The Counter-Reformation, Science, and Long-Term Growth: A Black Legend?

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First draft: November 1, 2021
This draft: September 5, 2023

Abstract

Is it true that the Catholic reaction to Protestantism—the Counter-Reformation—led to scientific and economic decline for hundreds of years? Introducing biography-based evidence, I show that Catholic and Protestant European cities long shared comparable trends of scientists per capita. But after imposing intellectual control in response to the Reformation, Catholics experienced a dramatic scientific collapse coinciding with the Counter-Reformation's different timing and intensity across cities. Reassuringly, science began to recover after the Counter-Reformation was dismantled, but the recovery stagnated when Counter-Reformation-rooted institutions were revived centuries later against new ideological threats. Although it has largely vanished by now, the gap in science that emerged during the Counter-Reformation was enormous, lasted centuries, and helps explaining Europe's unequal modern economic growth. Protestants also tried to impose their own bigotry but lacked sufficient coordination and authority. Had they been more effective, modern science and sustained economic growth might have never taken off.

Keywords: Science, Catholicism, Counter-Reformation, Inquisition, Spanish Empire, censorship, dictatorships, conservatism, political economy, causes of persistence, long-term economic growth.

JEL: N00, P00, N10, O11, O10, O30, O43, Z12, F50.

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†This work is part of a major project on science and growth that has benefited from discussions with Joel Mokyr (to whom I am particularly grateful), David de la Croix, Jeanet Bentzen, Steve Pfaff, Jared Rubin, Felipe Valencia, Ralf Meisenzahl, Mark Koyama, Larry Iannaccone, Lars Boerner, Battista Severgnini, Nuno Palma, Kevin O'Rourke, Eric Chaney, Andy Ferrara, Jacob Weisdorf, Christian Lessmann, Thilo Huning, Alessandro Nuvolari, Erik Hornung, Moritz Schularick, Michael Burda, Armin Falk, Lingwei Wu, Georg Fertig, Damien Tricoire, Hakon Albers, Matt Curtis, Susan Wolcott, Christopher Hanes, Jordan Adamson, James Hannam, Jack Goldstone, and participants at Rome Sapienza, Oxford University, ASREC Europe 2022, the European Historical Economics Society Conference 2022, the Cliometric Society Annual Conference 2022, the German Development Economics Conference 2022, the University of Southern Denmark, Manchester University, ASREC 2022 and IRES 2022 at Chapman University, the London School of Economics, the 2022 FRESH meeting at Lund University, the 8th CGDE Workshop at IWH Leibniz Institute, and MLU Halle-Wittenberg. My gratitude also goes to Jan Luiten van Zanden, Maarten Bosker, and Warren Anderson for sharing their data.

How should we learn the modern discoveries of the exact sciences, which have produced the wealth of France, England, and other industrious nations thanks to the Enlightenment? . . . Only by violating the prohibitive laws of the Inquisition. But this is dangerous, and few dare to take the risk.

— Juan Antonio Llorente, 1817
(former member of the Spanish Inquisition)

1 Introduction

The rise of science in early modern Europe has long been considered a precondition for the takeoff of sustained economic growth.[1] But exactly when and where did science rise? Why did some cities in Europe produce more scientists than others? And how does the geography of science relate to Europe's unequal modern economic growth thereafter? I address these questions by studying an event that has received little attention in economics, even though its impact on early modern science and subsequent long-term economic development was allegedly enormous: the Catholic reaction to Protestantism, the so-called Counter-Reformation.

Why, allegedly, did the Counter-Reformation affect science? Because to stop the spread of subversive Protestant ideas, Catholic leaders banned dangerous literature at unprecedented scale, restricted studying and teaching at foreign universities, and enforced strict conformity to a fixed philosophical dogma—all in concerted fashion and supported by powerful inquisitorial systems. It worked: the expansion of Protestantism was stopped. But also "the diffusion of new ideas to society at large slowed to a trickle," and "the pursuit of the strange and potentially heretical" was warned off (Landes, 1998, pp. 179–80). The outcome: southern Europe—which "before the Reformation [was] a center of learning and intellectual inquiry"—"missed the train of the so-called scientific revolution." This would cost "more than three centuries of backwardness . . . in income and achievement," with effects "not wear[ing] off until the twentieth century" (p. 250).

Is this true? Did the Counter-Reformation depress science dramatically and enduringly, reducing long-term growth? Many historians dismiss this narrative as nothing but the echo of old anti-Catholic propaganda, the continuation of the so-called Black Legend (e.g., Kamen, 2014). In contrast, this paper presents ample evidence that confirms (i) a sharp decline of science at the time, (ii) a remarkable persistence of this decline—largely explained by revivals, centuries later, of institutional legacies of the Counter-Reformation—and (iii) long-term economic consequences that seem indeed to stretch even into the 20th century.

The paper is divided chronologically in two parts. The first one deals with the Counter-Reformation period itself (ca. 1550–1700) and documents, based on scientific biographies, how the number of scientists per capita declined in Catholic relative to non-Catholic cities (figure 1a). This decline was particularly dramatic within territories leading the Counter-Reformation—Spain, Italy, Belgium, and

[1] Kuznets (1960), for example, argued that "modern science" was not just the "the major source of economic growth in the developed countries," but the "epochal innovation" that brought about the modern growth regime. For brief expositions of this interpretation, see Rosenberg and Birdzell (1990), Mokyr (2005), and Cohen (2009).

Portugal—where decline was not just relative but absolute, with the number of scientist per capita falling to levels not seen in centuries (e.g., figure 1b). As figure 2 shows, quality fell as well: the decline was larger among scientists of higher quality (measured by their fame today), again especially in the leading countries of the Counter-Reformation, and especially after Galileo's condemnation by the Inquisition in 1612–1633.[2] Analogous results can be confirmed within more homogeneous samples, such as German-speaking or Dutch-speaking territory. There, Catholic and Protestant cities had shared comparable trends of scientists per capita for decades or centuries, but Catholic cities began to underperform precisely when the Counter-Reformation was implemented (e.g., figures 6a and 6c). The timing of this treatment varied, beginning as early as 1521 and as late as 1618, depending on the military outcomes that shaped the Counter-Reformation map. Along these borders, a sharp discontinuity in science between Catholics and Protestants emerged particularly in frontiers where the Counter-Reformation authorities had overwhelming power (figure 5). Similarly, within Catholic territories across Europe, the decline was more pronounced in cities where the treatment was more intense, such as those where the inquisitorial tribunals were located. By contrast, when the treatment was weakened—for example, when inquisitorial activity receded—the number of scientists recovered systematically. In short, the decline of scientists coincides with the intensity of the Counter-Reformation in both time and space. The results hold both in Europe as a whole and in cities very close to confessional borders. They also hold when restricting the sample to Catholic cities that are close to each other, differentiating them by treatment intensity. Accounting for alternative explanations—sampling biases, economic decline, devastation by wars and plagues, changes in literacy, political institutions, or the Protestant ethos (more on this below)—does not affect the results.

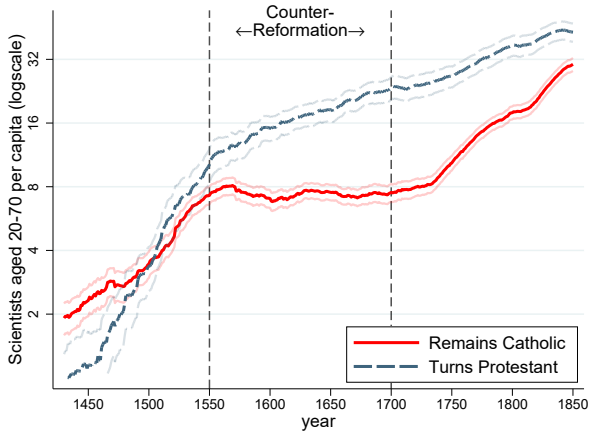
The second part of the paper deals with the subsequent period: from 1700 to the present. Did the shock endure, as some historians have claimed? As hinted by figure 1, the data support the narrative once more. Multiple proxies for the Counter-Reformation (Catholicism, historical inquisitorial presence, Spanish control by 1600) are associated with depressed science until the late 18th century, lending support to the claim that "the Counter-Reformation ... slowed down the diffusion of the *nuova scienzia* innovations and the rise of the Enlightenment" (Mokyr, 2016, p. 165). The persistence remains also significant until the 19th century (even longer, by some metrics), and it holds after controlling for plausible confounding factors, including economic and educational development, spatial proximity, languages, natural endowments, states, and institutions. Importantly, these results imply that science was *predetermined* by the Counter-Reformation at the time when modern economic growth—i.e. "science-based" growth (Kuznets, 1960, pp. 1–16)—found its way throughout the Continent.

But why did the shock persist for so long? I find that, while part of this persistence can be linked to a permanent Counter-Reformation-driven increase in clerical power (a predictor of less science in both Catholic and Protestant samples), the crucial factor was the revival of legacies of the Counter-Reformation (including censorship laws and religiously legitimized politics) during episodes

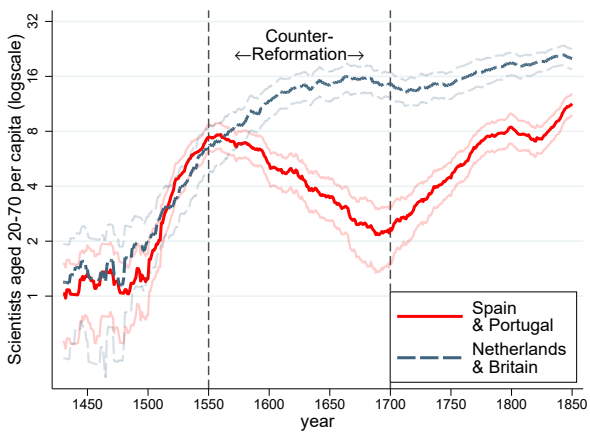
[2]This evidence supports the contested view that, especially after Galileo's trial, Italy became increasingly "excluded as a further breeding ground of innovation," and that "[the same] applied to Spain and Portugal and also to the Spanish Netherlands" (Cohen, 2015, p. 166). Recent research confirms quality decline during the Counter-Reformation overall. See Blasutto and de la Croix (2021) for Italy and Vitale (2022) for Spain.

Figure 1: The Counter-Reformation and persistent decline of scientists

(a) Cities across Europe



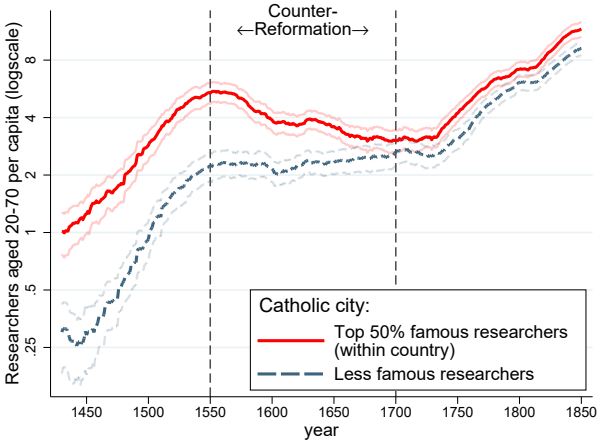
(b) Iberia vs. comparable countries



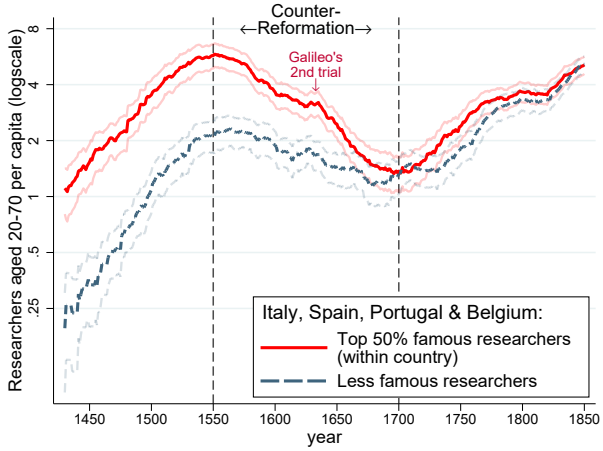
Notes: The figures show that the Counter-Reformation is associated with a dramatic and persistent decline of scientists per capita in Catholic cities relative to Protestant ones. This is observed in Catholic Europe as a whole (1a) and especially in the most heavily treated territories, such as Iberia (1b), where the decline is not just relative to comparable Protestant regions but also absolute. Plotted are means across cities ± 2 standard deviations. Number of scientists is based on biographies retrieved from Wikidata (see section 3) and city population, in thousands, is computed as described in the data appendix (section D.2.1).

