification: N33, J61, Z12

Keywords: Science

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Science under Inquisition: The allocation of talent in early modern Europe *

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September 17, 2022

Abstract

We study how an ideologically repressive authority, the Roman (or Italian) Inquisition, affected high-talent individuals. Descriptive analysis produces *prima facie* evidence that after its establishment in 1542, notable individuals born in Roman Inquisition states became less likely to undertake scientific careers. We then build and estimate a structural dynamic model of occupational and location choices to investigate causal pathways. The drivers of Italy's relative scientific decline after 1542 turn out to be the Inquisition's *deterrence effect*, which pushed scientists away from places under its grip, a (less important) *cultural effect*, whereby the Inquisition weakened the willingness to embrace a scientific career in the first place, and the *human capital effect* stemming from the consequent reduced availability of science masters. A counterfactual historical experiment indicates that absent the Inquisition, the share of notable Italians engaging in science would have remained at the pre-1540s level of 16% instead of dropping to 12%.

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> What good would it do you to have all the time you want for research if any witless monk of the Inquisition could simply suppress your ideas?
>
> Bertold Brecht, *Life of Galileo*

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1 Introduction

Governments that embrace strict ideologies have the ability to negatively affect social and economic outcomes. For example, religious rulers can increase the cost of education for women, tax minorities more heavily than other groups, or restrict freedom of thought and expression (Saleh and Tirole, 2021). A key detrimental consequence of these policies relates to the production of knowledge, as high-talent individuals can decide to emigrate or adjust *ex-ante* their career paths in response to altered incentives in a repressive environment. While often considered in isolation, these location and occupational choices are connected in important ways: when electing on their career in a certain cultural and institutional context, individuals may internalize their likelihood of migration, and, by doing so, affect the choices and opportunities of future individuals in different places via intergenerational human capital externalities. This paper provides a new theoretical framework and historical evidence to study these questions. Our case study is the Counter-Reformation (CR, henceforth), a major event in early modern Europe that affected scholarship during the two centuries that preceded the first Industrial Revolution.

The CR was the Catholic Church's response to Protestantism. Following ineffective attempts to find a theological agreement with the Lutherans, in 1542 Pope Paul III established in the Papal States the core of what quickly became a centrally organized policy of ideological enforcement: the *Roman Inquisition*. This institution was effectively the long arm of the CR; its activity spread over the Italian peninsula, where governments were strongly connected with the papacy. For nearly two centuries, the so-called *Sant'Uffizio* would prosecute, through special tribunals, thousands of individuals whose ideas were deemed heretical. The famous examples of Giordano Bruno (who in 1600 was sent to the stake for his philosophy) and Galileo Galilei (who in 1633 was forced, under the threat of a similar punishment, to abjure the idea "that the earth is not the centre [of the universe] and is movable") are revealing of the risk faced by intellectuals who would embrace or develop ideas in contrast with the religious orthodoxy.[1]

[1] Elite thinkers were not the only ones threatened by the Inquisition. Domenico Scandella, known as Menocchio, was a miller in north-eastern Italy who spread the idea that the earth's origins were similar to that of fermenting cheese and that men emerged from it like worms. These theories were perceived by the Inquisition as challenging creationism and Menocchio, who also possessed prohibited books and an Italian vernacular Bible, was tried and ultimately sentenced to death in 1599 (Ginzburg, 1976). While extreme, this example illustrates the far-reaching activity of the Roman Inquisition.

In such repressive environment, scientists were often pushed to migrate to places where they could avoid the threat of punishment, thereby shifting the development of scientific knowledge and practice towards places outside the Inquisition's reach.[2] In parallel, new generations of potential scientists may have been induced to choose different, less conflicting occupations when deciding over their careers. In either case, the subsequent decrease in the number of scientists in places under the Inquisition's grip may have had long-lasting economic consequences due to reduced positive intergenerational externalities from the stock of locally available knowledge and science masters.

Our goal is to quantify these dynamic effects using a newly-assembled dataset and a structural model of the occupation and location choices of high-talent individuals in Europe between the 15th and 17th centuries. We collected data on famous individuals from the *Index bio-bibliographicus notorum hominum* (IBN), a project initiated in 1978 that aims at gathering all biographies ever written. The *notable people* included in the IBN can be regarded as "geniuses", for their extraordinary ability and contribution to human knowledge. The biographical text allows us to extract their occupation and so to track scientific careers over time and across European polities. We use a sample of 11,669 such individuals born in 1454-1618 with known places of birth and death.

The first step of our analysis consists of providing descriptive evidence on the impact of the Roman Inquisition on the probability that notable individuals choose a scientific career – as opposed to other careers that were at lower risk of an investigation – and on the probability that they moved to alternative locations. Comparing, in a Difference-in-Difference (DiD) setting, states in the Italian peninsula to political entities in the rest of Europe that were not directly affected by the Roman Inquisition, we show that the probability that a notable person who was born in CR states chooses a scientific profession decreased by 4.7 percentage points after the establishment of the Inquisition, which corresponds to about 39% of the share of scientists in our sample. Moreover, we show that while scientists born in Italy were less mobile than other notable people before the establishment of the Roman Inquisition, they moved relatively more afterwards, and that notable people's migration to non-CR states became more intense for scientists.

[2] An example is Niccolò Buccella (or de Buccellis), a physician and surgeon from Padua who engaged in anatomical dissection of corpses with German students at the University of Padua. In 1571, following threats from the local bishop to stop this practice, he fled to Poland to avoid being arrested and standing trial in front of the Inquisition. He died in Krakow in 1599 (Caccamo, 1972).

However, while providing useful *prima facie* evidence, these patterns are not enough to capture the Inquisition's causal impact on the production of science. This is because the CR affected the presence of scientists in CR states but *also* in non-CR states, via location decisions; these, in turn, trigger a dynamic effect since a variation in the number of scientists in a given generation affects the availability of masters that are able to train scientists in the next generation. Spillovers on untreated units like these are in fact ubiquitous when the treatment is a major historical event, and they imply a violation of necessary conditions to produce valid causal inference via DiD.[3]

Therefore, the second step of our analysis consists of building and estimating a structural, dynamic Roy model of the occupational and location choices faced by notable people between the 15$^{\text{th}}$ and 17$^{\text{th}}$ centuries. Our theoretical framework takes into account endogenous location responses, pre-existing different trends in CR and non-CR states reflected in wages and total factor productivity dynamics, and the fact that the decision to become a scientist is not separable from the location decision – factors that would be difficult to control for in a reduced-form setting. In that sense, our methodological contribution is in the spirit of Bisin and Federico (2021), who advocate the use of structural models in historical economics as a way to study in a comprehensive way the effects of institutional shocks and the underlying mechanisms.

In our model, an individual is born in a given location and lives for two periods. A career decision (to become a scientist or a non-scientist) is made in the first period by sufficiently high-talent individuals, taking into account that the best location decision (to remain in one's birthplace or to relocate) will be made in the second period. This formulation embeds the idea that geniuses whose talent emerges are bound to become notable people regardless of how or where they choose to express such talent. While the emergence of talent may be affected by environmental factors, we assume – supported by the data – that these factors are independent of the unobserved drivers of one's decisions. Utility is career- and location-specific, and depends on net earnings; these, in turn, are proportional to an individual's specific human capital, which increases in the fraction of masters (scientists or non-scientists from the previous generation in one's birthplace).

[3]Moreover, it is hard to completely rule out the presence of confounding treatments. For instance, the returns to scientific careers were increasing before the Reformation, owing to the introduction of the printing press (Dittmar, 2019): if Gutenmberg's invention developed differently in CR and non-CR states, there would be reasons to suspect that the parallel trends assumption would also be violated.

The CR – via the establishment of the Roman Inquisition – affects this decision problem in three ways: (i) the threat of a trial and sanctions faced in the second period only by scientists in counter-reformed states, which we model as a tax on earnings, and label the *deterrence effect*;[4] (ii) the indoctrination of large parts of the society, which leads to anti-scientific social norms and thus to social stigma suffered by individuals who pursue a scientific career in polities affected by the CR; we label this the *cultural effect*; and (iii) a cumulative reduction in the fraction of potential science masters, which is a key input in the technology of scientific skill formation for future generations; we refer to this third effect, which is triggered by (i) and (ii), as to the *human capital effect*. Of course these negative impacts on CR states correspond to a positive impact on non-CR states as scientists would become more likely to relocate to (or remain in) the latter to avoid the Inquisition's threat. Thus, an indirect treatment effect on non-CR states arises naturally in this historical context and reinforces over time via the human capital channel.

Estimates of the model parameters indicate that the decision to become a scientist is significantly influenced by the human capital mechanism: the marginal effect of increasing the fraction of scientists in one's birthplace on the probability of becoming a scientist is nearly 9 percentage points (p.p.); it is also affected by a less relevant yet significant cultural effect: being raised in a place where the Inquisition is present at birth decreases by about 4 p.p. the probability that a young notable person chooses a scientific career. Moreover, the presence of the Inquisition affects scientists' location via the deterrence effect: conditional on having chosen a scientific career, notable people become (*ceteris paribus*) about 11 p.p. less likely to remain in or move to states where the Inquisition is present and correspondingly more likely to stay or settle in states where it is absent. These processes affect dynamically the stock of masters for future generations, thus magnifying the human capital effect. The model allows us to quantify, via a counterfactual historical experiment, the contribution of the Roman Inquisition to the decline of the share of notable people who engaged in science in the Italian peninsula during the 16$^{\text{th}}$

[4] The idea that the threat of the Inquisition alters individuals' incentives to pursue scientific activities is well described by Berthold Brecht in his *Life of Galileo*: "GALILEO *Your protection of freedom of thought is rather good business, isn't it? You get good teachers for low pay by pointing out that other towns are run by the Inquisition, which burns people. In return for protection from the Inquisition, your professors work for next to nothing.* THE PROCURATOR *You're being unfair. What good would it do you to have all the time you want for research if any witless monk of the Inquisition could simply suppress your ideas? No rose without thorns, Mr. Galilei, no prince without monks!*" (Brecht, 1955, p. 8)

and 17$^{\text{th}}$ centuries. It turns out that, absent the Inquisition, this share would have remained constant at the pre-1540 level of about 16% – which was larger than in non-CR states – while in reality it dropped to about 12%. Thus, the CR accounts for the bulk of the decline of science in Italian states.

Interestingly, this counterfactual experiment implies an average treatment effect on treated polities of about 3 p.p., which is in the same ballpark as the Average Treatment Effect on the Treated (ATET) that would be produced by a DiD approach. Thus, in practice, the consequences of possible violations of the assumptions that would ensure identification of the ATET in a DiD setting are not of first-order importance. We would not have known this without estimating and simulating a structural model, a manifestation of the advantages of combining in a consistent way reduced-form and structural methods in historical economics. Highlighting these facts is another methodological contribution of the present paper.

Our findings demonstrate from a novel angle the far-reaching, detrimental effects of ideological control of knowledge on talented individuals' choices and science. The CR provides an ideal case study, but there are other historical examples. Chaney (2016) argues that religious elites' increased political power during the "Sunni Revival" (11$^{\text{th}}$–13$^{\text{th}}$ centuries) accounts for a large share of the decline in scientific production in the Islamic world. This author shows, in particular, that following the spread of madrasas (educational centers that pivoted on the Islamic law), the scientific output of authors affiliated with these centers decreased by between 3 and 5 p.p., or between 30% and 50%. Although Chaney (2016) exploits a different margin of variation, this magnitude is similar to our estimate of a 25% drop in the likelihood that notable individuals embraced a scientific career following the CR. More recent examples include ostracism towards scientists who adopted ideas of Western origin in Soviet Russia after World War II (Krylov, 2021) and in China during the "cultural revolution" (Freeman and Huang, 2015).

Three recent papers are directly related to our study of the Roman Inquisition. The first is Becker, Pino, and Vidal-Robert (2021), who study the effect of the CR on printed books and provide causal evidence of a negative impact on the production of forbidden books. The authors also document that cities with milder enforcement were more successful in attracting notable individuals. Second, Blasutto and De la Croix (2021) study the effect of censorship on knowledge growth by focusing on the productivity of Italian academics in 1400-1750. They find that censored authors were of better quality than non-censored ones and that as censorship became less stringent, this gap was reduced. Comino, Galasso, and Graziano (2021) also study the effect of the Inquisition on the production of books, focusing on publishers in Venice. Findings indicate that censorship reduced output and the propensity to publish new, contemporary authors. The common finding in these papers – that through censorship the CR affected the stock of knowledge embodied in books and available in Italy – is complementary to our emphasis on the Inquisition's dynamic effects on the stock of human capital, i.e., the knowledge embodied in scientists themselves and that is transmitted to future generations via training.

Our results are also consistent with two papers that use IBN data: Lecce, Ogliari, and Squicciarini (2021), who find that religiosity reduced the incidence of scientists in 19$^{\text{th}}$ century France – in analogy to our cultural effect; and Serafinelli and Tabellini (2021), who find that the emergence of city institutions that protected economic and political freedom facilitated the attraction and production of creative talents in Europe between the 11$^{\text{th}}$ and 19$^{\text{th}}$ centuries – in analogy to our human capital effect. They are also consistent with Moser, Voena, and Waldinger (2014), who show that the migration of Jewish scientists from Nazi Germany to the US had long-lasting positive consequences on innovation in the receiving country, and Moser and San (2020), who quantify the large and persistent decline in invention induced by the reduced inflow of European scientists following US immigration quotas in the 1920s. The importance of masters in shaping the creativity and skills of next generation's talented individuals is also demonstrated by Borowiecki (2022) in a quantitative study of the careers of notable musicians since 1450.

More broadly, our study contributes to the literature on the economic and social consequences of religion, which dates back to Weber's (1905) seminal work. More recently, Barro and McCleary (2003, 2005) and Guiso, Sapienza, and Zingales (2003) study how religious beliefs affect economic growth. Becker and Woessmann (2009), Chaney (2011), Botticini and Eckstein (2012), and Valencia Caicedo (2019) emphasize the impact of religion on human capital, which is a key mechanism in our model. Chaney (2013) and Belloc, Drago, and Galbiati (2016) study how proximity between secular and religious authorities affects politics and institutional change. Finally, our research relates to historical work on scientific progress and religion, e.g., Mokyr (1998, 2004) and Chaney (2016), and to the political economy of religion and science, e.g., Saleh (2016), Rubin (2017), and

Bénabou, Ticchi, and Vindigni (2021). Drelichman, Vidal-Robert, and Voth (2021) study the persistent effects of the Spanish Inquisition (which preceded the Reformation and which targeted Jews and Muslims) and find negative effects on various development indicators of municipalities that were more strongly affected by inquisitorial activity.

The rest of the paper proceeds as follows. Section 2 provides the relevant historical background; Section 3 presents the data; Section 4 builds first-pass descriptive evidence; the structural analysis is carried out in Section 5, and Section 6 concludes.

2 Historical Background

Reformation and Counter-Reformation. At the beginning of the 16$^{\text{th}}$ century, the Italian peninsula was – like the rest of Europe – in great intellectual ferment. Theology was no exception: starting in 1517, Martin Luther's ideas spread from the north, with the first Italian translation of his texts appearing in 1518. In the south, Juan de Valdes, a Spanish scholar, brought to Naples in 1529 the doctrines of Erasmus and Calvinus, which will be very influential in the peninsula. The spread of these new ideas was facilitated by political and social instability. Since the 1490s, Italian wars had affected most states, culminating with the 1527 "sack of Rome" by Charles V's troops. By 1540, new ideas and heterodox christian doctrines had percolated through the Italian society, including the ecclesiastical elite. Even prominent figures like Vittore Soranzo, bishop of Bergamo, and cardinal Reginald Pole were open to discussing protestant ideas.

Pope Paul III and a number of cardinals lead by Gian Pietro Carafa feared these new ideas, and realized – especially after the failure of the Ratisbon Conference, where Catholic and Protestant leaders gathered in 1541 in search of a common ground – that a peaceful solution to contain them was doomed to fail. In an effort to oppose the Reformation, they started a Counter-Reformation (CR). In May 1542, Paul III announced the Council of Trent, which is considered the Catholic Church's doctrinal response to Lutheranism and Calvinism; two months later, in July 1542, he released the Papal bull *Licet ab initio*, which created a centrally organized judicial body whose mission was to deal with the new "heresies": the Congregation of the Holy Office (*Sant'Uffizio*), better known as the Italian, or Roman, *Inquisition*. Even at the time of the bull, inquisitorial practices were centuries old. The Medieval Inquisition had existed in Italy at least since the 12th century, to deal with the Cathar and Waldesian heresies. However, its practices varied and its activity had low intensity: most medieval inquisitors were chosen by local ministers (often from the Dominican order) and were notable clergymen with many other duties; most of them devoted little time and energy to inquisitorial activities. Moreover, an Inquisition existed in Spain since 1478 and in Portugal since 1536, but these institutions were initially targeting Jewish and Muslim minorities only.

The new Roman Inquisition targeted the entire population under its jurisdiction, was built on a strong legalistic base, and trained full-time professional inquisitors. It was lead by a group of six cardinals, one of whom was the future-pope cardinal Gian Pietro Carafa, whose diplomatic experience in Spain had produced a harsh and methodical conception of the inquisitorial activity. A year before the 1542 Papal bull, Paul III had instructed Carafa and others to organize such activity also in Italy. In the few months following the creation of the *Sant'Uffizio*, six legal processes for cases in Bologna were already filed. In 1549, the year Pope Paul III died, 92 investigations were conducted. Even if the severity of sentences – especially those regarding members of the clergy – depended on the idiosyncratic views of different popes, the process had set it. In 1567, the execution of Pietro Carnesecchi (a Florentine nobleman close to Reformation ideas who was convicted despite his influential connections) was the tombstone for intellectual diversity in states reached by the Roman Inquisition. Moreover, an "army" of missionaries was dispatched among the Italian popular classes with the specific task of establishing a culture in line with the CR goals (Prosperi, 2009).

Functioning. The Roman Inquisition was a hierarchical institution, with local tribunals responding to the one in Rome and so more centralized than episcopal inquisitions. It reached most of the peninsula despite Italy's political fragmentation. Although it faced some resistance even within the Papal States – especially where bishops had already inquisitorial activities in place – the central office did not need formal local tribunals to issue a conviction, especially in the early years. Outside the Papal States, the Inquisition needed the agreement of sovereign rulers and typically required some procedural guarantees (from simple consultation to power-sharing agreements like in the Republic of Venice),[5] yet it spread across the Italian peninsula relatively quickly. By the end of the

[5] The Online Appendix summarizes this development separately for each state.

16$^{\text{th}}$ century, almost all Italian states and the papal city of Avignon, Malta, and Venetian territories in the Balkans were under Inquisitorial scrutiny (see Figure 1). Sardinia and Sicily were under Spanish rule and had Spanish Inquisition tribunals since the late 15$^{\text{th}}$ century. In the Kingdom of Naples, the *Sant'Uffizio* was constrained to go through old medieval episcopal tribunals and practices, yet it operated extensively.

The Roman Inquisition was based on two key principles. The first, of Thomistic derivation, was that heretical ideas can arise by mistake; thus, the first step of the judicial procedure – like in the case of Galileo Galilei – was an attempt to persuade the indictee to correct his or her errors. The second principle derived instead from the Papal bull *Apostolici regiminis*, which had been issued in 1513 by Leo X and which established the primacy of the Holy Scripture over all scientific and philosophical ideas; thus, philosophy and science could not claim as true in their own domains those ideas that theology regarded as false. The Bull not only constrained university teachers (under penalty of being accused of heresy) but it was also used to control thinkers and to censor books.

In practice, most procedures started with reports to the Inquisition itself, e.g., from worried neighbors, priest-confessors, or acolytes seeking redemption. To a lesser extend, procedures also originated from information sharing between tribunals and the *Sant'Uffizio*. Such oppressive atmosphere often triggered self-denunciations, with the intention to "return to the Catholic doctrine", a practice that was warmly encouraged by inquisitors. The tribunals heard the indictees and called witnesses in case of denial. Based on these first hearings, the tribunal decided whether to start a summary or a formal trial. The former would be resolved without further due and with relatively light sentences; the latter instead could be lengthy and involve lawyers, witnesses and external experts. Sentences were extremely varied, with capital punishment being the exception rather than the norm. Aside from imprisonment, we record confiscation of property, forced labor, exile, public abjuration, shaming, and flogging. Death sentences were nevertheless cruel: mutilations, hanging, burning, and drowning.

As emphasized in the complementary work of Becker, Pino, and Vidal-Robert (2021), Blasutto and De la Croix (2021), and Comino, Galasso, and Graziano (2021), an important channel through which the Roman Inquisition operated was censorship, a process of close control of book production. The formal *Index Librorum Prohibitorum* (List of Prohibited Books) did not exist before 1559, but already in 1543 some books were prohibited and relationships with libraries were established to spot editorial production that was not consistent with the catholic orthodoxy. Censorship was initially in the hands of the *Master of the Sacred Palace*, and then was formally instituted in 1571 as the *Congregation of the Index*. In the meantime, upon being elected pope Paul IV, cardinal Carafa made it clear that certain books were to be burned, and he issued the first Index in 1559.

3 Data

Notable people. We use data from the *Index Bio-Bibliographicus Notorum Hominum* (IBN), an ongoing project started in 1978 that aims at gathering all biographies ever written. This data source was first used in economics by De la Croix and Licandro (2015). Compared to larger and more popular data bases such as Laouenan et al. (2022), IBN is hard copy/expert-based instead of online/crowd-sourced, which is arguably better for the period that we study. As of 2020, Volumes 1 to 205 of IBN have been published, containing data from more than 6,000 biographical sources on individuals with names from A to P. Each entry contains the dates and places of birth and death, and a biographical text of varying length, from a few words to a full paragraph.[6] We select individuals with non-missing places of birth and death, born between 1454 (Gutenberg bible) and 1618 (Thirty Years' War), resulting in a sample of 17,474 notable individuals.