Figure 2: Quality decline of science

(a) Catholic cities



(b) Heavily treated regions



Notes: By distinguishing between high and low quality researchers (measured by the degree of visibility of their biographies), the figures show that the quality of science fell during the Counter-Reformation, especially in the most-heavily treated territories (and there, especially after Galileo's condemnation by the Inquisition). Top and bottom 50% visibility corresponds to the within-country rank, based on five criteria, as computed by Laouenan et al. (2022): the number of Wikipedia editions, non-missing biographic information in Wikidata, length of Wikipedia pages, hits of pages, and the number of external links. "Researchers" are those categorized as "Science/Discovery" by the authors. Plotted are means across cities ± 2 standard deviations. City population computed as described in the data appendix (section D.2.1).

of reactive conservatism. For example, when conservative regimes emerged all over Europe in reaction to the French Revolution (1789), it is among Catholics, and especially among cities with a strong Counter-Reformation past, that we observe a slowdown of science. Spain, in particular, revived its Inquisition to counter revolutionary thought, and science collapsed more than elsewhere, especially in cities hosting inquisitorial tribunals. Similarly, when Western Europe reacted to the Bolshevik Revolution (1917) with fascist regimes, scientific growth declined where the Counter-Reformation had once been strongest. Even until the recent past, conservatism and dictatorships are associated with depressed science in cities or countries *conditional* on once having been subject to a strong Counter-Reformation.[3]

Finally, I asks what, if any, were the long-term economic consequences of the scientific decline that originated during the Counter-Reformation. I find that proxies for the Counter-Reformation and its intensity are indeed correlated with lower city growth during the initial phases of Europe's modern economic growth, from 1800 to 1939. I also confirm that this lower growth in treated cities can be largely attributed to having fewer scientists. However, some evidence suggests that there might have been additional Counter-Reformation-related mechanisms at play.

Recent years have seen the emergence of a vast and vibrant literature on the economics of religion and on the early modern roots of economic development.[4] Yet "the Counter-Reformation has seen relatively little study"—note Becker, Rubin, and Woessmann (2021)—"even though its long-run impact on European history and economic history is immense." Notable exceptions are Anderson (2015) and the very recent studies by de la Croix and Morault (2020), Drelichman, Vidal-Robert, and Voth (2021), Blasutto and de la Croix (2021), Becker, Pino, and Vidal-Robert (2021), and Dewitte et al. (2022), which provide supporting evidence on the Counter-Reformation's negative effects on science and growth found in this paper. Further support, albeit indirect, comes from recent studies finding that science and innovation relate positively to conditions that the Counter-Reformation tried to impede—such as freer access to knowledge (Dittmar, 2019; Buonanno et al., 2023) and greater religious diversity (Cinnirella and Streb, 2017)—but relate negatively to conditions fostered by the Counter-Reformation—such as increased religiosity (Andersen and Bentzen, 2022; Lecce, Ogliari, and Squicciarini, 2021; Bénabou, Ticchi, and Vindigni, 2015, 2021), ideological persecution (Moser and Parsa, 2023), isolation (Iaria, Schwarz, and Waldinger, 2018), and increased clerical power (Chaney, 2023).[5]

Thad said, many studies offer alternative explanations for the observed scientific and economic decline. All these explanations are either controlled for or rejected in this paper. One is the degree of political centralization, which, as shown by van Zanden, Buringh, and Bosker (2012), roughly coincides in time and space with the Counter-Reformation. Adding relevance to this confounder, recent studies

[3]Besides providing a rationale for the shock's persistence, this perspective—studying the Counter-Reformation long after it occurred—allows to test the relevance of the original shock in alternative settings, overcoming issues specific to the 16th and 17th centuries, such as data shortages or confounding factors, thereby strengthening identification. Importantly, conditioning persistence on the political reaction explains why persistence is observed in some countries but not others.

[4]Seminal studies include Iannaccone (1998), Barro and McCleary (2003), and Becker and Woessmann (2009).

[5]For the many analogies between the event in medieval Islam studied by Chaney (2023) and the Counter-Reformation, see footnote 67.

have found a positive relationship between intellectual creativity and institutional variables such as self-governance (Serafinelli and Tabellini, 2022) and post-Reformation laws (Dittmar and Meisenzahl, 2020). However, controlling for these and other institutional variables does not affect the results.[6]

Another popular alternative explanation is that differences in science between Catholics and Protestants arose not because of negative effects of the Counter-Reformation but instead because of alleged *positive* effects of Protestant asceticism (e.g., Merton, 1936). However, as figure 1a already reveals, the emergence of Protestantism (ca. 1517–1600) is not associated with an acceleration of the growth of scientist; and I show that neither is an intensification of Protestantism in time or space. Instead, I find that when and where it gained sufficient strength, Protestantism was *harmful* to science—although less harmful than the Catholic reaction to it. Both confessions *tried* to isolate themselves and enforce their dogma. But Catholics did it more effectively, I conclude, because of their logistic advantages (especially religious unity and political coordination).[7] Had Protestantism been a more unified faith, capable of controlling philosophical debate as Luther or Calvin would have liked, it seems likely that modern science may have not risen at all.

This paper differs from most of the so-called persistence studies by tracking the shock *continuously* from its inception to the present day.[8] Not only does this allow to show that the shock persisted indeed, but it allows a much better identification of the mechanisms driving persistence.[9] Another strand of related literature is the vast body of revisionist history of science, which emphasizes that many popular notions surrounding the alleged bloodiness of the Inquisition or the supposed lack of intellectual sophistication of the Counter-Reformation leaders (Jesuits, the Habsburgs, and popes) are false and grounded on propaganda.[10] While at times this literature acknowledges scientific decline during the Counter-Reformation, it tends to do so pointing at confounding drivers (for example economic conditions) specific to the studied cases. In contrast to such case studies, this paper provides more extensive time and space coverage, a big-picture perspective that allows to distinguish better between systematic causal factors and those that may matter specifically at most. This holistic perspective places this work into the perennial literature trying to understand the fundamental conditions that lead to the rise of the West and to the unequal rates of achievement within it. Lastly, the paper also connects to the centuries-old debates on possible negative consequences associated with censorship and intolerance.[11]

[6] Neither does controlling for other popular confounders such as printing (Boerner, Rubin, and Severgnini, 2021), literacy (Becker and Woessmann, 2009), or economic variables such as proximity to the Atlantic, soil quality, or transport routes.

[7] Others in the past have pointed in this direction too, such as Reusch (1883) and Putnam (1906), as I discuss below. On the relationship between fragmentation (which in religious terms was obviously greater among Protestants), persecution effectiveness, and intellectual development, see Mokyr (2007) and Mokyr (2016), chapters 9–12.

[8] For a review of persistence studies and the concerns associated with them, see Kelly (2019) and Voth (2021).

[9] My finding of persistence being strengthened during episodes of reactionary conservatism relates to the study of reactive fascism by Acemoglu et al. (2022), to the studies of enduring religiously-legitimized regimes by Rubin (2017) and Bentzen and Gokmen (2023), and to the studies of persistent political sentiments by Voigtländer and Voth (2012) and Cantoni, Hagemeister, and Westcott (2020), among others. Yet I am not aware of any study, other than this one, linking persistence to reactive conservatism systematically.

[10] See literature cited in footnotes 18, 19, and 60.

[11] The notion that freedom of expression is a desirable, if not necessary, condition for progress has featured prominently in Western society ever since the Enlightenment. It is worth pointing that some writers of the Enlightenment, such as Voltaire or Nicolas Masson de Morvilliers, saw in Counter-Reformation Europe an example of the alleged dismal

The remainder of this paper begins with a brief historiographical contextualization of the Counter-Reformation in section 2. Section 3 introduces the biographical data used extensively in the paper to proxy for scientific and intellectual activity. Based on these data, section 4 shows how the Counter-Reformation is associated with scientific decline from the 16th to the 17th century. Section 5 shows that the scientific geography produced by this decline persisted into the 19th century, identifies forces driving this persistence, and shows how it played a role for city growth after 1800. Section 6 concludes. The paper also contains several appendixes. Appendix A provides details about the Counter-Reformation policies that seem to have affected science. Appendix B rejects alternative explanations of the scientific decline. Appendix C studies persistence in more detail, covering echoes of the Counter-Reformation during dictatorships and waves of international reactionary conservatism. Appendix D provides details on the data and appendix E contains supporting maps.

2 Historiographical context

2.1 The Counter-Reformation: when and where

As traditionally defined, the Counter-Reformation refers to the concerted reaction of the Catholic political and religious establishment against the spread of Protestantism.[12] Many historians date its beginning to the Council of Trent (1545-63), during which a clear doctrinal distinction between Catholicism and Protestantism was established, and after which the coordination and intensity of measures taken increased significantly (details in appendix A). However, it should be noted that the fight against Protestantism had begun decades earlier in parts of Europe, right after the papal condemnation of Martin Luther in 1520.[13] Geographically, the Counter-Reformation was implemented all across Catholic Europe but it took a particularly intense form in localities subject to the Spanish, Portuguese, and Roman inquisitorial systems (figure A3) and in the vast European territories controlled by imperial Spain, which acted, throughout much of Europe, as political, financial, and military spearhead of the Counter-Reformation.[14] This is relevant for causal inference: the volatility

consequences of intellectual repression (see, e.g. Goodman, 2005). Academic interest in the consequences of censorship and intolerance has recently reemerged, addressing current issues such as internet censorship (e.g., Chen and Yang, 2019) and the so-called "cancel culture" (e.g., Norris, 2023).

[12]For a definition of the term and a distinction to the related concepts "Catholic Reform," "Catholic Reformation," and "Early Modern Catholicism" see Bireley (2004). For a comprehensive treatment, see O'Connell (1974), Trevor-Roper (2001), Bamji, Janssen, and Laven (2013), Wright (2017), and other titles in the series of the latter. For a treatment of the Tridentine reforms, see O'Malley (2013). For an economic perspective on these reforms, modeled as a defensive strategy of an incumbent-firm monopoly, see Ekelund, Hebert, and Tollison (2004).

[13]Some landmark episodes are the prohibition of Lutheranism in the Holy Roman Empire through the Edict of Worms in 1521, the creation of the Portuguese Inquisition in 1436, the reorganization of the Roman Inquisition in 1542 (specifically in reaction to Protestantism) and the proliferation of inquisitorial tribunals in northern Italy thereafter, the publication of the first comprehensive Spanish and Roman indexes of prohibited books of 1558-64, the Spanish death penalty for possessing prohibited books after 1558, the ban to visit foreign universities imposed to Spanish subjects in 1559 and in 1568, and the military-imposed recatholicization of several territories between the late 16th and early 17th centuries, usually through Spanish military interventions.

[14]During the reign of Philip II, Spain ruled over roughly 45% of the Western European urban population—including Spain, Portugal, southern Italy, Milan, and Belgium (appendix map E1)—while other 30% or so were part of a broad network of clients across Italy and the German lands. It is particularly in these territories that the Counter-Reformation held sway, as I explain in section 4.3. Catholic France, being "the great power opposed to Spain, found itself opposed to the Counter-Reformation, which, in its first century, had been so openly associated with Spanish power. Consequently,

of Spain's power—which was subject to military contingencies and accidents of inheritance (more on this below)—reflected itself in the reach and intensity of the Counter-Reformation, thereby providing useful quasi-random variance in both time and space. Indeed, it is only after the defeat of Spain's hegemonic ambitions in 1648 (the end of the Thirty Years War) that the Counter-Reformation began to slowly fade off. In Italy, the majority of the tribunals of the Inquisition were abolished in the course of the 18th century in line with Enlightenment ideals, whereas in Portugal and Spain the Inquisition was weakened as well but not abolished definitively until 1821 and 1834 respectively (Bethencourt, 2009, p. 116).

2.2 Effects on science... or nothing but the Black Legend?

Besides military engagement, and doctrinal and disciplinary reforms correcting ambiguities and abuses (Catholicism was to be made attractive again), central to the Counter-Reformation were a set of measures aimed at *isolating* Catholic Europe from "infection" with the dangerous ideas of Protestantism.[15] While not antiscientific per se, these measures—which include coordinated censorship and restricted academic mobility—significantly raised the costs of scientific communication as a side effect (details in appendix A). Similarly, the reformed Catholic dogma produced during the Council of Trent, while not antiscientific in itself, may have solidified dogmatism and intellectual conservatism: the teachings of Aristotle, Galen, and Ptolemy, for example, which had been made compatible with Catholic thought, were not to be questioned, "for to discard one part of the interlocking system of ideas was to threaten the rest of it" (O'Connell, 1974, p. 339).