Geography. We geocoded notable people's places of birth and death, and we mapped them into polities using EurAtlas historical maps. Polities are states ruling over a clearly defined territory and population. Although their political power may derive from other states, we consider them as distinct entities provided that they maintain some autonomy and homogeneity.[7] For each location, we determined the political entity in 1500 and 1600. When the two were different, we investigated and encoded the changes occurring between the two dates. Appendix Figure A-1 maps the resulting entities and places of birth of notable people. These states are the geographic level of our analysis.

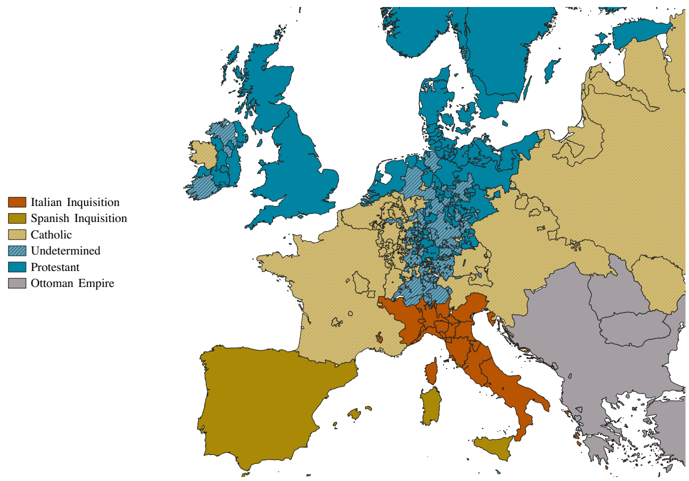
[6]This is a record for a notable Englishman:

> dalmare, cesare; 1558-1636; tottenham-london; british jurist, judge of the admiralty, master of the chancery, master of requests.

[7]E.g., the Duchy of Milan, which during the 16th century was under French and then Spanish rule.

Religion. We imputed each state a religious status by cross-checking detailed encyclopedic maps and historical accounts. The key distinction that we exploit – whether or not a polity was subject to the Counter-Reformation – is determined by objective elements: we classify a state as Counter-Reformed (CR) if the Roman Inquisition was active in that political entity;[8] we further differentiate non-CR states along different religious lines, as illustrated in Figure 1.[9]

Figure 1: Religion in Europe around 1600



Notes: The figure shows the boundaries of political entities (states, which are the geographic level of our analysis) around 1600 and the imputed religious status. Source: EurAtlas historical maps for polities' boundaries and several historical sources for their religious status.

In our empirical analysis, we drop about 5,300 individuals born or dead in Spain or Portugal (because they are "treated" by a different type of Inquisition both before and after 1542) or born or dead in the Ottoman Empire (which spanned at some point large portions of Eastern Europe but yet is hardly comparable to christian polities).

Occupations. Following De la Croix and Licandro (2015), we determine an individual's occupations from the biographical text available in the IBN. The left part of Table 1 shows the most common occupations in our data. An individual can have multiple occupations. These are then grouped into the broader categories reported in the right part

[8]The list and specificities of each of these political entities can be found in Appendix Appendix A-1

[9]This classification obviously implies assumptions and simplifications, as religious predominance does not follow political boundaries; we thus focussed on the main and most stable position of entities' governing bodies. Note that it will only be used to select different control groups in our robustness analysis, and has no incidence on our identification set up.

of Table 1. We define as a scientist someone whose occupations includes at least one of the following: *agronomist, architect, astronomer, botanist, cartographer, chemist, doctor, engineer, geographer, geologist, inventor, mathematician, naturalist, pharmacist, physician, physicist, surgeon, zoologist*; i.e., technical professions that make use of scientific knowledge. We drop 470 individuals whose only occupation is "nobility" (which one cannot choose) or "army" (which is an occupation that is heavily affected by the contemporaneous military events). The resulting final sample is composed of 11,669 individuals.

Note that the incidence of notable people on total population may vary over time, due to bias in recording or to the evolution of environmental factors that determine whether geniuses actually express their talent in some way. This is not a problem for our analysis as long as such factors are independent of the unobserved determinants of notable individuals' occupational or location choices. The data support this scenario. Using population data for a group of European cities in 1500 and 1600 assembled by Bairoch et al. (1988), we can check the correlation between, on the one hand, changes in the share of notable individuals born in those cities and recorded in IBN and, on the other hand, changes in the share of those individuals who chose to be scientists. The correlation is a statistically insignificant -0.082, indicating that variations in IBN entries do not predict variations in occupational choices.

Table 1: Occupations of notable individuals

Top 10 occupations

Occupation	Count	Frequency
author/writer	4269	0.365
professor	1542	0.132
teacher	1499	0.128
priest/pastor	1218	0.104
theologian	1172	0.100
doctor/physician	1147	0.0981
poet	1072	0.0917
painter	1071	0.0916
clergyman	1007	0.0861
lawyer	730	0.0625

Categories

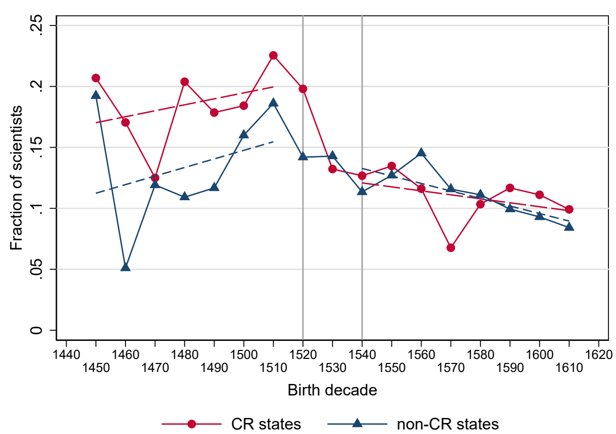
Category	Count	Frequency
army	365	0.0312
art et metiers	3412	0.292
business	610	0.0522
education	5210	0.446
humanities	1206	0.103
law and government	2397	0.205
nobility	547	0.0468
religion	5007	0.428
science	1390	0.119

Notes: These tables count the occurrences of profession/profession-categories among notable individuals. Multiple professions or profession-categories are possible. Sample: 11,669 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

4 Descriptive analysis

We report here *prima facie*, descriptive evidence that the Roman Inquisition led to changes in the incidence of scientists among notable people in Italian polities. The share of notable individuals who become scientists in each cohort can be interpreted as the probability that a talented individual in that cohort chooses a scientific career instead of an alternative occupation. The changes in this share among individuals born in CR and non-CR states before and after the establishment of the Roman Inquisition can be inferred from Figure 2. The vertical lines represent the advent of the Inquisition: cohorts born after 1541 experience this institution throughout their life. Instead, individuals born in 1521-1541 (and possibly earlier) belong to "transition" generations as the Inquisition appears while they are already in the process of choosing a career or a location. Our analysis takes into account their possible different response. Figure 2 shows that before the Inquisition, the incidence of scientists was growing roughly at the same rate in both CR and non-CR states, but it was actually higher in the former. After the establishment of the Roman Inquisition, this advantage of CR states disappears.

Figure 2: Incidence of scientists among notable people



Notes: The figure reports the fraction of scientists among notable people born in CR and non-CR polities by birth decade. Sample: 11,689 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

We test whether the pattern in Figure 2 is confirmed in a formal regression analysis that conditions on cohort and place effects, postponing until the structural analysis the causal inference question. The estimating equation is a linear probability model,

$$s_{icpg} = \alpha + \beta_1 CR_p + \beta_2 \text{Post-}CR_g + \beta_3 \text{CR}_p \times \text{Post-}CR_g + \gamma \mathbf{X}_c + \mu_g + \nu_p + \epsilon_{icpg}, \quad (1)$$

where s_{icpg} is a variable equal to 1 if notable individual i, born during decade g in city c located in polity (state) p is a scientist, and 0 otherwise; CR_p and Post-CR_p are dummy indicators equal to 1 if i was born, respectively, in a CR state and after the establishment of the Roman Inquisition (the fourth decade of the 16$^{\text{th}}$ century); $\mathbf{X}_c$ is a vector of city-level controls (elevation, river, sea, presence of a university, and a proxy for city-size), and μ_g and ν_p are decade and polity fixed effects, respectively.[10] The coefficient of interest is β_3, which measures the differential impact of the establishment of the Inquisition on the probability of becoming a scientist for a notable individual born in a CR state with respect to another individual born in a non-CR state.

Results are reported in Table 2. The all-inclusive specification in column [4] indicates that the Inquisition is associated with a 4.7 percentage points decrease, on average, in the share of individuals born in a CR state who choose to become scientists (relative to those born in other states), which corresponds to a 39% decrease relative to the mean of the dependent variable in the sample. In column [5], we exclude notable people born within 20 years before the start of the Inquisition, who are individuals in a transition generation. The point estimate is some 9% larger, suggesting the presence of a dynamic mechanism that generate a stronger negative effect for subsequent generations.[11]

Equation (1) is the DiD statistical model that a researcher approaching our question from a reduced-form angle would employ. As discussed in the Introduction, there are plausible concerns that the DiD assumptions would not hold because (i) a scientist can move to a different state in order to escape the Inquisition, and (ii) trends in potential outcomes would not be parallel. The possibility to migrate in the future to avoid punishment, in particular, affects career choices in the early stages of the life cycle. This important margin – which is central in the structural model that follows – is missed by Equation (1) but its footprints are visible in the data. Consider Figure 3; here we assign individuals to birth cohorts defined by a 20-year interval, and we calculate the fraction of scientists and non-scientists who moved to another state during their lifetime accord-

[10] In the states of Este, Modena, and Savoy (where 196 individuals in our final sample, or 1.7% of the total, were born) the Inquisition became effective during the 1560s and 1570s (Jenkins Blaisdell, 1975; Lavenia, 2008), and these are the dates used in our baseline analysis for these states. To avoid the perils from the resulting staggered DiD design (which do *not* arise in our structural analysis), we show in the Appendix that the DiD results are robust to choosing 1540 as the cutoff date for all CR states.

[11] Appendix Tables A-1 and A-2 show that these results hold when comparing scientists to sub-groups of occupations, and when comparing CR states to sub-groups of non-CR states with a specific religion.

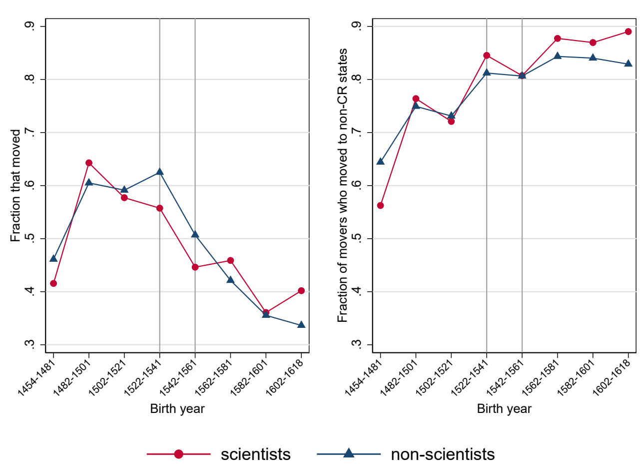
Table 2: Results of descriptive regression analysis

	Dep. Var. Mean= 0.12; SD= 0.32 Full sample, born in 1454-1618				Excluding those born in 1521-1541
	[1]	[2]	[3]	[4]	[5]
Post-CR	-0.032^{***}	-0.031^{***}			
	(0.008)	(0.008)			
CR State	0.040^{**}	0.036^{**}	0.040^{**}		
	(0.018)	(0.018)	(0.017)		
Post-CR*CR State	-0.039^{**}	-0.038^{**}	-0.046^{**}	-0.047^{**}	-0.051^{**}
	(0.018)	(0.018)	(0.018)	(0.021)	(0.024)
City-level controls		✓	✓	✓	✓
Decade FE			✓	✓	✓
Polity FE				✓	✓
Observations	11,669	11,669	11,669	11,669	10,392
R^2 (within)	0.004	0.005	0.002	0.001	0.001

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is a dummy equal to one if the individual is a scientist. Columns [2]-[5] include city of birth controls (city size, elevation, proximity of rivers and access to the sea). Columns [3]-[5] condition on decade-of-birth fixed effects, and Columns [4]-[5] on political entity ('realm') fixed effects. The models are estimated using OLS. Standard errors are indicated in parentheses and are clustered at the place of birth ('city') level. Coefficients for the controls are not reported for the sake of space. Sample: 11,669 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

ing to the information on place of death. The figure's left panel shows the fraction of movers. Scientists move relatively more than non-scientists after the establishment of the Roman Inquisition. The right panel shows instead the fraction of these movers that moved to non-CR states. After the cutoff, this event is more likely for scientists than for the rest. These patterns suggest that the Roman Inquisition had indeed a differential impact on the mobility of scientists, not only on their occupational choices. We next turn to structural modeling and estimation to address these issue in a rigorous way.

Figure 3: Mobility patterns: scientists vs non-scientists



Notes: The figure shows the fraction of notable individuals born in CR states who died in a different state (left panel) and the fraction of these movers who moved to non-CR states (right panel). Sample: 11,669 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

5 Structural analysis

5.1 Setup

The population is composed of overlapping generations $g \in \mathbb{N}$ of individuals who live for two periods $t = 1, 2$. The discount rate is zero. Each individual was born in an exogenous place $p = 1, \cdots, P$ (a polity), lives in her/his birthplace during $t = 1$, and can migrate to a different location p' at $t = 2$, at a cost equal to fraction $m_{pp'}$ of earnings at $t = 1$.[12] For "stayers" it is $p' = p$ and $m_{pp'} = 0$.

Each individual is characterized by an exogenous cognitive trait ψ (intelligence) and by an endogenous job type j (occupation). Let $\bar{\psi}_g$ denote a generation-specific, exogenous intelligence threshold. For each generation, those with $\psi \leq \bar{\psi}_g$ are ordinary people that end up in ordinary jobs ($j = o$). Those with $\psi > \bar{\psi}_g$ instead are geniuses that become "notable individuals" and hold extra-ordinary jobs of two types: scientist ($j = s$), or non-scientist ($j = n$). As discussed above, threshold $\bar{\psi}_g$ may vary in response to environmental factors; however, we have also discussed that such changes do not predict changes in the share of notable individuals who become scientists. Therefore, we assume that the environmental factors in questions are independent of unobserved factors that affect occupational and location decisions. As shown in what follows, the assumption that only geniuses can hold extra-ordinary jobs (and that all individuals maximize income) rules out any residual self-selection into the pool of notable individuals.

Human capital and earnings. Any young worker in any generation is endowed with a unit of job-specific skills, $H_{jg} = 1$. There is no human capital accumulation for ordinary workers, while extra-ordinary workers accumulate human capital via on-the-job training during $t = 1$. Such skill formation process occurs in one's place of birth via a technology whose only input are local *masters*, i.e., notable individuals from the previous generation who live in that place. In other words, scientific, technical, artistic, or any other type of advanced knowledge is transmitted from one generation to the next locally (via social contact), and a young genius' ability in a particular activity increases with the share of older geniuses who specialized in that activity and who live where a young

[12] This assumption simply means that moving costs are proportional to total factor productivity in one's birthplace, as would be the case if relocation services are provided by workers in the place of origin.

person grows up. Such share captures the probability of meeting a master with specific skills. The model rules out that a young genius migrates to a different place in search of masters. Denoting by ϕ_{spg-1} and ϕ_{npg-1} the fractions of notable individuals who are, respectively, scientists and non-scientists in place p and generation $g-1$, a generation g notable individual's ability at $t=2$ is given by

$$H'_{jg} = (1+\phi_{jpg-1})^{\theta}, \quad j = \{s, n\}, \tag{2}$$

where $\theta > 0$ is a technology parameter that determines the effect of the local supply of masters on a genius' scientific and non-scientific skills. If there are no masters locally, i.e., $\phi_{jpg-1} = 0$, then $H'_{jg} = 1$, which is the first-period skill endowment.

Earnings vary across jobs, places, and over time. Specifically an individual in generation g who was born in place p and later chooses place p', earns w_{jpg} at $t=1$ and $w'_{jp'g}$ at $t=2$. Earnings are given by the return to an individual's career-specific ability and place-specific total factor productivity (TFP, denoted by A), i.e.,

$$w_{jpg} = A_{pg} \tag{3}$$

$$w'_{jp'g} = A'_{p'g} \exp(\alpha_{jp'}) H'^{\rho}_{jg} \tag{4}$$

where ρ is the skill elasticity of earnings and $\alpha_{jp'}$ is a job- and place-specific productivity shift. In words, for unskilled ($H_{jp} = 1$) young workers, earnings are determined by local TFP only, while for older, skilled geniuses job-specific human capital acquired during $t=1$ matters on top of local TFP, with a possible job-specific shift of local TFP. Note that the OLG structure implies $A'_{pg} = A_{pg+1}$.

The Inquisition and preferences. The Inquisition is an institution that imposes a penalty π on geniuses who become scientists, thus exerting a *deterrence effect* on science. We model this penalty as a proportional tax on a scientist's earnings at $t=2$. The Inquisition not only punishes scientists, it also establishes anti-scientific perceptions that exert a *cultural effect* on scientific careers: a genius who was born in a place where the Inquisition is active and who chooses to be a scientist experiences disutility γ (social stigma) at $t=1$ for deviating from such anti-scientific cultural norms.

Preferences over job types j and second-period locations p' are represented by a lifetime utility function $u(j, p')$. This function, which is conditional on one's exogenous birthplace p and cohort g (we do not keep track of this fact in order to simply the notation), is given by

$$u(j,p') = \underbrace{\ln(w_{jpg}(1-m_{pp'}))}_{\text{net income at } t=1} + \underbrace{\ln(w'_{jp'g}(1-\pi\mathbb{I}[j=s]I_{p'g}))}_{\text{net income at } t=2} - \underbrace{\gamma\mathbb{I}[j=s]I_{pg}}_{\text{social stigma}} + \epsilon_{jp'}, \tag{5}$$

where $\mathbb{I}[j=s]$ is an indicator function equal to 1 if an individual chooses to be a scientist and 0 otherwise, I_{pg} and $I_{p'g}$ denote the presence of the Inquisition in places p and p', respectively, during the lifespan of generation g (equal to 1 if present, equal to 0 if not), and $\epsilon_{jp'}$ is an unobserved (to the econometrician), zero-mean preference shock.

In words, an individual derives diminishing utility from net income (after deductions for moving costs and Inquisition punishment for scientists) and suffers disutility from deviating from the anti-scientific cultural norm established by the Inquisition. The assumption that the different utility components are additive is standard and allows for empirical tractability.

Specifying a linear mobility cost share $m_{pp'} = \mu d_{pp'}$, for $d_{pp'}$ the distance between p and p', using approximations $\ln(1-\mu d_{pp'}) \approx -\mu d_{pp'}$ and $\ln(1-\pi\mathbb{I}[j=s]I_{p'g}) \approx -\pi\mathbb{I}[j=s]I_{p'g}$, and replacing wage equations (3)-(4), utility can be written as

$$u(j,p') \approx \ln A_{pg} - m_{pp'} + \ln A'_{p'g} + \alpha_{jp'} + \rho\theta\ln(1+\phi_{jpg-1}) - \pi\mathbb{I}[j=s]I_{pg} - \gamma\mathbb{I}[j=s]I_{pg} + \epsilon_{jp'}. \tag{6}$$

Summing up, the Inquisition affects the career decisions of geniuses through three channels: (i) *deterrence*, via the punishment imposed on scientists; (ii) *culture*, via the disutility of deviating from anti-scientific social norms; (iii) *masters*, via the altered availability of scientists in the previous generation – the key input for the development of young geniuses' scientific skills. Note that while a scientist can neutralize the deterrence effect by moving to a non-Inquisition place (thus avoiding punishment), the cultural and training effects cannot be controlled because they are tied to one's exogenous place of birth. It is also important to note that the deterrence and masters effects are exerted not only on individuals born in places where the Inquisition is present; they are exerted on *all* geniuses who can potentially migrate to those locations, regardless of their birthplace. This is so because the presence of the Inquisition in a certain place discourages in-migration of scientists to that place and encourages their out-migration from that place, thus affecting dynamically the future stock of masters. It follows that the results from a standard DiD design should be interpreted with caution because the migration of scientist implies a violation of SUTVA, although at this stage one cannot tell how important the practical consequences of this violation are.