Galileo was famously condemned by the Roman Inquisition in 1633 (for claiming, based on his astronomic observations, that Earth revolved around the sun), and his work was banned in the Roman Index of Prohibited Literature.[16] Similar cases of direct clashes between science and the Counter-Reformation's dogma, however, are rare. That said, we know for a fact that: (i) book censorship to counter Protestantism was so extensive that scores of *scientific* books were censored indeed (figure A1); (ii) international academic mobility fell—especially in Spain (figure A2), where harsh prohibitions on visiting foreign universities were imposed to avoid Protestant infection—; and (iii) self-censorship occurred, such as that of René Descartes, who, "though living in the Dutch Republic, far beyond the reach of the Inquisition, was 'so astonished' by Galileo's fate 'that [he] almost [took] the decision to burn all [his] papers, or at least to let no-one see them'" (Parker, 2013, p. 654). Further, available evidence on contemporary impressions suggest that Iberians in particular went from being "those bright lampes of learning" (Hakluyt, 1599), who "confidently saw themselves as the first 'moderns,' superseding the ancients" (Cañizares-Esguerra, 2004), to becoming—as the Spanish physician Juan de

in France, the social repression of the Counter-Reformation was long unfelt" (Trevor-Roper, 2001, p. 37). Meanwhile Habsburg Austria, which dealt with multiconfessionalism until its last days, had no option but to adopt a soft stance lest lose legitimacy in much of its territory.

[15] The sense of "infection" was explicit and common at the time. "[I]f one of the arms of my body was infected with this corruption," France's king Francis I declared in 1535, "I would cut it off, and if my children were tainted with it, I would myself offer them in sacrifice." (Kaplan, 2006, p. 486). Contagion was a particularly serious concern in Spain, which had its soldiers fighting all across Europe at risk of being infected and become, as a Spanish monk residing in Brussels put it by 1600, "sparks of heresy that may fly from Flanders to Spain" (Thomas, 2014).

[16] "In denying the geocentric and geostatic system of Ptolemy," Shapin (1998, p. 136) explains, "Galileo was taken as rejecting the truth of Scripture."

Cabriada wrote in 1687—both intellectual *conservatives* ("[sticking to] outdated doctrines . . . idolized to the detriment of the truth") and intellectual *isolates* ("the last to receive [knowledge] spread across Europe, as if we were Indians").[17] Such evidence has long motivated the idea that the Counter-Reformation "sealed the fate of southern Europe for the next three hundred years" (Landes, 1998, p. 181).

Yet the theory linking the Counter-Reformation with scientific (and eventually economic) decline is far from being consensus.[18] Since the 20th century, historians have become increasingly aware that many popular notions about the Counter-Reformation, from the supposed bloodiness of the Inquisition to the supposed antiscientific stance of the Jesuits, are false, often being just the enduring reflection of anti-Catholic propaganda of the early modern information war—the so-called Black Legend.[19]

With contamination being undeniable, the following question arises: may the idea that the Counter-Reformation harmed science be *nothing* but the enduring echo of propaganda? Is it true or false that "the prohibitive laws of the Inquisition" (recalling this paper's epigraph) were an impediment to "learn[ing] the discoveries of the exact sciences"? Two hundred years later, statements like this remain controversial—and so does the role of the Counter-Reformation as a whole.

3 Biographical data

To investigate whether science was affected by the Counter-Reformation, this paper proxies scientific activity by the number of "scientist per capita" (to be defined below) at the city-year level, based on biographical data gathered from Wikidata (`wikidata.org`), a repository of encyclopedic metadata which draws information from several biographical dictionaries (e.g., *Neue Deutsche Biographie*), from authority files of national libraries (e.g., the *Bibliothèque nationale de France*) and from encyclopedias (e.g., *Britannica* or *Wikipedia* in different languages). Following the usual practice in dealing with the early modern period, this paper defines a "scientist" as somebody engaging in what we broadly call science today (including non-experimental fields like mathematics and historiography) or engaging

[17] See López Piñero (1979, pp. 421–24).

[18] It has been noted that, considering the common practices of repression across Europe in early modern times, neither the Roman, nor the Spanish or Portuguese Inquisitions were as repressive as it is commonly believed (e.g., Monter, 2004, Tarrant, 2014, and Kamen, 2014). The famous trial of Galileo by the Inquisition is seen as an exception to an otherwise constructive relation between the Church and early modern science (Shapin, 1998, Hannam, 2011, and Ferngren, 2002, among others). Jesuits—a key force of the Counter-Reformation—were "men of letters" including figures like Athanasius Kircher and Christopher Clavius, they educated the likes of Descartes, Voltaire, and Diderot (see, e.g., Feingold, 2003), and spread science education through their missions (Ma, 2021; Valencia Caicedo, 2019) or the founding of universities (Frijhoff, 1996). For such reasons, many historians (and historians of science in particular) are now reluctant to confirm a negative impact of the Counter-Reformation on science. Instead, they prefer to highlight how the narrative is known to have been affected by propaganda (e.g., Malta Romeiras, 2020). Some deny any negative effect at all: The Spanish Inquisition—so Kamen (2014, p. 149)—"was never in a position to affect or dictate the cultural evolution of Spain."

[19] As explained by Maltby (2009, p. 118), "hundreds of anti-Spanish publications appeared in English, Dutch, French, and German in the sixteenth century[, and then again] in the Thirty Years' War and on other occasions when it seemed useful to stir up anti-Spanish sentiment. Given the pervasiveness of such material, it is not surprising that the authors of scholarly histories absorbed anti-hispanism and transmitted it to later generations." The term Black Legend has been used among historians to describe not just the anti-Spanish bias of historiography, but the broader anti-inquisitorial, anti-Catholic, and anti-religious bias present in historiography.

in philosophy or branches of protoscience such as alchemy and astrology.[20] Additionally, either for robustness purposes or in order to augment the number of observations, I sometimes use the more broadly defined metric "intellectuals," including thinkers, theologians, and other influential nonfiction writers in addition to scientists. Even though we usually have twice the number of biographies when considering intellectuals instead of scientists, the behavior of the time series is remarkably similar (see appendix figures D1-D2).

I use the incidence of such biographies to proxy scientific and intellectual activity across time and space. How exactly? Since data on actual activity are scarce, I proxy activity over time using a researcher's age combined with the empirically-observed distribution of the age of scientific genius during the analyzed period (Hongzhou and Guohua, 1985, López Piñero, 1979, Wray, 2009, Jones, 2010 and Jones, Reedy, and Weinberg, 2014).[21] With regard to activity locations, I proxy them using birth and death places (each adding to the sum of scientists or intellectuals in a city). This approximation will be inaccurate for superstars, many of whom traveled greatly around the Continent. However, for the median 16th-century scientist, for example, birth and death locations coincide but for 10 kilometers (or 0 kilometers in the case of intellectuals), suggesting that mobility was low (see table D2).

Unless stated otherwise, "per capita" means "per city's population" (based primarily on Bairoch, Batou, and Chevre, 1988 and within-century observations from de Vries, 1984, Lees and Hohenberg, 1989, and Biraben and Blanchet, 1999), where population has been log-linearly interpolated to create yearly time series (details in appendix section D.2.1).[22]

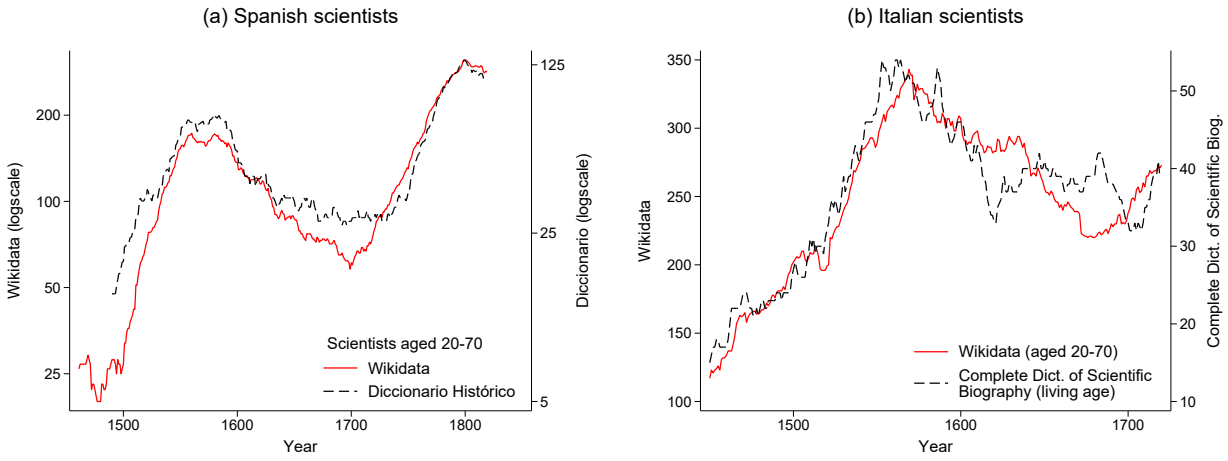
Are the data used in this paper consistent with other scientometric studies? Yes. For example, figure 3 compares time series of Spanish and Italian scientists based on Wikidata with those based on the *Diccionario histórico de la ciencia moderna en España* (López Piñero et al., 1983) and the *Complete Dictionary of Scientific Biography* (as coded by Anderson, 2015), confirming similar dynamics. The same can be said about Belgian scientists (figure 6c), which peaked around 1600, then declined until 1700, and recovered vigorously in the 18th century, precisely as drawn by Quételet (1864, p. 374) in his account of Belgian mathematicians and physicists since 800—a shape later confirmed by Pelseneer (1941), with data from the *Biographie nationale*, not just for mathematicians and physicists but for people in other fields of intellectual activity. In general, the overall trends in the data find support in comparable biography-based scientometric country-year panels, such as Gascoigne (1992), Murray

[20] Explorers are *excluded* in order to avoid a spurious pre-Counter-Reformation spike in Iberia driven by a unique contingency—the discovery and exploration of the Americas. Including them would only strengthen the results.

[21] Taken together, these studies suggest that, from 1400 to 1900, scientific activity occurs roughly between ages 20–70, with higher densities around ages 25–50. While smoothing is stronger using a wider interval, switching between age intervals 25–50 and 20–70 has no big impact on the timing of structural changes: see appendix figures D1-D2.

[22] For robustness purposes, I will at times divide the number of researchers not by urban population but by the quantity of all "notables"—i.e. all persons with biographies in Wikidata. Using the number of famous people as denominator is desirable *if* both the numerator and denominator share comparable time-space sampling biases. However, this approach is subject to much higher variance overall and also to marked distortions over time, which are the result of important periods (great wars, for example) being associated with more biographies and hence with an artificially depressed density of scientists. For example, even though science was thriving in 18th century France (as the "per urban citizen" ratio correctly shows), the share of French scientists among famous Frenchmen *declines* abruptly during the 18th century and especially during French Revolution, given the abnormally high number of non-scientific biographies we have during those years.

Figure 3: Different sources, similar dynamics: Italian and Spanish scientists



Notes: The figure shows similarities between time series based on Wikidata and those based on (a) the *Diccionario histórico de la ciencia moderna en España* (López Piñero et al., 1983) and (b) the *Complete Dictionary of Scientific Biography* (as coded by Anderson, 2015).

(2003) and Anderson (2015); and also, albeit less precisely, in Sorokin's (1937) count of notable discoveries and inventions (appendix figure B8). Even more similar are the data recently published by Laouenan et al. (2022), which are also based on Wikidata, and which I incorporate in this paper to corroborate the overall findings. In more recent periods indicators of scientific activity such as R&D spending and publications also strongly correlate with densities of scientific biographies. For all these reasons and for the sake of abbreviation, I henceforth use the shortcut "science" when referring to the "observed number of scientists per capita." Further details on queries, the definitions of "scientists" and "intellectuals," summary statistics, and other details can be found in the data appendix.