5.2 Choice

It is convenient to distinguish between components that vary across careers and across locations (i.e., the two decision variables) and to rewrite equation (6) as

$$u(j, p') = v + v_j + v_{p'} + v_{jp'} + \xi_j + \xi_{p'} + \xi_{jp'}, \tag{7}$$

where

$$\begin{aligned} v &= \ln A_{pg} & (8) \\ v_j &= \rho\theta \ln(1 + \phi_{jpg-1}) - \gamma \mathbb{I}[j = s] I_{pg} & (9) \\ v_{p'} &= \ln A'_{p'g} - \mu d_{pp'} & (10) \\ v_{jp'} &= \alpha_{jp'} - \pi \mathbb{I}[j = s] I_{p'g} & (11) \\ \xi_j + \xi_{p'} + \xi_{jp'} &= \epsilon_{jp'}. & (12) \end{aligned}$$

Each genius (i.e., conditional on intelligence $\psi > \bar{\psi}$) solves a dynamic problem,

$$\max_{j,p'} \; u(j, p'), \tag{13}$$

while an ordinary worker (i.e., conditional on intelligence $\psi \leq \bar{\psi}_g$) chooses only p' because he/she is constrained into occupation $j = o$. For a genius, the timeline of choices is the following. At $t = 1$, the individual chooses whether to become a scientist or a non-scientist, i.e., job type j, by solving

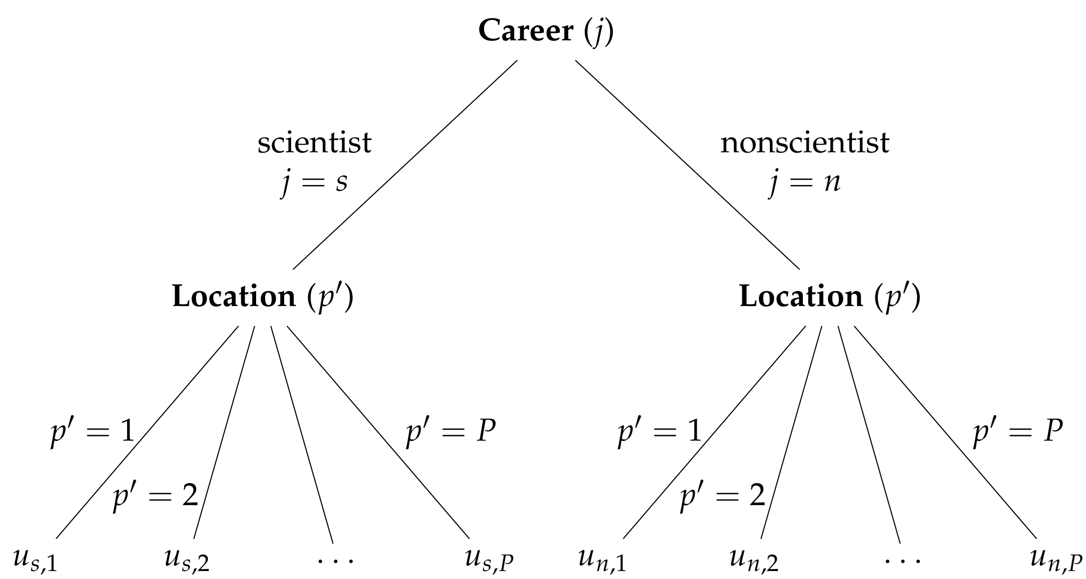
$$\max_{j} \; v_j + \xi_j + V_j, \tag{14}$$

where V_j is the value function of the location problem that is solved at $t = 2$. At that point, conditional on a job type $j = s, n$, an individual chooses where to live, i.e., second-period location p', by solving

$$\max_{p'} \; v_{p'} + v_{jp'} + \xi_{p'} + \xi_{jp'}. \tag{15}$$

The value function V_j that appears in (14) is the optimized value of the objective function in (15). This two-stage decision problem is illustrated in Figure 4. It is a discrete-choice problem and therefore boils down to choosing the maximum value among the utilities given by the terminal nodes of the decision tree.

Figure 4: A notable individual's problem



Notes: This figure illustrates the decision problem that a notable individual solves given a birthplace p and a generation g. A career j is chosen in the first period of the life cycle, $t = 1$, and migration to location p' is possible in the second period $t = 2$. Choices are represented here in a sequential fashion but they may be simultaneous. In either case the problem is dynamic.

To gain more intuition into this problem, note first that a genius never chooses to be an ordinary worker. This is so because given $\psi > \bar{\psi}_g$, one has always the option to become a non-scientist, avoid the Inquisition, and earn more than an ordinary worker. Thus, there is no self-selection into the pool of notable people. Also note that it doesn't actually matter whether geniuses choose a career j and a location p' sequentially or simultaneously; what matters is that they are forward-looking, i.e., they choose a career taking into account that they will choose their location optimally when they are allowed to move. Such rational behavior makes the problem dynamic, as indicated by the presence of value function V_j in the first-period problem (14). So, for example, a rational notable individual who was born in a place where the Inquisition is present and who has a large unobserved utility ξ_s from being a scientist, chooses a career while considering that in the future he/she can move to places where there is no Inquisition. Contrary to cultural disutility γ or the lack of masters, which cannot be avoided by would-be scientists born in Inquisition places, the direct punishment from the Inquisition can be avoided by migrating to places that are beyond the reach of the Inquisition.

5.3 Structural econometric model

This theoretical structure leads naturally to an econometric framework that can be used to recover the model parameters (or functions of these parameters). These structural estimates enable us to (i) disentangle the three different mechanisms and (ii) perform a counterfactual historical experiments to figure out what the stock of scientists would have been in CR states in the absence of the Roman Inquisition, thus providing a causal estimate that sidesteps the identification problems of a reduced-form model like equation (1). Of course the answers to these questions are strictly tied to the specification of the underlying theoretical and statistical models. It is convenient (and standard in a discrete choice setting) to assume that vector $\boldsymbol{\epsilon} = \{\epsilon_{jp'}\}$ has a generalized extreme value (GEV) cumulative distribution,

$$F(\boldsymbol{\epsilon}) = \exp\left(-\sum_j \left(\sum_{p'} \exp(-\epsilon_{jp'}/\beta_j)\right)^{\beta_j}\right), \tag{16}$$

where for any two places k and ℓ, the scale parameter β_j is such that $\beta_j^2 = 1 - \text{corr}(\epsilon_{jk}, \epsilon_{j\ell})$. If, conditional on a career choice j, unobserved preference shocks are actually uncorrelated across potential destination locations then $\beta_j = 1$ and we have a Multinomial Logit model. Otherwise, the problem features the "nested" choice structure in Figure 4 and results into the Nested Logit model (McFadden, 1978). As represented in Figure 4, a career choice leads to a nest of possible location choices whose utility is nest-specific. In our case, such specificity results from the fact that the Inquisition punishes only scientists. Thus, the utility of spending the second period of the life cycle in a place where the Inquisition is present is different for scientist and nonscientists. A non-zero correlation between ϵ_{jk} and $\epsilon_{j\ell}$, i.e., $\beta_j \neq 1$, means that utilities are correlated within nests, i.e., $\text{corr}(u_{jk}, u_{j\ell}) \neq 0$ for a given career choice j. So for example, unobserved preferences for being a physicist in Tuscany are allowed to be correlated with unobserved preferences for being a physicist in Cologne. Such unobservable component may be the kind of pure scientific talent that someone like Galileo Galilei had. However, we assume that unobservables, and therefore utilities, are uncorrelated across career choices, i.e., $\text{corr}(\epsilon_{sk}, \epsilon_{n\ell}) = 0$ for any two places k and ℓ, like in the Multinominal Logit model. So for example, unobserved preferences for being a physicist in Tuscany are uncorrelated with unobserved preferences for being a sculptor in that place or any other place. In other words, there are no relevant location-specific unobservables after migration costs, place fixed effects, and the presence of the Inquisition have been taken into account, i.e., $\xi_{p'} = 0$. This is an identifying assumption. We believe that it this is reasonable in the historical context under investigation. It implies that, for example, Galileo Galilei grew up and died in Tuscany because, after taking into account the presence of the Inquisition, it was too costly to permanently move elsewhere given the benefit of living in Tuscany captured by the place-by-occupation fixed effect $\alpha_{jp'}$ and the idiosyncratic benefit of being a scientist in that place captured by $\xi_{jp'}$.

As demonstrated by Ben-Akiva and Lerman (1979), when $\xi_{p'} = 0$, so that $\epsilon_{jp'} = \xi_j + \xi_{jp'}$, the parametric assumption in (16) is equivalent to assuming that: (i) the terms $\xi_{jp'}$ are i.i.d. GEV with scale parameter b_j; and (ii) the terms ξ_j are such that $\max_{p'} u(j, p')$ is GEV with scale parameter $b_{p'}$. The ratio of these scale parameters is equal to the corresponding parameter for $\epsilon_{jp'}$, i.e., $b_j / b_{p'} = \beta_j$. Since only this ratio can be identified, we impose the normalization $b_{p'} = 1$. These authors also show that random utility maximization requires $\beta_j \leq 1$, which is a testable hypothesis. This equivalent way of expressing our parametric assumptions allows us to derive choice probabilities in Conditional Logit form, which provides a more intuitive representation given that it is natural to interpret occupation and location choices as sequential in our lifecycle setting.

Thus, proceeding backward along the decision tree in Figure 4, the conditional probability that a generation g notable individual who was born in place p and who has chosen career j lives in location ℓ at $t = 2$ is given by

$$\begin{aligned} \mathbb{P}_{pg}(p' = \ell \mid j) &= \mathbb{P}_{pg}(u_{j\ell} \geq \max_k u_{jk} \mid j) \\ &= \frac{\exp(\beta_j^{-1}(\alpha_{jp'} + \ln A'_{\ell g} - \mu d_{p\ell} - \pi \mathbb{I}[j = s] I_{\ell g}))}{\sum_{k=1}^{P} \exp(\beta_j^{-1}(\alpha_{jk} + \ln A'_{kg} - \mu d_{pk} - \pi \mathbb{I}[j = s] I_{kg}))}, \end{aligned} \tag{17}$$

where the Multinomial Logit form follows from the fact that $\xi_{jk} - \xi_{j\ell}$, which is a difference between two independent GEV random variables, is logistically distributed.

The probability that a generation g notable individual who was born in place p and who will optimally choose to live in place p' at $t = 2$ chooses at $t = 1$ to be a scientist is instead given by

$$\begin{aligned} \mathbb{P}_{pg}(j = s) &= \mathbb{P}_{pg}(u_{sp'} \geq u_{np'}) \\ &= \Lambda\left(\rho\theta \ln \frac{1 + \phi_{spg-1}}{1 + \phi_{npg-1}} - \gamma I_{pg} + V_s - V_n\right), \end{aligned} \tag{18}$$

where $\Lambda(X) = \frac{\exp(X)}{1+\exp(X)}$ is the logistic function, and where

$$V_s = \beta_s \ln \sum_{k=1}^{P} \exp(\beta_s^{-1}(\alpha_{jk} + \ln A'_{kg} - \mu d_{pk} - \pi I_{kg})) \tag{19}$$

$$V_n = \beta_n \ln \sum_{k=1}^{P} \exp(\beta_n^{-1}(\alpha_{jk} + \ln A'_{kg} - \mu d_{pk})) \tag{20}$$

are the "inclusive utility" terms. Recall that V_j, for $j = s, n$, is the value function of the location problem that is solved at $t = 2$. Thus, inclusive utility captures the rational, forward-looking nature of the migration decision: when choosing at $t = 1$ whether to become a scientist, a notable individual takes into account whether scientists are subject to penalty π in the location that will be optimally chosen in the future.

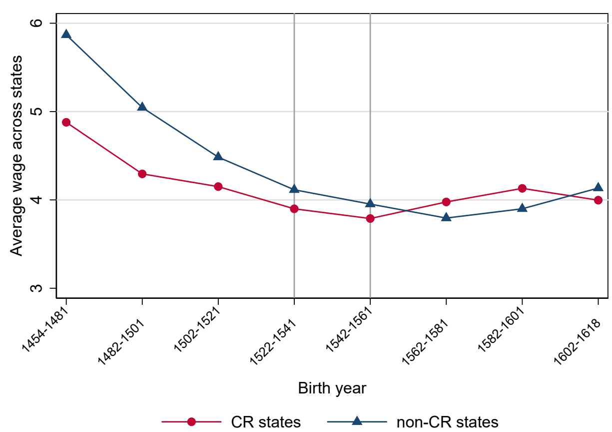
The joint probability of being a scientist in a certain location (i.e., the probability of choosing any of the terminal nodes in the left branch of the decision tree in Figure 4) is then simply given by the product of the marginal probability in (18) and the conditional probability in (17), which is the endpoint of a Roy model with binary occupational choice and multinomial location choice:

$$\mathbb{P}_{pg}(j = s\ ,\ p' = \ell) = \mathbb{P}_{pg}(j = s) \times \mathbb{P}_{pg}(p' = \ell \mid j = s). \tag{21}$$

5.4 Identification and estimation

We take two final steps in order to obtain an estimable version of the model. First, we capture the role of unobserved TFP in place p during the second period of the lifespan of generation g (i.e., A'_{pg}), by leveraging historical data from Fochesato (2018), who provides estimates of aggregate real wages across fourteen European cities between 1300 and 1800. After constructing a mapping between these fourteen cities and the polities in our data set based on a plausible definition of regional labor markets, we express $\ln A'_{pg} = \alpha \ln W_{pg}$, where W_{pg} is the imputed average aggregate wage in place p during the fifty years after each individual in our sample turns 20, i.e., the end of the training stage in our model. Thus, these are the market wages received by workers born in a given cohort. These wages are reported in Figure 5, which shows that during the period that we study real wages were declining across cohorts, with convergence between CR states and other states.

Figure 5: Daily real wages



Notes: The figure reports the average daily real wage measured in grams of silver received in their adult life by workers born in a given cohort. Source: authors' computation on wage data from Fochesato (2018).

Second, we must take into account that the Inquisition is established *during* the lifespan of one or more generations, which therefore end up being "transition generations". For example, individuals born between 1501 and 1521 are between 20 and 40 years old when the Roman Inquisition is created in 1541. Observed through the lens of our model, individuals in this generation have already made their occupational and location choices when the Inquisition is established, under the expectation that there is no Roman Inquisition. These individuals are "caught by surprise" and so will revise their location plan. In order to capture the different response of individuals in the transition generations to the establishment of the Inquisition, we modify utility component $v_{jp'}$ in equation (11) as follows,

$$v_{jp'} = \alpha_{jp'} - \pi \mathbb{I}[j=s] I_{p'g} + \widetilde{\pi} \mathbb{I}[j=s] \widetilde{I}_{p'g} \tag{22}$$

where $\widetilde{I}_{p'g}$ is equal to 1 if the Inquisition is established in place p' when an individual in generation g is alive but *older* than 20 (i.e., born before 1522), and equal to 0 otherwise. The third term on the RHS of (22) introduces a triple interaction (being a scientist in a potential location where the Inquisition is not initially present but is present later on) in the utility of a potential location given one's occupation decision. The sign of the additional parameter $\widetilde{\pi}$ is unrestricted: if it is negative then individuals in the transition generation respond more strongly, in terms of moving out from (or avoiding moving into) locations where the Inquisition is suddenly established. Similarly, we allow for the cultural effect to be different for the transition generation of those who are alive but *younger* than 20 when the Inquisition is established (i.e., born between 1522 and 1541), as these individuals may revise their occupational decision. That is, using indicator $\widehat{I}_{p'g}$ to track this generation,

$$v_j = \rho\theta \ln(1 + \phi_{jpg-1}) - \gamma \mathbb{I}[j=s] I_{pg} + \widetilde{\gamma} \mathbb{I}[j=s] \widehat{I}_{pg}. \tag{23}$$

Thus, for estimation purposes, the marginal probability in (18) and the conditional probability in (17) become:

$$\begin{aligned} \mathbb{P}_{pg}(j=s) \quad = \quad & \Lambda \Bigg(\rho\theta \ln \frac{1 + \phi_{spg-1}}{1 + \phi_{npg-1}} - \gamma I_{pg} + \widetilde{\gamma} \mathbb{I}[j=s] \widehat{I}_{pg} \\ & - \beta_n \ln \sum_{k=1}^{P} \exp(\beta_n^{-1}(\alpha_{jk} + \alpha \ln W_{kg} - \mu d_{pk})) \\ & + \beta_s \ln \sum_{k=1}^{P} \exp(\beta_s^{-1}(\alpha_{jk} + \alpha \ln W_{kg} - \mu d_{pk} - \pi I_{kg} + \widetilde{\pi} \mathbb{I}[j=s] \widetilde{I}_{kg})) \Bigg), \end{aligned} \tag{24}$$

$$\mathbb{P}_{pg}(p' = \ell \mid j) = \frac{\exp(\beta_j^{-1}(\alpha_{jp'} + \alpha \ln W_{\ell g} - \mu d_{p\ell} - \pi \mathbb{I}[j=s] I_{\ell g} + \widetilde{\pi} \mathbb{I}[j=s] \widetilde{I}_{\ell g}))}{\sum_{k=1}^{P} \exp(\beta_j^{-1}(\alpha_{jk} + \alpha \ln W_{kg} - \mu d_{pk} - \pi \mathbb{I}[j=s] I_{kg} + \widetilde{\pi} \mathbb{I}[j=s] \widetilde{I}_{kg}))}. \tag{25}$$

Composite parameter $\rho\theta$ (the effect of *masters* on occupational choices) and parameters α (the effect of aggregate wages on location choices), β_s and β_n (the scale parameters of unobservables), γ (the effect of anti-scientific *culture* on occupational choices), μ (the effect of travel distance between birth place and potential destination places on location choices), π (the effect of *deterrence* of science on location choices), $\widetilde{\pi}$, and $\widetilde{\gamma}$ (the additional deterrence and cultural effects, respectively, for the transition generations) are identified and can be estimated via Full-Information Maximum Likelihood (FIML). The occupation-by-place fixed effect $\alpha_{jp'}$ is identified and estimated relative to a base (j, p) combination. Given our sample of $i = 1, \cdots N$ notable individuals, the FIML estimator maximizes the log-likelihood function

$$\begin{aligned}\ln L \;=\; & \sum_{i=1}^{N} \mathbb{I}[i \text{ is a scientist}]\mathbb{P}_{ipg}(j = s) \\ & + \sum_{i=1}^{N} \sum_{\ell=1}^{P} \mathbb{I}[i \text{ is a scientist and dies in location } \ell]\mathbb{P}_{ipg}(p' = \ell \mid j = s), \quad (26)\end{aligned}$$

where $\mathbb{P}_{ipg}(j = s)$ and $\mathbb{P}_{ipg}(p' = \ell \mid j = s)$ are the individual-level versions of (24) and (25), after indexing appropriately all quantities that vary across individuals.

To clarify the meaning of identification in this context and its relation to the causal effect that we aim at quantifying, recall that identification simply means that model parameters are "uniquely determined from the observable population that generates the data" (Lewbel, 2019, p. 835). Thanks to our parametric assumptions (distributional assumptions and linear-in-parameters utility), the population analog of (26) is globally concave and so there is only one maximum and the model parameters are indeed uniquely determined. The claim that the subset of these parameters that capture the effects of the Inquisition via different mechanisms (i.e., $\rho\theta$, γ, π, $\widetilde{\gamma}$, and $\widetilde{\pi}$) are causal parameters that, contrary to reduced-form DiD parameters, reveal the causal effect of the Inquisition on the evolution of scientific careers among notable people in Europe relies on the model being correctly specified. Although all models are false by definition, we believe that the forces that we have built into our model are the fundamental ones at play and therefore our structural analysis provides a reasonable and disciplined way to inferring the effects of the Inquisition in a context in which reduced-form approaches are less credible.

5.5 Results

After dropping seven small states not chosen by any scientist (a total of 42 observations) and one small state not chosen by any non-scientist (2 observations), we are left with a sample of 11,625 observations for the structural analysis. The three panels of Table 3 contain three group of estimated parameters: those affecting the occupational choice (Panel 1), those affecting the location choice (Panel 2), and the scale parameters of the distribution of unobservables in equation (16), the "dissimilarity parameters" (Panel 3). For each parameter we report point estimate, standard error, and, in order to facilitate the interpretation, a measure of marginal (for continuous variables) or differential (for discrete variables) effects.

In Panel 1, parameters $\rho\theta$ (human capital effect) and γ (cultural effect) are estimated to be statistically significant, with a sign consistent with our theory. Note that, for the former, the marginal effect of 8.6 p.p. is computed relative to the fraction of science masters ϕ_{spg-1} rather than the more convoluted quantity $\ln\left(\frac{1+\phi_{spg-1}}{1+\phi_{npg-1}}\right)$, i.e., it is $\frac{\partial \mathbb{P}_{pg}(j=s)}{\partial \phi_{spg-1}}$. This is a large effect relative to the average baseline probability of 12%. The estimated cultural effect indicates that the presence of the Inquisition at birth in one's birthplace reduces by 4.3 p.p. the probability of choosing a scientific career; this effect is smaller in absolute value and insignificant (1.2 p.p.) for the transition generations, i.e., when the Inquisition is absent at birth in one's birthplace but is introduced before age 20.

The estimates in Panel 2 indicate that increasing the distance between one's birthplace and a potential alternative location by 100km decreases by 15 p.p. the probability of moving to that location, while notable individuals in our sample are 0.48 p.p. more likely to move to a certain state if wages in that state increase by 10%. As for the third key mechanism that mediates the Inquisition's effect, deterrence, the presence of the Inquisition in a given location reduces by 10.9 p.p. the probability that a scientist chooses to live in that location. Thus, after the establishment of the Roman Inquisition scientists become more likely to move out of CR states and to move to (or remain into) non-CR states. However, this deterrence effect is not significant for the transition generations, i.e., for those scientists who have already chosen their career when the Inquisition is established in their birthplace. This finding may be explained by the fact that it takes time to set up tribunals and by the initial uncertainty about the Inquisition's actual severity. Of course these are all *certeris paribus* statements; for example, a deterrence effect of 10.9 p.p. translates into a smaller actual effect on mobility because moving costs vary across alternative locations. Finally, our estimates of the scale parameters in Panel 3 are below 1 as required by random utility maximization. The null hypothesis that these parameters are equal to or greater than 1 is comfortably rejected.