4 The Counter-Reformation and scientific decline

4.1 The geography of scientific decline

As we shall see, the number of scientists per capita fell when the *intensity* of the Counter-Reformation—both in time and space—was stronger. Before looking at how this claim is supported in the time dimension, let us first focus on the spatial one, studied in table 1 through city-level OLS estimates of

$$\ln\left(\frac{\text{Scientists born C17}_i}{\text{Population in 1700}_i}\right) - \ln\left(\frac{\text{Scientists born C15 \& C16}_i}{\text{Pop. in 1500 \& 1600}_i}\right) = \alpha D_i(\text{CR-proxy}) + \text{controls}_i + \text{error}_i. \quad (1)$$

Here α captures the correlation of a Counter-Reformation proxy with the growth of scientists per capita in city i from the start of the Counter-Reformation (measured as the 15th- to 16th-century average) to its apogee in the 17th century. Controls include distances to the Atlantic and to the Mediterranean, initial scientists per capita, early printing output, urban development, institutional

variables, and fixed effects for countries and fluvial catchment regions.[23] Column 1 begins with the simplest proxy for the Counter-Reformation, a dummy for 17th-century Catholicism, finding that growth of scientists was on average 55 logpoints lower if the city was Catholic.[24] A similar result is confirmed in column 2, restricting the regression to a narrow religious frontier: cities located on the western flank of the Holy Roman Empire and within 50 km distance from a city with the opposite denomination.[25]

A quasi-natural experiment. Among such cities at the confessional border, the case of the Low Countries (roughly today's Belgium, Luxembourg and the Netherlands) offers an interesting quasi-natural experiment to study the treatment-effects of both Catholicism and Spanish imperial policy (two related but distinct aspects of the Counter-Reformation). Before treatment, the bulk of scientists in the Low Countries came from a largely *homogeneous* cultural area—a wealthy, densely-urbanized, and Dutch-speaking territory centered around Antwerp (its cultural capital), which spanned from Brussels to north Holland and from Bruges to Nijmegen (figure 4). Inherited by Charles V and then by his son Philip II (both kings of Spain and key leaders of the Counter-Reformation), these domains were subject to repressive but ineffective attempts to stop the proliferation of Protestantism, which eventually spread throughout the whole territory.[26] Partly in response to religious repression, multiple cities revolted against Spanish rule, beginning in 1566 with a wave of iconoclasm—that is, the destruction of Catholic images—beginning in the southwestern Belgian towns of Steenvoorde, Poperinge, Ieper, and Menin and then spreading to Antwerp, 's-Hertogenbosh, and further north, as shown in panel (a) of figure 4.[27] Yet, despite its southern origins, and mostly because of geographical accidents—the north enjoyed natural defenses and the military forces of Spain were sent from Italy through the Alps (Parker, 2004)—the rebellion succeeded in the north but was crushed by Spain in the south. We can thus think of a homogeneous population affected by a geographically-determined geopolitical shock, namely effective Spanish military control.[28] Protestantism, which had spread across the whole Dutch-speaking territory by 1550, was fully eradicated by 1650 in Spain-controlled areas.[29]

Spanish-Empire effect. As shown in figure 4, Spanish occupation is not just evidently related to

[23] One role played by these controls is the absorption of plausible geographical biases in biographical sampling (say an underrepresentation of southern Europe); Interestingly, however, the estimated α is similar to the one we would obtain without controls, suggesting rather unbiased sampling (see figures B9, B10a, and B10b).

[24] The dummy indicates a Catholic majority among the city's population by the late 17th century, the only exception being France, where cities firmly controlled by Protestants early in the century are coded as non-Catholic despite a Catholic majority. See map E2.

[25] Map E4a shows this restricted sample. Including other confessional frontiers, such as those in southern France, Poland, and Hungary, would not alter the results.

[26] As explained below, repression backfired. See also footnote 38.

[27] Admittedly, the event of 1566 was not fully spontaneous: The iconoclastic fury was initiated by an "organized itinerant body of image-breakers who came over from England" (Parker, 1977, p. 77). That said, the widespread incidence of Protestantism in the south at the time is clearly evidenced by the proclamation of "Calvinist Republics" in Antwerp, Bruges, and Ghent.

[28] Spanish troops used a south-north corridor from Italy to Spain known as the Spanish Road (see figure E1). Thus logistics allowed Spain to control the south more effectively. Spaniards came close to reconquer the north too, but they abandoned their positions by 1590 in order to attend another conflict: the troops were sent to France, where they captured Paris to prevent the takeover of the French crown by the Protestant Henry of Navarre (see, e.g., Nexon, 2009 and Parker, 1977, ch. 6). This distraction permitted the construction of Dutch fortified defense lines and led to a long-standing stalemate. This boundary came to determine a geography of religious affiliation that last even until today.

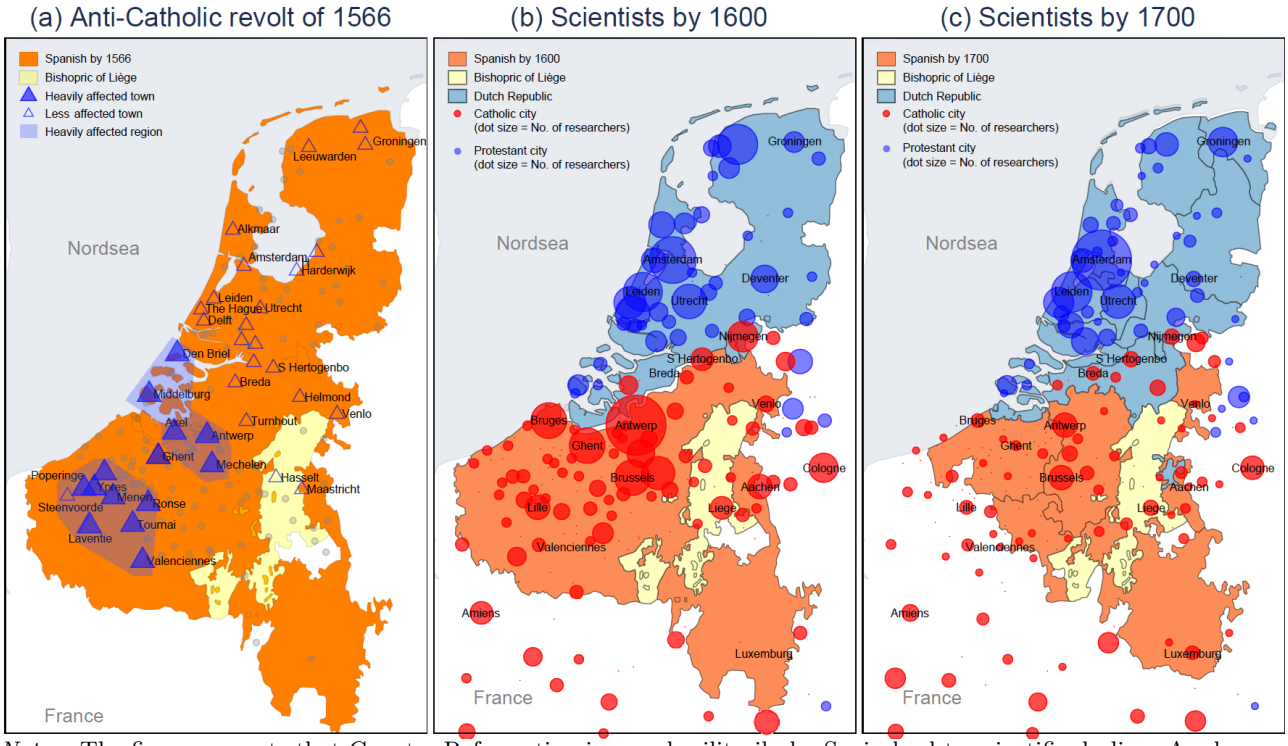
[29] So the Calvinist Republics of Antwerp, Bruges, and Ghent became Spanish and Catholic strongholds, while Amsterdam, originally loyal to Spain, became the capital of a Protestant majority country.

Table 1: Decline of science in Counter-Reformation cities by the 17th century

	Dependent variable: Change in scientists p.c. from 16th to 17th century									
	(1) All cities	(2) Religious border (50km)	(3) All cities	(4) Empire border (50km)	(5) All cities	(6) Nearby Catholics (50km)	(7) Italy	(8) Iberia	(9) All cities	(10) Religious border (100km)
Counter-Ref. proxy										
Catholic by 1650 = 1	-0.55***	-0.51***							-0.37***	-0.52***
	(0.14)	(0.19)							(0.14)	(0.13)
Spanish by 1600 = 1			-0.53***	-0.48***			-0.72***		-0.47***	-0.35***
			(0.13)	(0.15)			(0.13)		(0.13)	(0.10)
Inquisit. tribunal = 1					-0.41***	-0.30***	-0.36***	-0.42***	-0.40***	-0.27***
					(0.13)	(0.08)	(0.13)	(0.03)	(0.14)	(0.05)
Counter-Ref. interactions										
Catho. × University 1600									-0.58***	-0.50***
									(0.12)	(0.14)
Catho. × New Uni. C17th									-0.91***	-0.46**
									(0.21)	(0.19)
Controls										
University in 1700	0.16*	0.17	0.13	-0.17	0.18*	-0.24***	-0.11	0.07	0.65***	0.54***
	(0.10)	(0.18)	(0.09)	(0.30)	(0.09)	(0.02)	(0.12)	(0.30)	(0.13)	(0.14)
Calvinist presence (> 1%)									0.06	-0.09
									(0.09)	(0.12)
Calvinist majority									0.03	0.15
									(0.16)	(0.11)
Fully Calvinist (> 80%)									-0.29**	-0.38**
									(0.12)	(0.17)
Dist. to Atlantic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dist. to Mediterranean	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Initial researchers p.c.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Printing volume (by 1500)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pop. growth 1600–1700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pop. growth 1500–1700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Parliament meetings C17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Loc. particip. govt. C17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ethno-linguistic FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fluv. catchment region FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	563	86	567	62	567	110	104	43	563	209
R-squared	0.48	0.45	0.47	0.53	0.45	0.44	0.54	0.58	0.52	0.52

Notes: The table shows that cities affected by the Counter-Reformation experienced a decline of scientists per capita during the 17th century. Among Catholics, the decline was larger in cities where the Counter-Reformation was logistically easier to enforce—that is, those within the Spanish Empire, those with a tribunal of the Spanish, Portuguese, or Roman Inquisition, or those with universities, either old or new. The table suggests detrimental effects stemming from Protestant bigotry as well, since cities *fully* controlled by Calvinists are associated with scientific decline too (arguably because of effective social control). Estimates are cross sectional regressions across Western European cities. Fixed effects (FE) by ethno-linguistic groups listed in the appendix (map E8). FE by fluvial catchment region are dummies for the Atlantic, the North Sea, the Baltic, the Black Sea, and the Mediterranean based on Buringh (2021). Numbers of scientists and religious indicators are based on Wikidata (details in appendix D). University founding dates are from Verger (1991) and Frijhoff (1996). Locations of inquisitorial tribunals are from Bethencourt (2009). Spanish imperial limits as shown in figure E1. City population based on Bairoch, Batou, and Chevre (1988), extended as shown in appendix D. Early printing data based on the *Incunabula Short Title Catalogue* (ISTC, 1998). Institutional data based on van Zanden, Buringh, and Bosker (2012), Bosker, Buringh, and van Zanden (2013), and Henriques and Palma (2023). Constants omitted from the table. Spatial-autocorrelation-adjusted standard errors in parentheses, based on the procedure of Colella et al. (2019) within 250 km. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 4: Military logistics leading to a religious and scientific outcome



Notes: The figure suggests that Counter-Reformation imposed militarily by Spain lead to scientific decline. As shown in panel (a), the anti-Catholic, iconoclastic fury of 1566 that initiated the Dutch war of independence against Spain was more intense in the south. However, as shown in panel (b), it was also the south that was reconquered by Spain (because Spanish troops came from Italy), leading by 1600 to a military boundary within which all cities were recatholicized. Panel (b) also shows that Antwerp was the city with the most scientists and that cities such as Brussels, Bruges and Ghent were important centers of science too. However, panel (c) shows that over the course of the 17th century their positions declined precipitously compared to their northern counterparts in the Dutch Republic. Dot size is proportional to the number of scientists born in a city during the preceding 100 years.

a city's eventual religious affiliation but also to the change in the number of scientists born in a city. Antwerp, for example, went from being the most common birthplace of scientists in the region in the 16th century (the largest bubble in subfigure b) to being a modest player in the 17th century (subfigure c). The other important birthplaces (Brussels, Bruges, Ghent, Leuven, Mechelen) fell behind as well, suggesting an important negative effect of Spanish occupation. Neither destruction by war nor plague outbreaks (two negative shocks affecting the south more than the north after 1600) can explain such a large decline, as we will see below. Indeed, in other fields of creative activity—most notably painting—the developments of north and south remained comparable.[30]

[30] Another interesting point of the Low Countries is that it allows to separate Catholicism from the empire: The frontier cities of Breda, S-Hertogenbosch, Nijmegen, and Maastrich fell into permanent rebel control during the 17th century, yet they "[had been] under Spanish control just long enough to feel the impact of Tridentine reform; despite their subsequent conquest and absorption into a Protestant state, the population remained overwhelmingly Catholic" (Tracy, 1985, p. 547). Interestingly, these Catholic cities do not show any signs of per capita scientific decline in the 17th century (see figure B10b), unlike the cities governed by Spain (and Liège, which being a bishopric surrounded by Spain, was a Counter-Reformation state as well; see Trevor-Roper, 2001). This evidence on lacking decline outside the empire is unfortunately based on a few observations. That said, it would suggest that the causal force was not the religious doctrine by itself, but the way in which it was enforced (bans of literature, strict control of universities, intellectual isolation and conservatism, episcopal inquisitorial activity, etc.).

This negative association of science with Spanish occupation by 1600 is confirmed in table 1, first across Europe in column 3 and then again when comparing cities close to the imperial borders in column 4. While Catholicism and Spanish occupation are closely related (as the Spanish reconquest of the southern Low Countries demonstrates), both dummies also individually explain the decline when included together (in columns 9 and 10 of the table), suggesting a more severe treatment under Spanish rule—not surprisingly, given that the Counter-Reformation can largely be seen as a Spanish enterprise (e.g., Nexon, 2009). It is also important to notice that the negative association of the Spanish Empire with science is not dominated by Iberian cities nor by southern Italy; this is shown in column 10, which is restricted to cities close to the confessional borders, excluding both Iberia and southern Italy from the sample (see appendix map E4d).