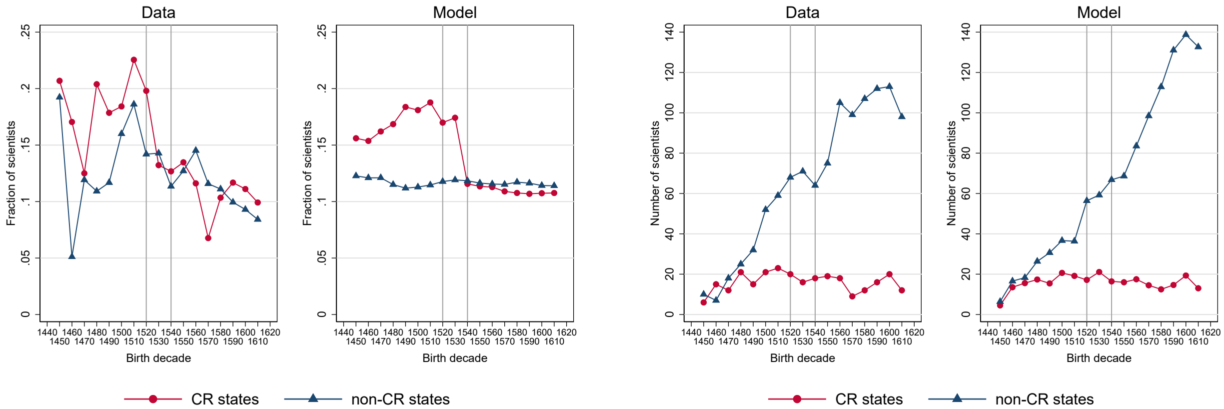
The model's fit is illustrated in Figure 6 for the incidence of scientists among notable individuals (top panel) and for their their absolute number (bottom panel). The figure contrasts the data already shown in Figure 2 and the model's predictions. The model averages out noise that is present in the data and so these predictions result in much smoother series; nonetheless, the model reproduces fairly accurately the key trends, particularly the decline in the frequency of scientists among notable individuals in CR states after the creation of the Roman Inquisition. This fit increases our confidence that the model is capturing the fundamental forces at play during the period that we study.

Table 3: Structural estimates

Parameter	Effect	Estimate	"Marginal" effect
1. Occupational choice (j): probability of being a scientist			
$\rho\theta$	human capital (masters)	0.575^{***}	0.086
		(0.216)	
γ	cultural	-0.470^{**}	-0.043
		(0.202)	
$\gamma + \tilde{\gamma}$	cultural, transition generation	0.247	0.012
		(0.163)	
2. Location choice (p')			
μ	distance (moving cost)	-0.558^{***}	-0.150
		(0.172)	
α	log wages	0.178^{***}	0.048
		(0.069)	
π	deterrence	-0.601^{***}	-0.109
		(0.193)	
$\pi + \tilde{\pi}$	deterrence, transition generation	0.114	0.057
		(0.122)	
3. Scale (dissimilarity) parameters			
β_s		0.463	(0.141)
β_n		0.417	(0.129)
Observations		11,625	

Notes: * p<0.10, ** p<0.05, *** p<0.01. The table reports structural parameter estimates obtained by FIML on equation (26). Standard errors are indicated in parentheses. The "marginal" effects are marginal for continuous variables and differential for binary variables. To facilitate the interpretation, for the human capital (masters) channel the marginal effect refers to marginally increasing the share of masters. Sample: 11,625 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army", and who died in places chosen by at least one scientist and at least one non-scientist.

Figure 6: Model fit



Notes: The figure reports the actual, total number of scientists and their share among notable people born in CR and non-CR polities by birth decade (left panels), and these same statistics as predicted by the model (right panels). Sample: 11,689 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

Overall, our structural analysis suggests that the Roman Inquisition depressed science in Counter-Reformation states through the interaction between cultural, deterrence, and human capital effects: this institution, where present, weakened high-talent individuals' desire to undertake a career in contrast with stronger anti-scientific social norms; and those who nonetheless chose to be scientists became more likely to migrate out of states under the Inquisition's control and towards states free from it (the aforementioned case of Niccolò Buccella is a case in point). Symmetrically, the Inquisition reduced the propensity of scientists located outside its sphere of influence to move inside it. These altered propensities directly reduced the fraction of scientists located in CR states and increased it in non-CR states. As generations unfolded, this direct effect translated into an altered availability of science masters. That is, there was an indirect effect that reduced the fraction of scientists located in CR states because geniuses in younger generations became less likely to meet a science master and therefore less likely to become scientists themselves, while the opposite happened in non-CR states, where science masters became relatively more frequent. Our model allows us to illustrate these points via a counterfactual historical experiment, which we present next.

5.6 Counterfactual historical experiment

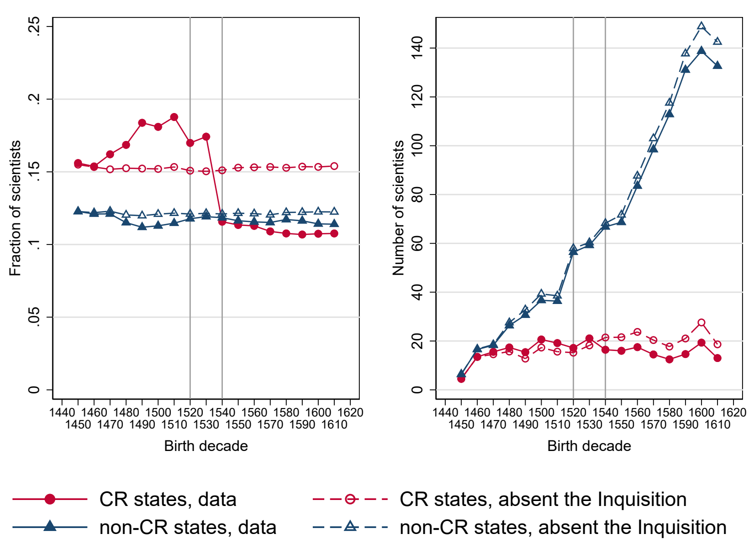
Calibrating the model with the estimated parameters allows us to perform counterfactual historical experiments. In particular, we can provide an estimate of how the number and fraction of scientists would have evolved in CR states and other states if the Roman Inquisition had not been established. Of course the results of such an exercise should be taken with a grain of salt, for two reasons. First, the complexity of history cannot be captured by a simple model like ours; while our theoretical framework captures in a reasonable way the effects of the Inquisition on the career and location choices of notable individuals (which is what it is designed for), it is silent about broader events and so it cannot tell us what Europe would have looked like (including the dynamics of science) in the 16$^{\text{th}}$ and 17$^{\text{th}}$ centuries under this counterfactual scenario. Second, even within the narrow focus of the model, we are taking wages as exogenous and we do not allow them to change in the counterfactual. Most likely, the dynamics of wages in Europe would have been different in the absence of the Roman Inquisition, and this might have altered both career and migration decisions in a way that we cannot capture.

Yet the counterfactual exercise is useful because it gives a sense of the magnitude of the causal effect of the Roman Inquisition on the scientific careers of notable individuals implied by the model. This computational experiment is performed as follows: we shut down the Inquisition channel in the model by setting to zero, for any place of birth or death p and generation g, indicators I_{pg}, $\widetilde{I}_{pg}$, and $\widehat{I}_{pg}$, even if the Inquisition is present in polity p during the lifespan of generation g; we then re-compute location probabilities under this counterfactual scenario, which determine the expected number of scientists in each place and period and therefore the expected availability of masters for the future generation; finally, we compute the expected number and share of scientists in each generation and place, taking the total number of notable individuals as given.

The result is illustrated in Figure 7. Consider CR states first. The counterfactual simulation indicates that the number of scientists would have been sufficiently higher to prevent the drop in the fraction of scientists that is observed in the data after the Counter-Reformation. Having built a counterfactual, we can easily estimate the average treatment effect of the Inquisition on the fraction of scientists in CR states. In these states, the *actual* average fraction of scientists among notable individuals born between 1520 and 1618 (post-1520 average of the filled circles in the right panel of Figure 7) was 0.119; the corresponding *counterfactual* fraction absent the Inquisition (post-1520 average of the hollow circles in the left panel) is 0.153. Therefore, the model-based average treatment effect on treated states is $0.119 - 0.153 = -0.034$, which is smaller yet in the same ballpark as the reduced-form DiD specifications in columns [1]-[4] of Table 2. When removing individuals born between 1521 and 1541 like in column [5] of Table 2, the model's predicted average effect is slightly larger, $0.110 - 0.153 = -0.043$, in line with the slightly larger (in absolute value) DiD point estimate in that smaller sample. It is remarkable that such different empirical methodologies like DiD and the fully-fledged structural model that we have employed provide a similar answer. We interpret this concordance of estimates as evidence that the consequences of the violation of SUTVA or possible pre-existing different trends in the DiD model, despite being present, are mild. However, we would have not known this without a proper structural analysis.

Finally, note in Figure 7 that, according to the model, in the counterfactual scenario of no Inquisition the number of scientists and their incidence among notable individuals would have slightly increased also in non-CR states. The reason is that even if scientists in CR states have, in the counterfactual, a lower probability of migrating towards non-CR states, the overall larger number of scientists implies that non-CR states still receive a larger inflow as some of the additional scientists want to move there anyway. This observation is in line with the fact that the establishment of the Roman Inquisition also affects, indirectly via equilibrium responses, non-CR states.

Figure 7: Counterfactual number and fraction of scientists absent the Roman Inquisition



Notes: The figure reports the actual, total number of scientists and their share among notable people born in CR and non-CR polities by birth decade, and the counterfactual total number and share absent the Roman Inquisition, obtained by simulated the model. Sample: 11,689 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

6 Conclusions

Ideological strictness by states, churches, or other religious organizations that hold political power may have dramatic consequences for individuals who are unaligned with a particular orthodoxy and therefore end up being targeted by rulers. It may also have far-reaching consequences on a country's long run economic outcomes. In this paper we have documented these consequences using data from individual histories of high-talent individuals to study a key episode of European history: the establishment of the Roman Inquisition. We have shown how a shift from a relatively liberal context to one where religious dogmatism controlled the production of scientific and technical ideas affected the occupational and location choices of these individuals during the run-up (16^{th} and 17^{th} centuries) of the first Industrial Revolution.

The production of scientists is one of the main drivers of economic growth. As argued by Mokyr (2017), scientific knowledge was a necessary condition for the Industrial Revolution to occur, because of science's potential to improve technology. Thus, from a historical point of view, our investigation provides a better understanding of how the Counter-Reformation affected the decline of the Italian peninsula, which up to that point was relatively more advanced than the rest of Europe in terms of scientific careers and, therefore, possibly in a better position to obtain technological breakthroughs. Of course this conjecture is largely speculative as it derives from an analysis that should be taken with a grain of salt. Yet, such an analysis reveals that this fundamental switch from scientific advantage to relative disadvantage was to a significant extent driven by the establishment of the Roman Inquisition. This conclusion agrees with the results of recent work by Cabello (2022), who shows that the Counter-Reformation led to a decline in science that was more pronounced in cities with stronger enforcement, and that such an effect persists over subsequent centuries.

From a methodological perspective, our exercise illustrates the benefits of using both reduced form and structural analyses in economic history. While the "natural experiment of history" that we consider may seem suited for a standard DiD strategy, a little reflection on the possible underlying mechanisms suggests that DiD alone is unable to provide a credible answer. Hence the need for a theoretical model in which the main forces at play are made explicit in a transparent way. The benefit is twofold: first, identification of the mechanisms that drive the effects of the ideological crackdown that came with the Counter-Reformation on the allocation of talent in Europe; second, indirect estimation, via quantitative analysis within the model, of the average treatment effect that the reduced-form analysis aims at estimating directly. It is reassuring that the two different levels of our analysis are both mutually consistent and deliver similar answers in the respective domains.

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Appendix

A-1 Dataset construction

We detail here how we assembled our dataset on notable individuals' key dates, occupations, and the political and religious status of the states in which they lived.

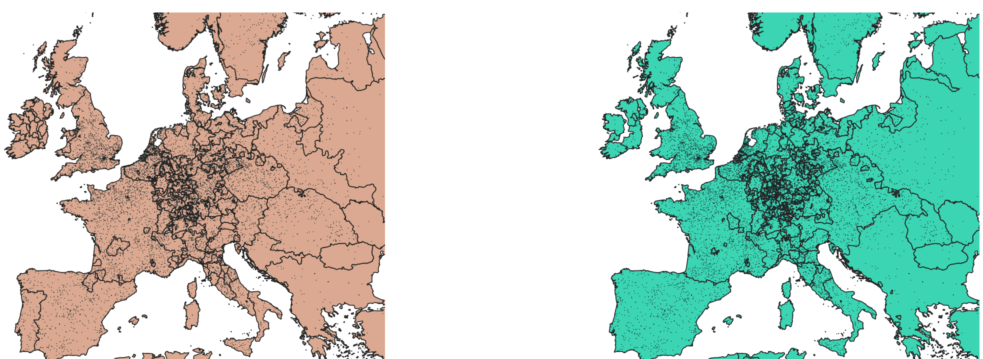
A-1.1 Collection and Sampling

We scraped data from the online version of the Index Bio-Bibliographicus Notorum Hominum (IBN), available behind a paywall at `http://ibn.zeller-verlag.de/`. More specifically, we collected information from all individuals born or dead during a year, for each year between 1430 and 1670. This represents 207,803 individuals. Among them 39,262 have no date of birth; we dropped them from our sample. We also filtered out the 129,943 individuals for which the birth year was too imprecise (e.g., "before 1420" or "prime-time in 1523-1540").

A-1.2 Geography

Among the remaining individuals, 19,011 have a place of birth and death provided. We obtained coordinates of these 15,047 unique locations using the OpenCage API (`https://opencagedata.com/`). The places not automatically localized were searched for manually. We then used the geographical software QGIS to link these geocoded locations with political entities from shapefiles of EurAtlas historical maps. Using other shapefiles, we also determined whether the locations were (i) close to a river, (ii) close to the sea, (iii) high in elevation. We finally extracted information on where individuals lived (places of "activity") by searching all the occurences of the above locations in the individuals' biographical texts.

Figure A-1: Political entities and birthplaces of notable people



Year 1500 Year 1600

Notes: The figure shows the boundaries of political entities (states, which are the geographic level of our analysis) in 1500 and 1600. A dot is a notable person, represented in her or his birthplace. Source: EurAtlas historical maps and *Index Bio-Bibliographicus Notorum Hominum*, sample of 11,689 individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

A-1.3 Religion and the spread of the Inquisition

Within the list of all existing political entities of the 16th century, we identified those that saw the arrival (or intensification) of the Roman inquisitorial activities after the 1541 papal bull, as well as the decade, if different, during which it happened. They are listed below.

- *The Duchy of Ferrara & the Duchy of Modena*. Both under the rule of the House of Este (the former was ceded to the Pope in 1597), the duchies were initially very tolerant to modern scientific ideas (Copernic spent several years in Ferrara under Domenico Maria Novara da Ferrara). This changed when Alphonse II came to power in 1559, and gave free rein to the Inquisition.
- *The Republic of Florence*. During the whole rule of the Medici, the Republic authorized the Inquisition to act on its ground – Cosimo, in particular, had very good relationships with the Vatican –, while maintaining a reputation of relative tolerance. In 1555, it annexed *the Duchy of Sienna*, and, in 1569, became the *Grand Duchy of Tuscany*.
- *The Republic of Genoa*. Independent since 1528, the city was officially catholic and had a milder but active Inquisitorial presence since its start.
- *The Republic of Lucca*. While it did not accept the formal control of the Holy Office, the Republic set up its own tribunal in 1545 to prosecute protestants and other heretics.
- *The Duchy of Mantua*. The initial relations between the Gonzaga family, ruling over the Duchy, and the Inquisition, present from the start, were tensed. But a visit of the Cardinal Borromeo, who promised half of all Inquisitorial confiscations to the duke, ended these tensions and allowed the Sant'Uffizio to operate freely. Since 1536, the Duchy was also ruling over *the March (then Duchy) of Montferrat*.
- *The Duchy of Milan*. Even if the Duchy fell under Habsburg rule from 1556 onwards, the ferocity put by the bishop (then Cardinal) Carlo Borromeoand its successors in prosecuting heretics made it a key center of the Counter-Reformation.
- *The Papal States*. States under the direct authority of the Pope almost immediatly experienced the consequences of the 1541 bull. They included the recently acquired territories of the *cities of Ancona, Bologna, Forli, Perugia, and Rimini*, and the *Duchies of Urbino, Parma and Piacenza*.
- *The Kingdom of Naples*: even if it was under the Spanish rule since the beginning of the 16th century, Naples territories were famously not under the rule of the Spanish Inquisition (contrary to the Kingdom of Sicily); yet, the Pope managed to install Roman inquisitors in the Kingdom as soon as 1547.
- *The Marquisate of Saluzzo*. Occupied by the French for most of the 16th century, the Marquisate nevertheless had an active Inquisition, which gained in intensity after the takeover by the Duchy of Savoy, in 1601.
- *The Duchy of Savoy*. Initially close to the Swiss confederation and protestant ideas, the duke of Savoy formally rejected in 1569 the "heresy of the reformation" and declares the Catholicism as the only religion in the duchy, thereby paving the way for the Inquisition.

- *The Republic of Venice*. Even if Venetian rulers had a complicated relationship with the Vatican, the Inquisition was particularly active in the city and its territories, in close interaction with secular courts and bishops.

A-1.4 Occupations

To determine individuals occupations, we extracted all words with more than 3 letters from the biographical text and translated all non-english words using DeepL. We then manually determined which of these words were actual professions, and regrouped these occupations into two levels of aggragation, extending those used by De la Croix and Licandro (2015). They are listed below.

- *Army*: admiral, brigadier-general, captain, colonel, commander, corporal, fighter, general, lieutenant, lieutenant-colonel, major, major-general, marshal, military, officer, soldier, sergent.
- *Arts & Metiers*: actor, artisan, artist, bellmaker, blacksmith, bookmaker, caligraph, cantor, carpenter, collector, composer, designer, dramatist, embroider, engraver, glassmaker, goldsmith, gunmaker, iconmaker, illustrator, inlayer, instrument-maker, kapellmeister, lithograph, mason, moneymaker, musician, organist, painter, pewterer, pianist, poet, potter, regisseur, sculptor, singer, tenor, violinmaker, violinist.
- *Commerce & Entreprise*: antiquary, barber, bookseller, banker, businessman, director, editor, explorer, farmer, founder, guildmaster, librarian, merchant, manufacturer, printer, trader, wholesaler.
- *Humanities & Education*: academician, archaeologist, author, classicist, dean, economist, historian, journalist, lecturer, orientalist, pedagogue, professor, philologe, philosopher, rector, scholar, translator, teacher, writer.
- *Law & Government*: administrator, adviser, ambassador, bailiff, beamter, chief, civil servant, congressman, consul, councillor, deputy, diplomat, governor, inspector, judge, jurist, lawyer, magistrato, mayor, minister, money-master, notary, parliamentarian, politician, prefect, president, procureur, secretary, senator, sheriff.
- *Nobility*: baron, baroness, chamberlain, dinasty-member, duke, duchess, earl, emperor, empress, king, knight, lord, marquis, marquise, noble, prince, princess, queen.
- *Religion*: abbot, archbishop, archdeacon, benedictine, bishop, capuchin, cardinal, clergyman, deacon, franciscan, friar, jesuit, martyr, missionary, nun, monk, pastor, piarist, preacher, priest, priar, protestant, rabbi, theologian, vicar.
- *Science*: agronomist, architect, astronomer, botanist, builder, cartographer, chemist doctor, engineer, geograph, geologist, inventor, mathematician, naturalist, pharmacist, physician, physicist, surgeon, zoologist.

A-2 Additional Tables

Table A-1: Descriptive difference-in-differences results – Robustness

	All	vs. other Scholars	vs. Artists & Artisans	vs. Merchants & Entrepreneurs	vs. Civil Servants
	(1)	(2)	(3)	(4)	(5)
Post-CR*CR State	-0.047^{**}	-0.091^{***}	-0.057	-0.119^{**}	-0.056
	(0.021)	(0.035)	(0.038)	(0.052)	(0.052)
Decade FE	✓	✓	✓	✓	✓
Polity FE	✓	✓	✓	✓	✓
City-level controls	✓	✓	✓	✓	✓
Observations	11,669	6,173	4,507	1,945	3,684
Mean DepVar	0.12	0.23	0.31	0.71	0.38
Sd DepVar	0.32	0.42	0.46	0.45	0.48

Notes: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The dependent variable is a dummy equal to one if the individual is a scientist. Columns (2)-(5) include city of birth controls (city size, elevation, proximity of rivers and access to the sea). Columns (3)-(5) controls for decade-of-birth fixed effects, and Columns (4)-(5) for political entity ('realm') fixed effects. The models are estimated using OLS. Standard errors are indicated in parentheses and are clustered at the place of birth ('city') level. Coefficients for the controls are not reported for the sake of space. Sample: 11,689 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".

Table A-2: Descriptive difference-in-differences results – Robustness

	All states	vs. Protestant only	vs. Unclear only	vs. Catholic only
	(1)	(2)	(3)	(4)
Post-CR*CR State	-0.047^{**}	-0.064^{***}	-0.056^{**}	-0.032
	(0.021)	(0.025)	(0.025)	(0.023)
Decade FE	✓	✓	✓	✓
Polity FE	✓	✓	✓	✓
City-level controls	✓	✓	✓	✓
Observations	11,669	4,881	4,570	5,692
Mean DepVar	0.12	0.13	0.12	0.12
Sd DepVar	0.32	0.34	0.33	0.32

Notes: * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is a dummy equal to one if the individual is a scientist. Columns (2)-(5) include city of birth controls (city size, elevation, proximity of rivers and access to the sea). Columns (3)-(5) controls for decade-of-birth fixed effects, and Columns (4)-(5) for political entity ('realm') fixed effects. The models are estimated using OLS. Standard errors are indicated in parentheses and are clustered at the place of birth ('city') level. Coefficients for the controls are not reported for the sake of space. Sample: 11,689 notable individuals born between 1454 and 1618 in Europe (excluding Spain, Portugal, and the Ottoman Empire), with non-missing places of birth and death, whose occupation is not *only* "nobility" or "army".