Inquisitions. Central institutions for the design and enforcement of the Counter-Reformation were the Spanish, Roman, and Portuguese Inquisitions (details in appendix A). Did they play a role in the region's relative decline of science? While the inquisitorial systems attempted to impose control over all towns within their jurisdictions, presumably their activities were more concentrated in the cities where inquisitorial tribunals were located. In line with this hypothesis, columns 5 to 10 of table 1 find indeed a negative association between the tribunal dummy and the growth of scientists. Note that this is an *intra*-Catholic phenomenon: we observe this negative correlation within Italy (column 7), within Iberia (column 8), and in a sample of Catholic cities within 50 km of the tribunals (column 6; sample shown in map E4c).[31]

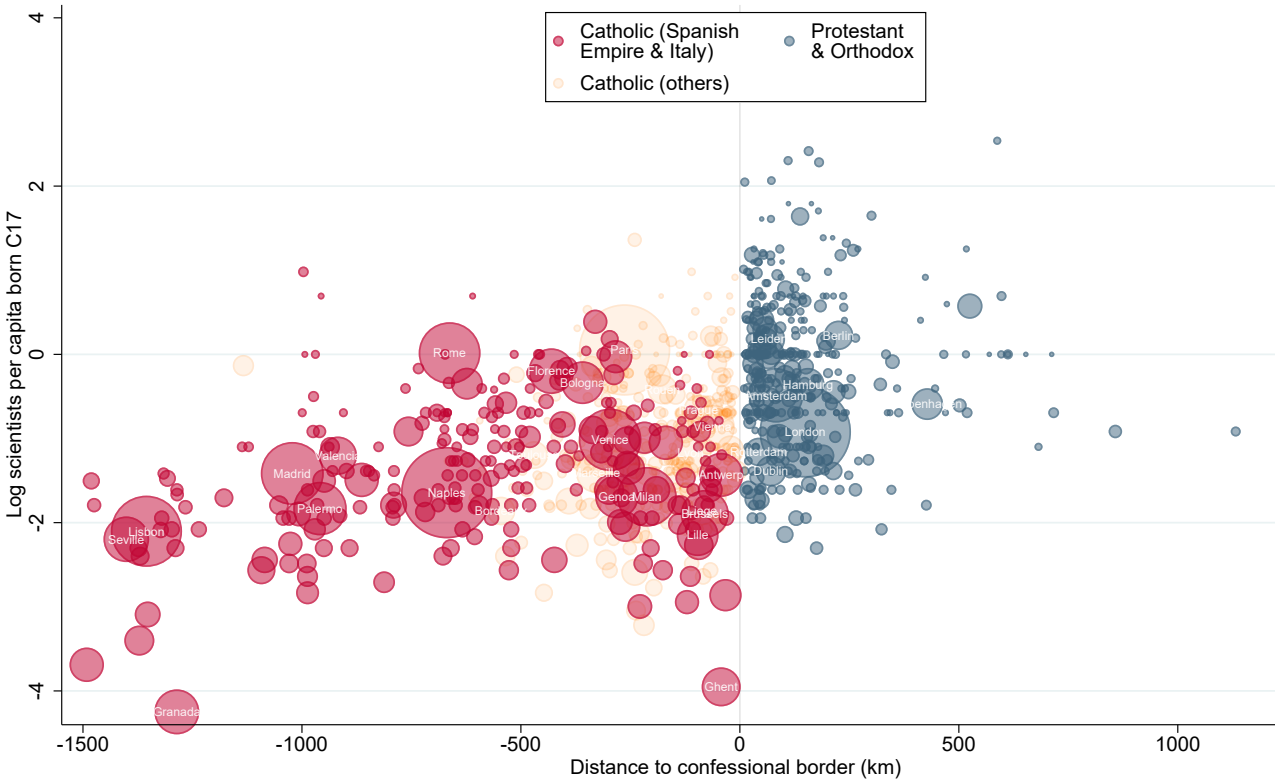
Logistics and enforcement. Columns 9–10 further show that the negative association of the tribunals with science is maintained after controlling for Catholicism and Spanish occupation. In other words, a city that was at the same time Catholic, occupied by Spain, and the seat of a tribunal of the Inquisition is statistically associated with a sharper decline than is a city with just one or two of these characteristics. An interpretation of these results is that logistics mattered: censorship, closure, and indoctrination were more effective if enforced by coordinated inquisitorial systems and supported by the military, political, and financial weight of imperial Spain.[32] This interpretation is indeed supported by another finding in the table: among Catholic cities, the scientific decline was more pronounced in cities with universities, which were seen as dangerous spots for the propagation of Protestantism but were at the same time logistically easy to control.[33] Even new Catholic universities (those founded

[31] Uncontrolled variance offers a similar picture: see appendix figure B11.

[32] Was Spain's empire a really centralizing and coordinating entity in this regard? Certainly yes. Even if the empire was rather decentralized in matters such as taxation or market integration (see, e.g., Espinosa, 2008 and Grafe, 2012), it was very centralized in matters of war and religion. While this may seem a contradiction, it was not. Decentralization in form of so-called "privileges" (like monopolies or tax exemptions) were an important pillar granting legitimacy to dynastic composites agglomerated by inheritance and marriage, particularly so for the Habsburgs (see, e.g., Nexon, 2009). At the same time, the Habsburgs also relied heavily on religious legitimacy, what explains why the empire was decentralized economically yet very centralized in religion. Religious unity was indeed one of the primal objectives of Habsburg policy (more in section 4.3). Philip II for example, stated that he would prefer not to have subjects at all than having to rule over heretics; and he consistently appointed regents which shared this view.

[33] How universities and printing centers were seen a dangerous spots of contagion is discussed in appendix A. For example, "Pope Paul III," writes Norwich (2003), "was alarmed ... by the number of young German students at the University of Padua who, he believed, would spread the contagion whenever and wherever they could. Nor could he forget that Venice was still one of the principal centers of printing and book production in all Christendom, and thus uniquely placed to subvert—if she wished or were otherwise persuaded—the minds of the faithful." An example of how effective university-driven repression was is found in Scibner (1976).

Figure 5: Discontinuity at the border



Notes: The figure shows that 17th-century science was depressed close to the confessional border especially when subject to the Spanish Empire or to the Roman Inquisition. This points to the importance of centralized structures enforcing intellectual control. Dot size represents population in 1700. *Sources*: see section 3.

in the 17th century) are negatively associated with science, in stark contrast to the positive association that universities have across non-Catholic Europe. Overall, we find a highly significant negative association of science with proxies for enforcement-logistics—the Spanish Empire, the inquisitorial tribunals, and the presence or founding of a university, all of this subject to being Catholic—pointing at the importance of logistic capabilities in enforcing intellectual control.[34] (Below we will confirm a similar result applied to Protestants instead.)

Further support for the role of centralized logistics comes from figure 5, which explores discontinuities at the confessional border in the number of 17th-century-born scientists per capita. It shows that Catholic cities close to the "heresy-frontier" had particularly low numbers of scientists *if* they were in Italy or in Spanish imperial territory, while the remaining Catholic borderland shows a much less pronounced discontinuity.[35] This suggests that cities at similar risk of Protestant infection were

[34]For the robustness of these finding using different metrics of scientific and intellectual decline, alternative radios of spatially autocorrelated errors, and weighting by data quality, see appendix table B2.

[35]France is an interesting case, as it granted official toleration of Protestantism during much of the 17th century (see figure 6d below). Protestants minorities were scattered all across, and at times they had so much political power that they constituted a "state within the state." Toleration and political fragmentation, added to how "France found itself opposed to the [Spanish-led] Counter-Reformation" (Trevor-Roper, 2001), appears to have restricted repressive capacity and allow a much more plural environment, possibly explaining why France outperformed its Catholic neighbors in terms of scientific growth. A similar point can be made with regard to Austria and Poland.

more affected by the Counter-Reformation's scientific isolation and philosophical rigidity if these were effectively enforced thanks to the centralized coordination of the inquisitorial systems and the Spanish Empire.[36]

4.2 The timing of scientific decline

When did the scientific decline of Catholic Europe begin? Figures 1 and 2 discussed in the introduction show that, overall, this decline occurred approximately between 1550 and 1700, roughly coinciding with the Counter-Reformation in Europe as a whole. But the precise timing of the Counter-Reformation differed from country to country. Does this different timing match with different episodes of decline? As shown in figure 6, the answer is positive. Within Germany (figure 6a), we observe that Catholic and Protestant cities showed similar paths until around 1520 but decoupled markedly afterward. This coincides with the condemnation of Luther in 1520 and the Edict of Worms of 1521, issued by Charles V (king of Spain and newly-elected Holy Roman emperor), which prohibited Luther's works and ordered them burned. The edict proved ineffective in most of the German states, where enforcement was weak. However, some states, most notably Bavaria and Cologne, actively enforced the edict right after 1521 (Creasman, 2012, pp. 58, 35–36). In Cologne, one of the major printing centers in Germany, the enforcement was exceptionally effective, Scibner (1976) argued, because of the close cooperation between the state, ecclesiastical authorities, and the university.[37]

In the Low Countries, however, the divide happened much later (figure 6c). Firm Spanish control of the southern territories (and thus *de facto* enforcement of the Counter-Reformation) could not materialize until after 1585, the year Antwerp was retaken. Prior to that, "not only the rebel provinces of the north, but also the greatest cities of the southern Netherlands were firmly in the grasp of militant Calvinist minorities" (Tracy, 1985, p. 549). Thus, even if, *de jure*, the Low Countries were subject to the Edict of Worms (and subsequent similar regulations) and the central authority tried to impose it with brute force—burning books and people—the share of citizens ignoring the edict was such that the measures did not have the intended effect, as shown by McDonald (2017) and Parker (1977).[38] This explains why the differences in science that we see starting already by 1521 in Germany, and around 1550 in Europe as a whole (recall figure 1), appeared in the Low Countries only in the decades after 1585, with Antwerp under Spanish control, and especially after the truce of 1609, which allowed Spanish governors to implement the Counter-Reformation internally.[39]

Yet the most striking discontinuity is observed in Spain itself (figure 6b). Scientific activity there had evolved since 1500 in the same manner as in England and the Netherlands but collapsed suddenly

[36] On the fully centralized and coordinated religious policy of the Spanish Empire, see footnote 32.

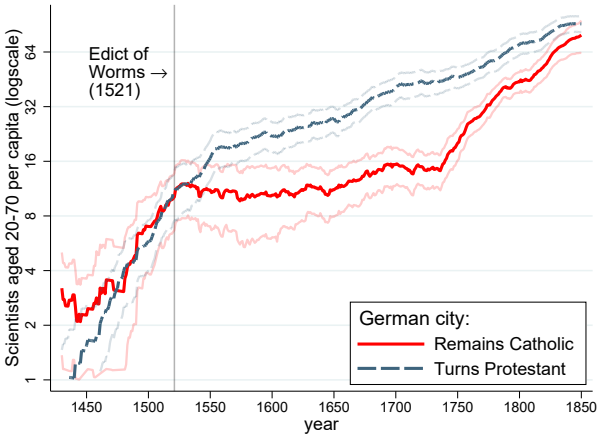
[37] See also Creasman (2012), pp. 35–36.

[38] The powerful book industry was not willing to give up neither control nor profits. Intellectuals, including Catholics such as Erasmus, saw the edict as an attack to humanist principles. Judges, often sympathetic to the Protestant cause, were unwilling to enforce it. Holland, already an important printing location, was almost untouched by the edict. And in Antwerp, the capital and printing powerhouse of the Low Countries, the day in which the edict was read aloud in the town hall and books began to burn, the crowd went out of control and made a public mockery of the ceremony.

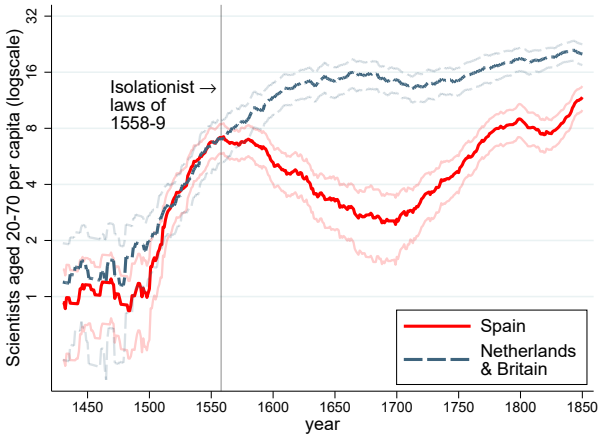
[39] Especially during the Twelve Years' Truce (beginning in 1609), given peace and economic recovery, did the governors of the Spanish Netherlands concentrate their efforts in the internal implementation of the Counter-Reformation. As Parker (1977) remarks: "[the] new 'south Netherlands identity', religious and political, was born under the archdukes and above all during the Truce."

Figure 6: Divergence when we would expect it – country-specific cases

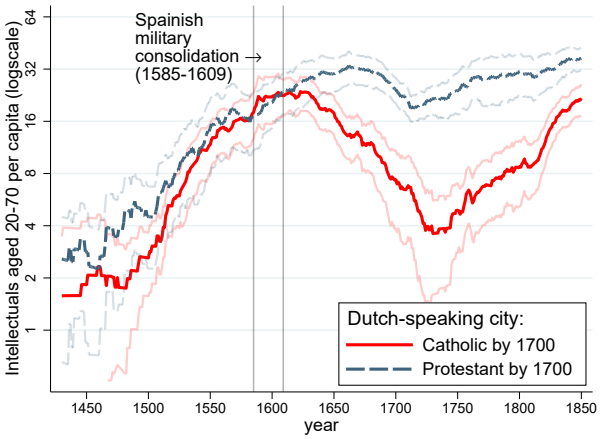
(a) German-speaking cities



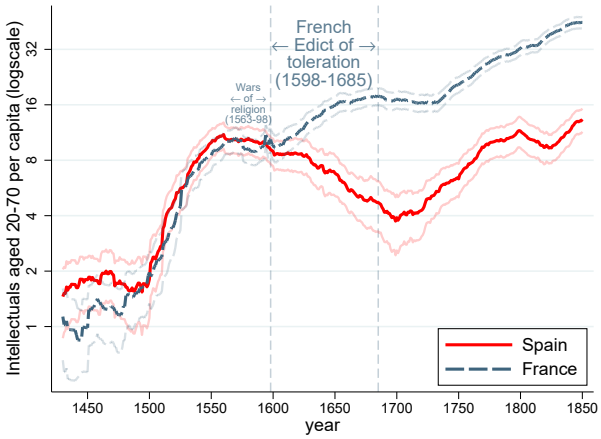
(b) Spain vs. Britain and the Netherlands



(c) Dutch-speaking cities



(d) France's special case



Notes: The figure illustrates how the Catholic scientific decline begins precisely when one would expect. In Germany, this happens 30 to 40 years prior to most other Catholic regions, right after the Edict of Worms (1521), which inaugurates the repression of Protestant literature in states such as Bavaria and Cologne (Scibner, 1976). By contrast, in the Low Countries this happens only in the decades after Spain takes effective military control (1585–1609). In Spain, after sharing a trend with Britain and the Netherlands, an abrupt decline begins after 1559, right after the isolationist laws triggered by the discovery of Spanish Protestant cells since 1557. In France, the trend was like that of Spain for more than hundred years but diverges markedly during the implementation of the Edict of Nantes (1563), which grants Protestants extensive religious and civil liberties, including access to education, public worship, and the right to maintain military fortifications. *Sources*: Population is from Bairoch, Batou, and Chevre (1988), extended with Biraben and Blanchet (1999), Lees and Hohenberg (1989), de Vries (1984), Lourens and Lucassen (1997), and others to cover changes within the 16th and 17th centuries. Scientists and intellectuals are based on biographical data retrieved from Wikidata (see section 3).

after 1558.[40] The timing coincides with an explosion of inquisitorial activity (Drelichman, Vidal-Robert, and Voth, 2021, figures A1 and A2) and fits precisely with the implementation of an array of isolationist decrees in 1558 and 1559 (in reaction to the discovery of multiple cells of Protestants in Spain; see, e.g., Goodman, 1983 and Luttikhuizen, 2017).[41] The new measures included the death penalty for possessing prohibited literature, the first comprehensive index of prohibited books, and the prohibition on visiting foreign universities imposed by Philip II in 1559. Whether this last ban was effective has been debated among scholars.[42] However, appendix figure A2 shows that the share of famous Spaniards studying abroad declined abruptly, suggesting that the measure was effective.[43]

We have seen that the effective implementation of the Counter-Reformation correlates in time and space with subsequent scientific decline. Does the *relaxation* of such policies generate the opposite effect? An interesting case is France in the 17th century, precisely when the Counter-Reformation was peaking throughout the rest of Catholic Europe. In an act that would have been unthinkable in neighboring Spain, Italy, or Belgium, France issued in 1598 the Edict of Nantes, which granted effective toleration of Protestantism in specific locations scattered all across the kingdom. Figure 6d suggests that the edict may have been key in limiting the effects of the Counter-Reformation: France had shared a path of intellectual development comparable to that of Spain for a long time but diverged markedly after 1598, after which France decisively took off.[44] Moreover, the revocation of the edict by Louis XIV in 1685 seems to have had a negative effect until his successors reintroduced some degree of toleration after he died in 1715. Indeed, all over Europe science began to recover fast after 1700, when religiously-driven policy receded in favor of the more tolerant ideas of the Enlightenment. This recovery was particularly strong among Catholics, apparently thanks to the retreat of the Counter-Reformation. We will confirm this interpretation later in section 5 when studying, for example, how science reacted to the relaxation of the Spanish Inquisition after 1700, its revival after the French Revolution, and its eventual dissolution in the 1830s.

[40] The timing seems consistent with historiographical research, which shows that Spain was indeed scientifically connected to Europe by the mid century, but increasingly less thereafter. See appendix section B.5.

[41] Not only were authorities' actions taken against the Protestant cells prompt and wide-ranging—they also received massive popular support. For example, when the discovered heretics were to taken to the *auto da fe*, "the public outcry . . . was such that the prisoners had to be moved at night to prevent enraged mobs from lynching them[, and one of them] was convinced that his family would have him assassinated before he reached court" (Rodriguez-Salgado, 2008, p. 218).

[42] "The frontiers"—writes Kamen (2014, p. 107)—"were never closed."

[43] This finding also is consistent with López Piñero (1979), who studied international interactions of Spanish researchers and identified two "clearly differentiated phases," divided by the aforementioned panic of 1557-58 (the discovery of Protestants within Spain): before 1559, about half of Spanish researchers had visited foreign universities; thereafter, the share fell to virtually zero (p. 141). The decline of mobility was strongest in Spain, yet it fell in Europe as a whole during the 17th century, as shown in the appendix (table D2). Similar effects were recently found by de la Croix and Morault (2020), who analyze mobility of early modern researchers and find that the decline of connectivity was particularly strong in Southern European universities during the Counter-Reformation.

[44] That the devastation during the Wars of Religion may explain part of the preceding downturn more than repression and intolerance seems unlikely, given that in other similar cases of devastation such as the Thirty Years War, the Italian Wars, or the Dutch Revolt there is no visible decline of intellectual activity (more on this in appendix B). That said, there are two qualifications to the interpretation. First, some arrangements of toleration were already implemented during the stalemates of the Wars of Religion, yet the number of scientific and intellectual biographies continued to fall. And second, the chaos of the wars may have rendered much of the repression attempts fruitless anyway.

4.3 Exogenous forces

England *had* its Counter-Reformation too. It began in 1553 when Mary Tudor was proclaimed queen of England and married Philip II, inheritor of Spain's empire and fervent leader of the Counter-Reformation. Catholic rule came back and many Protestants were killed or fled to exile.[45] But Mary's Counter-Reformation, together with Philip's English title, *died with her* only five years later in 1558. Had she not died prematurely, or had she had a son, or had the Spanish army successfully landed in England 30 years later, England would most likely be Catholic today, historians have dared to assert (Parker, 2014, p. 57; MacKenney, 1993, p. 220; Duffy, 2010, p. 187);[46] and so would Scotland and the Netherlands (Green, 1896, p. 167), if not Western Europe as a whole, dominated by a "unified Anglo-Iberian Habsburg monarchy" (Johnson and Koyama, 2019, p. 165). The point I want to raise here is that in the age of *cuius regio, eius religio* (Latin for "whose realm, their religion") the religious affiliation of a city was as volatile and unpredictable as was dynastic succession (in a context of high mortality). Religion was thus shaped not just by the contingencies of war (as we saw in the case of the Low Countries), but even more so by the "accidents of inheritance" that "shaped the power blocs of Europe as a whole" (MacKenney, 1993, p. 219). Indeed, the spatial distribution of Catholicism is intimately linked to the greatest of such accidents of inheritance: the "remarkable series of births, marriages and deaths" which "united the possessions of four European dynasties under a single sceptre" (Parker, 2021, p. 4)—that of Charles V of the house of Habsburg, founder of the Spanish Empire and Holy Roman Emperor. As stressed by his biographers, "[n]o one foresaw that [he] would rule the greatest empire seen in a millennium" (Parker, 2021, p. 4).[47] Highly randomized, "the lands that Charles was destined to inherit comprised a vast patchwork of principalities that were neither geographically contiguous nor similar to one another in culture or traditions" (Maltby, 2002, p. 8). Claims were weak however, and the legitimacy of these titles rested largely on the traditional order associated with a united Catholic church.[48] Armed with an unbeatable Spanish military and

[45] In words of Philip's confessor Bernardo de Fresneda, their efforts had "reduced the English realm to obedience" (Rodriguez-Salgado, 2008, p. 218).

[46] "As Eamon Duffy correctly observed, 'It was the death of the queen, not any sense of failure, loss of direction or waning of determination,' that ended the Catholic England recreated by Philip and Mary. Even without [a son of Philip] from his marriage to Mary Tudor, a durable Catholic establishment would probably have emerged in England had the queen lived to be 56, like her father, Henry VIII—let alone 70, like her similarly childless sister Elizabeth" (Parker, 2014, p. 57).

[47] "None of Charles's grandparents desired this outcome, however, and it would have been undone had the unions between Princess Isabella and Manuel of Portugal, between Prince John of Spain and Margaret of Austria, or between Ferdinand of Aragon and Germaine de Foix, produced an heir that survived infancy" (Parker, 2021, p. 5).

[48] Charles V and his Spanish descendants had much at stake in the defense of Catholicism for clear reasons. First, in 1517, the very same year in which Luther triggered the Reformation publishing his famous 95 theses at Wittenberg, the pope had previously bestowed Charles the title "Catholic King"—a title inherited from Ferdinand and Isabella, who had expelled the last Muslim rulers from the Iberian peninsula. Charles' religious legitimization was further enhanced with the Holy Roman imperial title, especially after being crowned by the pope in 1530, in a legitimizing ceremony which goes back to Charlemagne in 800. Further, and in contrast to other rulers like England's Henry VIII or the German princes, breaking with Rome provided no benefits: first, because the Church in Spain was already under the king's control, and second, because the papacy itself became increasingly a military hostage and client of Habsburg Spain. And last, Catholicism was demanded by the most important Habsburg subjects, the Spaniards, mainly for two reasons: first, the Church had already been reformed to tackle many of the issues that generated outrages in Germany—indulgences were prohibited, celibacy had been enforced, corruption had been reduced (MacKenney, 1993); and second, Spain was still home to very large and recently conquered non-Christian communities (thus the campaign of religious homogenization was already underway) and the papacy—which had "funded around three-quarters of the fight against Granada" (Rubin,

the inflowing riches of the New World, the Habsburg kings thus desired no less than unifying all of Europe under the Catholic faith.[49]

The religious consequences of this "accident of inheritance" are clear: Habsburg-controlled territory remained Catholic (as in Iberia) or became recatholicized (as in Belgium and Austria), and in the neighboring territories that fell under Spanish military control, Protestantism was either extirpated (as in the Rhineland and the Palatinate in Germany) or was not allowed to strongly develop in the first place (as in the northern Italian states, where the Roman Inquisition was welcomed, if not imposed, by Spanish hegemony).[50] Even France, the other great Catholic power, owes its Catholicism in no small part to Spanish monetary and military intervention.[51]

Subjects could of course rebel against their ruler, but the spatial allocation of inheritance again determined the rebellion's likelihood of success, and thus the subjects' willingness to rebel in the first place. In Germany, for example, the adoption of Protestantism cannot be explained by any positive association with printing, universities, and economic indicators; rather, as Cantoni (2012) notes, it fits a military-logistics interpretation: adoption happens first far from Habsburg territory (military retaliation being less likely there); and cities close to Habsburg territory preferred to remain Catholic until neighboring Protestant states could offer military protection (see also Ziegler, 2008). What holds in Germany holds in Europe as a whole: the south and much of central Europe, easily accessible to Spain's mighty military, remained under firm Habsburg and Catholic control (revolts *did* happen in Italy, Iberia, Bohemia, but were suppressed) whereas Europe's north, being out of the military reach of Spain, could effectively oppose Habsburg hegemonic plans, creating an environment in which Protestantism could develop. There, far away from Habsburg military centers, the "fortunes of war" had a chance, since logistic limitations imposed by distance and geography interacted with contingencies of weather, plague outbreaks, the timely arrival of silver from the Americas, or even the decisions by the commanders in charge.[52] Among such contingencies, an important one was the degree of military pressure at the great Habsburg-Ottoman front. As many students have pointed out, Ottoman incursions into Habsburg territory diverted the Spanish military toward the Ottoman front and forced the Habsburgs to seek religious compromises, allowing Protestantism to develop (Iyigun, 2008; Nexon, 2009, pp. 189, 193; Parker, 2021, p. 512). By contrast, when the Ottomans retreated (e.g., when defeated in Lepanto in 1572, or when busy combating the Persians), the Habsburgs were able to redirect their might against Protestantism. All this shows that Habsburg power and influence were highly randomized outcomes that determined the geography, the timing, and the success rate of the

2017, p. 173)—symbolized the union of the five Iberian kingdoms in their centuries-long and victorious struggle against the Moors.

[49] On Habsburg geopolitical objectives, see Allen (2000), Nexon (2009), and Rodriguez-Salgado (2008).

[50] Habsburg meddling in papal affairs is well documented (see, e.g., Parker, 2014; Parker, 2021). The Habsburgs tried to introduce the Spanish Inquisition in Naples and Lombardy, but given fierce local resistance, they allowed and supported the activity of the Roman Inquisition instead (see Lea, 2010 and Bethencourt, 2009).

[51] Spaniards offered key support to the French Catholic Leage during the French Wars of Religion. Crucially, they defended Paris from Protestant takeover in 1588–1592 (Holt, 2005, p. 151; Nexon, 2009, p. 258). Had Catholics not controlled Paris, Henry of Navarre may have become king without being forced to abjure his Calvinist faith and France may be Protestant today.

[52] For instance, the failed Spanish attempt to invade England in 1588 was a rather unlikely failure given Spain's military strength. A fatal combination of a tactical error with a particularly stormy weather made the invaders believe that "God does not approve the enterprise" (Parker, 2014).

Counter-Reformation. The outcome was so contingent that historians have long speculated about potential consequences for European history, and for science in particular, had Spain been slightly more lucky: What "propelled scientific advances toward the end of the seventeenth century," Eisenstein (1980) claims, "began with defeats suffered by the Spanish Habsburgs in the sixteenth-century Dutch war—minor scuffles on a corner of the globe, to be sure, but with world-wide repercussions nonetheless."[53] "Had the [Spaniards] landed [in England]," McCloskey (2010) claims, "it seems likely that Europe would have suffered from the innovative sclerosis that infected at the time the great empires further east." "Had Spain prevailed [militarily] and Catholic conservatives been able to monopolize education and intellectual discourse," Mokyr (2016, pp. 220–1) speculates, "there may have been no Enlightenment"—thus *no* "big difference between Europe and the rest of the world," *no* sustained industrialization, *no* modern economic growth.[54]

4.4 Alternative explanations? Protestantism-driven science?

The assertion that the Counter-Reformation caused intellectual and scientific decline has been contentious since the 18th century at least.[55] Appendix B thus deals with alternative explanations in detail. Among them, an often-mentioned one is the economic decline suffered Spain and its empire in the 17th century. Spain's economic decline, however, is comparable to other episodes of economic decline in early modern Europe, which did not cause scientific decline at all (figure B1).[56] Another popular alternative explanation is the development of parliamentary activity, which fell in Catholic Europe between 16th and 19th century (van Zanden, Buringh, and Bosker, 2012). Yet, the results are not affected by controlling for parliamentary activity and other institutional confounders proposed in the literature, such as those proposed by Dittmar and Meisenzahl (2020) and Serafinelli and Tabellini (2022). Also biographical sampling biases are not driving the overall results. To be sure, ethno-religious sampling biases may cause or exaggerate some observed differences between countries or even between Protestants and Catholics within a country; but ethno-religious biases cannot explain, for example, why Italy's decline was steeper in cities with inquisitorial tribunals than in similar, neighboring ones, nor why a sudden collapse occurs precisely after 1559 in Spain and after 1609 in Belgium, coinciding with the implementation of the Counter-Reformation.

A particularly prominent confounder is Protestantism. According to Landes (1998, p. 179), "[i]t gave a big boost to literacy, spawned dissents and heresies, and promoted the skepticism and refusal of authority that is at the heart of the scientific endeavor." And Merton (1936; 1938; 1968), inspired by Max Weber, argued that peculiar elements of the Protestant ethos—found especially among Calvinists,

[53] "[T]he fate" of the "rise of science," she writes, "was still being affected by the shifting fortunes of the Thirty Years War"—which ended with the decisive defeat of Spain in 1648, but could have ended otherwise (pp. 647–9).

[54] Mokyr's argument is concerned with the potential loss of pluralism and fragmentation. "Had the Protestants been a single faith"—he wrote to me in a private letter—"and had some benighted Calvinist power been able to unify Europe, things may not have been a lot better."

[55] The debate has been particularly intense among Spaniards. See Goodman (2005) for a excellent overview.

[56] The lack of correlation is consistent with Serafinelli and Tabellini (2022), who find that, between the 11th and 19th centuries, the densities of intellectuals in European cities seem not driven by prosperity (measured either by population size or by wages). I may also point to the case of Belgium during the Twelve Years Truce (1609–1621), a period of vigorous economic recovery but enormous scientific decline.

Puritans, and Pietists—were (and remained being) particularly conductive to science.[57] Yet, the data in this paper suggest that a strong-enough intensification of Protestantism, either across time or space, is not associated with scientific growth but rather with scientific decline. Calvinism in particular—the ideal form of Protestantism in Weber's and Merton's hypotheses—is not statistically associated with better outcomes. As can be seen in table 1, while science grew slightly more in cities with moderate shares of Calvinists (arguably because these were more tolerant cities, allowing the presence of unconventional views and religious minorities), in fully-Calvinist cities science *declined*.[58] The results suggest that once Calvinism took control of a city, the imposed Protestant orthodoxy had negative effects analogous to those stemming from the Counter-Reformation. A similar argument can be made from the time-series perspective.[59] These findings should not be surprising: "censorship was by no means the exclusive province of the Roman Catholic Church" (Creasman, 2012, p. 11); and "when Martin Luther, John Calvin, and other[s] established their own Protestant churches, the latter showed themselves to be no less intolerant of heretics and dissenting Christians than was the Catholic Church" (Zagorin, 2003, p. 2). In terms of violence, the Catholic Inquisition was by no means severe compared to Protestant authorities.[60] Protestants were indeed often more intolerant and brutal that Catholics, and some Protestant rulers tried to implement strict Protestant orthodoxy through censorship, persecution, and bans to visit foreign universities as late as the 19th century.[61]

But then, why didn't Protestants experience a collapse of science like the one observed among Catholics? A simple argument—long put by Reusch (1883, pp. 595–8) and Putnam (1906, p. 206), and that is consistent with the evidence presented so far—is that Protestants "lacked a central organizational structure to administer a uniform censorship policy," and that they "could not articulate a unified response to the problem of heterodoxy" because they "were divided on basic theological principles" (Creasman, 2012, pp. 11-2). Catholics, by contrast, both organized and deployed coordinated intellectual control based on the unity of the Catholic Church and the geopolitical power of imperial

[57] As summarized by Shapin (1988, p. 597), Merton "systematically mobilized evidence from eighteenth- and nineteenth-century Germany to argue that 'the impression made by this [Protestant] ethic has lasted long after much of its theological basis has been largely disavowed.' Indeed, the 1957 bibliographic postscript to that essay reasserted and refined the claim for persistence, citing 1940s and 1950s studies of U.S. scientists that purported to show a disproportionately large representation of Protestants and a correspondingly small representation of [C]atholic[s]."

[58] On Calvinist intolerance and social control, see Gorski (2003).

[59] Consider figure 6c: Dutch scientists decline abruptly during the late 17th century, coinciding with a period of increased Protestant power and censorship. As noted by der Weduwen (2015): "In the second half of the seventeenth century a shift occurred in the use of repressive censorship. The number of edicts and persecutions against 'seditious' books and pamphlets increased and financial punishment for convicted authors and booksellers increased tenfold throughout the century." Another example is Britain at the height of Puritanism in the 17th century: the density of scientists remained stagnant (figure D2), in stark contrast to developments before and after.

[60] "[The Spanish, Portuguese, and Roman Inquisitions] put far fewer people to death ... than the 40,000 people who were executed for witchcraft by secular authorities across Europe between 1580 and 1650. There is blood on the inquisitors' hands, ... but there is much less of it than the 'black legend' has supposed" (Monter, 2004, p. 267). And Galileo's trial, perhaps the most significant anti-scientific action of the Counter-Reformation, sentenced him not to be burned at the stake as popular culture imagines, but simply to house arrest.

[61] Miquel Servetus—the first Westerner to correctly describe the function of pulmonary circulation—was burned alive by Calvinists in Geneva in 1553. Even during the Enlightenment, in 1723, German Pietists managed to dismiss Christian Wolff, an influential philosopher, from his university position in Halle; he had to abandon Prussia "in forty-eight hours or be hanged" (Mokyr, 2016, p. 245). And as late as 1790 did Prussia try to censor the views of philosophers non-conforming to the religious dogma, such a Immanuel Kant (Epstein, 2015, pp. 365–6). Indeed even in "1824, the Prussian crown prohibited its subjects from studying at Tübingen as well as Basel, due to insufficient rigor on the part of the Württemberg and Swiss authorities in suppressing radical ideas" (Israel, 2002, p. 796).

Spain. Moreover, as shown in figure 7, the power of clergymen (proxied by a city's share of clergymen among famous people) increased among Catholics after the Reformation but fell among Protestants, opening a large gap between the two confessions (see also Cantoni, Dittmar, and Yuchtman, 2018). This gap must have been reflected in the clergymen's capacity to effectively implement religious and intellectual control, either by force or by argument. So Protestants had the will but lacked the power. Luckily so: had Protestants been more homogeneous and organized, had the teachings of Calvin—who "himself deprecated science" (Merton, 1938, p. 417)—not led to an increasing number of dissenting sects "bickering and quarreling amongst themselves" (p. 416), or had the anti-Copernicanism of Luther endured, supported by a strong state analogous to Spain, science may have collapsed not just in Belgium and the Mediterranean but in Europe as a whole.[62] That would have meant no scientific revolution, and hence no industrial one.[63]

5 Shock persistence and economic effects

5.1 Persistence into the 18th and 19th centuries

Returning to figure 1a, we see that while 1550–1700 was a period of Catholic scientific decline, 1700–1850 was a period of Catholic scientific recovery.[64] The recovery took long time, however, and Catholics had on average still fewer scientists per capita around 1800—a key point in time for economic history, marking Europe's transition to what we call "modern" or "science-based" economic growth (Kuznets, 1960, pp. 1–16). Can we attribute this underperformance to enduring legacies of the Counter-Reformation? An answer is provided in table 2. Except for column 9, it shows estimates of

$$\log\left(\text{Scientists p.c. born in century } x_i\right) = \text{Count.-Reform. proxy}_i \cdot \alpha \quad + \text{controls}_i + \text{error}_i, \qquad (2)$$

where the per capita number of 18th- or 19th-century born scientists in city i is regressed on the controls listed in the footer and on different Counter-Reformation proxies, all of which confirm a negative association. The first proxy is a dummy indicating a city's Catholic majority by 1700. Column 1 shows that Catholicism is associated with depressed numbers of scientists either in born in the 18th century (panel A) or in the 19th (panel B); and column 2 confirms the same negative association when restricting the sample to cities north of the Alps and close to the religious frontier, no more than 60 km away from a city with the opposite denomination. The second proxy is a dummy indicating the Spanish Empire by 1600. Again, we confirming a negative association in Europe as a whole (column 3) and north of the Alps (column 4), both among 18th-century- and 19th-century-born scientists. The third proxy captures the degree of enforcement of the Counter-Reformation *within* Catholicism (Protestant cities are excluded from the regressions) through a dummy indicating an inquisitorial

[62] The anti-Copernican stance of Luther and other Protestant leaders is documented by Stimson (1917, pp. 39–48). Catholics, I may note in passing, were initially much more receptive of Copernican theory than Protestants.

[63] For discussions of how these "revolutions" relate to each other, see sources listed in footnote 1.

[64] This is again consistent with causal effects stemming from religiously-driven intellectual conservatism, since the recovery coincides with the retreat of such ideals in favor of the more tolerant views of the Enlightenment.

Table 2: Scientists born C18th or C19th still explained by the Counter-Reformation

	CR proxy = Catholic city		CR proxy = Spanish 1600		CR proxy = Inquisit. headq.		Treatement = Clergy/famous C17, C18		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All cities	Northern border (50 km)	All cities	Only north of Alps	Only Catholic	Only northern Catholic	All	Only Catholic	Only Protest.
	PANEL A								
	Dep. var.: 18th-century-born scientists per capita (logs)								
Treatment (see header)	-0.86***	-0.59**	-0.86***	-0.99***	-0.43***	-0.54***	-0.28***	-0.17***	-0.40***
	(0.19)	(0.24)	(0.13)	(0.23)	(0.14)	(0.14)	(0.04)	(0.05)	(0.08)
No. of cities	1098	181	1120	798	765	443	643	491	145
	PANEL B								
	Dep. var.: 19th-century-born scientists per capita (logs)								
Treatment (see header)	-0.48**	-0.39***	-0.75***	-0.62***	-0.29*	-0.51**	-0.17***	-0.28***	-0.11*
	(0.20)	(0.11)	(0.16)	(0.19)	(0.16)	(0.21)	(0.04)	(0.08)	(0.06)
No. of cities	1343	204	1403	929	981	507	776	566	196
Baseline controls									
Education by 1800	✓	✓	✓	✓	✓	✓	✓	✓	✓
Institutions C18	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geography & resources	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban development by 1800	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fixed effects									
By state (ca. 1820)	-	✓	-	✓	✓	✓	✓	✓	✓
By language (ca. 1800)	-	✓	-	✓	✓	✓	✓	✓	✓

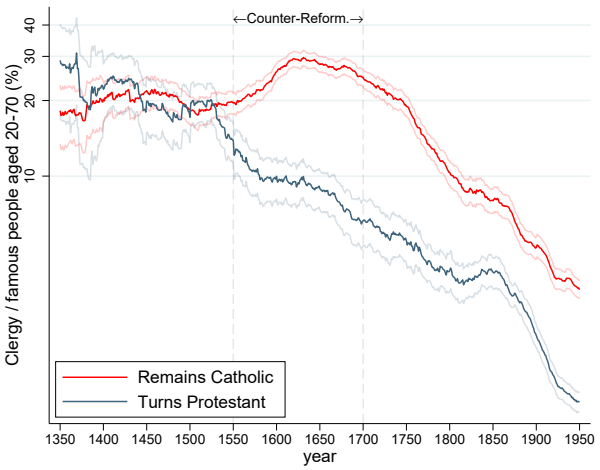
Notes: The table shows that cities treated by the Counter-Reformation or by more clerical power in the past had significantly fewer scientists per capita born in the 18th or 19th centuries. Baseline controls are: literacy rates by 1800; active university in C18; active parliament in C18; no. of parliamentary meeting in C18; representative government (commune) in C18; the distances to the Atlantic, to the Mediterranean, to water transportation ways, to coal fields, and to London; indicators of crop suitability; population growth 1600–1800; and population in 1800 (also squared and cubed to capture non-linearities). To reduce the error produced by noisy measurement of the depend variable in small cities, observations are weighted by the number of biographies available. Standard errors in parentheses, corrected for spatial aucotorrelation within 150 km using the procedure of Colella et al. (2019). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Sources*: See appendix section D.3.

headquarter—defined here as a tribunal of the Roman, Spanish, and Portuguese inquisitorial systems, or as the seat of a bishop or archbishop in all remaining Catholic territories, except for the kingdom of France, "where, outside of the Papal territory of Avignon, the king would not allow the Inquisition to exercise its power" (Jacob and Stewart, 2004, p. 4). Again, we find a negative association of the inquisition with scientists born either in the 18th century or in the 19th.

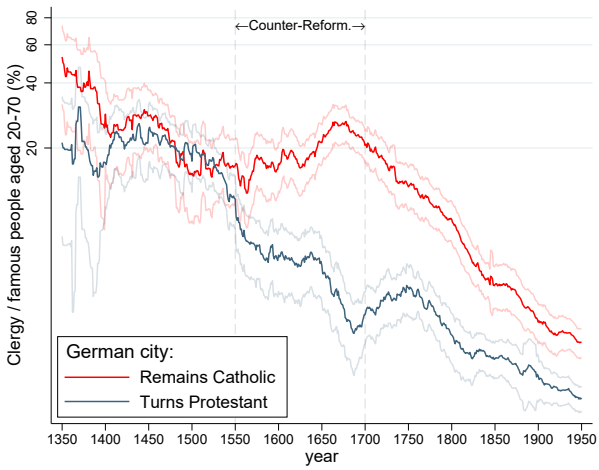
Column 7 introduces yet another proxy for the Counter-Reformation: the share of clergymen among famous personalities born in the 17th and 18th centuries. As shown in figure 7, during the 16th and 17th centuries this share increased among Catholics but fell among Protestants, leading to a large and persistent confession-driven difference in what we may label "clerical power." Unsurprisingly (given how strongly this variable correlates with the Catholic dummy), we find that it associates with fewer scientist born one century later. But also restricting the sample to Catholic cities only (column

Figure 7: Power of the clergy – Protestants vs. Catholics

(a) Cities across Europe



(b) German-speaking cities



Notes: Share of clergymen among all people aged 20-70 in Wikidata (average ± 2 st. dev.) based on Laouenan et al. (2022). After being comparable among Catholics and Protestants-to-be prior to the Reformation, this share declined abruptly among Protestants thereafter but *increased* among Catholics during the Counter-Reformation.

8), a negative correlation is confirmed, in line with the Counter-Reformation-*intensity* estimates of columns 5 and 6. More interesting still, we confirm a negative association between clerical power and science also when restricting the sample to Protestant cities only (column 9). In other words, science was lower also in cities which were "more Protestant." This calls again into question the Merton thesis, which proposes that the confessional differences in science are explained by a Protestant impulse instead of a Catholic decline. Further, the results reject the notion that doctrinal differences drive the outcomes, and instead point at the intensity of religious control as driving factor, irrespective of the confession. The 1800s, it must be noted, is a time in which a conflict between religion and science—so often exaggerated and indeed rare in previous epochs—*did* unquestionably began to increasingly take place, both among Catholics and Protestants.[65] All that said, it is among Catholics that the clergy had become persistently more powerful ever since the Counter-Reformation. Thus, by 1800, it is among Catholics that the influence of reactionary conservatism against modernism must have been stronger.[66]

Overall, the consistency of negative associations in table 2 offer support to the view that science found difficulties developing in environments of intellectual conservatism associated with clerical power and other legacies of the Counter-Reformation.[67] They offer support to Llorente's (1822) contemporary complain, quoted in this paper's epigraph, that the "prohibitive laws of the Inquisition" were

[65] An example is the controversy between evolutionists and creationists after Darwin's seminal work, published in 1859.

[66] For anecdotal evidence on this conflict, see appendix C.

[67] The results resemble those of Chaney (2023), who finds that increased political power of religious leaders explain the decline of Islamic science between the 11th and 13th century. There is indeed great analogy between that episode and the Counter-Reformation: the Tridentine Catholic consensus resembles the emerging Sunni ijmā'; the founding of inquisitorial tribunals and the Jesuit takeover of universities resembles the emergence of madrasas; and the censoring of previously accepted Catholic leaders such as Erasmus, who entered the Catholic indexes of prohibited literature, resembles the rejection of deviant Islamic scholars during the Sunni revival.

a hindrance to "learn the modern discoveries of the exact sciences," and to Mokyr's assertion that "the Counter-Reformation ... slowed down the diffusion of the *nuova scienzia* innovations and the rise of the Enlightenment" (Mokyr, 2016, p. 165). More important still, the results suggest that its impact on the spatial distribution of science lasted at least until the 19th century—that is, until the crucial period in which Europe embarked the era of modern economic growth. But, before studying the consequences of this persistence, let us dig a bit deeper into its causes.

5.2 Why so persistent? Revived legacies, 1789–1990

That the Counter-Reformation had effects on 18th-century science might not be surprising, given that inquisitorial systems and other legacies were only beginning to be dismantled. Yet we saw that effects on science lasted much longer, at least until the 19th century. What could explain such long persistence? A simple explanation would be that the clergy remained more powerful among Catholics than among Protestants, as figure 7 suggest. But this metric fails to explain many stark differences in science. For example, science recovers very fast among the Catholics in Germany, yet the levels of clergymen per famous people evolved just as in other Catholic regions across the Continent where science persisted depressed for much longer. What explains such stark differences?

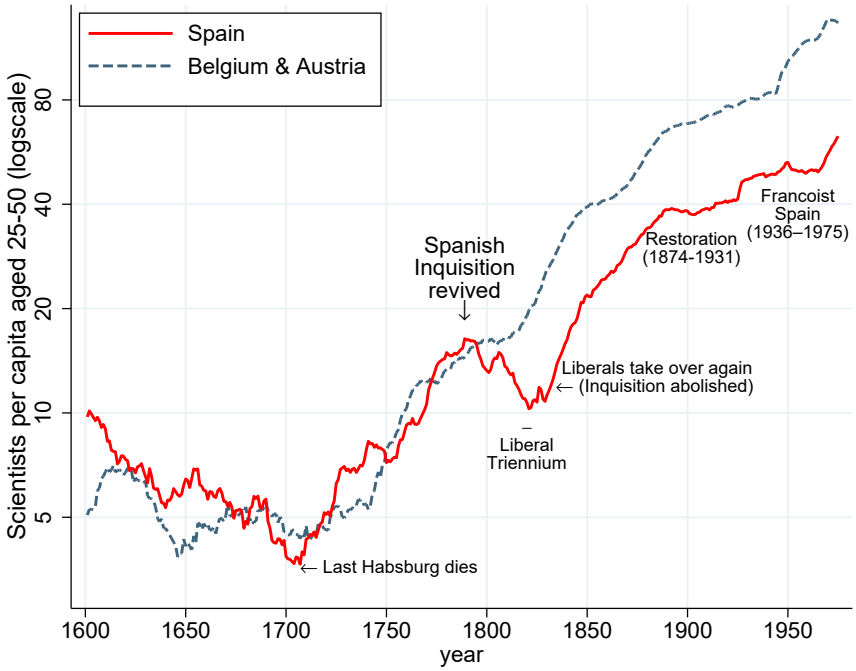
I will propose that much of the decline's persistence (or the absence of it) has to do with how ruling elites reacted in terms of policies during a particular set of shocks: when ideologies emerged that seriously threatened the power of the elites *and* of the clergy, just as the Reformation once did. This happened, for example, after the French and Bolshevik revolutions. In places once subject to the Counter-Reformation, the threatened elites were endowed not just with a reserve army of supportive conservative clergymen, but also with a set of historical laws and traditions rooted in the Counter-Reformation. These were originally designed to counter the dangerous ideas of Protestantism, but they could be revived and repurposed against the new ideological threats. Enacting some of those institutional legacies, I propose, unintentionally harmed science once more and hindered the recovery.

This mechanism is supported by consistent statistical evidence, presented in appendix C in the form of four examples of what we may call "echoes of the Counter-Reformation." The first one concerns the Spanish reaction to the French Revolution of 1789, which triggered a revival (continuing until the 1830s) of the Inquisition and old censorship laws.[68] As shown in figure 8, the revival of the Inquisition (which had been dormant since nearly a century) coincided with a sudden decline of science in Spain that lasted until the Inquisition was finally abolished in 1834. City-level evidence confirms the interpretation: cities with inquisitorial tribunals saw the steepest intellectual decline in the period of inquisitorial revival but the strongest intellectual growth in periods of inquisitorial inactivity (table C1, column 1). Similar results are obtained when extending the analysis to the conservative revivals triggered by the French Revolution elsewhere in Europe.[69] Intellectual growth in this period was lower among Catholic cities, especially among those that at the height of the Counter-Reformation,

[68] The swift revival of full-scale censorship to counter French revolutionary ideas is known by historians as the "Floridablanca panic." See Calvo Maturana (2014), Lea (1890, pp. 168–73), and appendix C.

[69] On the conservative order emerging after the French Revolution, see, e.g., Epstein (2015) and Israel (2019).

Figure 8: The revival of the Spanish Inquisition



Notes: Spain, Belgium, and Austria share comparable densities of scientists during the 17th century (at the height of the Counter-Reformation) and during the 18th century (when inquisitorial activity ceases in these realms and science begins to recover). However, Spain's recovery stops abruptly around 1790, when inquisitorial censorship is revived in response to the spread of revolutionary ideas from France. Scientific growth resumes only after the definitive abolition of the Inquisition in 1834, yet it stagnates during the conservative regimes of the Restoration and Franco. Population (in millions) based on the Maddison Project Database 2020 (Bolt and Van Zanden, 2020), Buyst (2011), and Prados de la Escosura, Álvarez-Nogal, and Santiago-Caballero (2021).

by 1600, belonged to the Spanish Empire (table C1, columns 2-4). The next example concerns another information shock that similarly shaped European politics: the Bolshevik Revolution of 1917, which triggered the emergence of fascism and other forms of right-wing authoritarianism throughout the Continent (figure C2). Again, we will see that it is among former dependencies of the Spanish Empire, where the Counter-Reformation had been particularly intense, that science declined more (table C2). A final example in the appendix concerns dictatorships worldwide since 1870 and shows that dictatorships need not be bad for science overall, but their effect is negative in former dependencies of the Spanish Empire (table C4), where dictators have tended to revive elements of the religiously-legitimized politics of the past. Overall, these examples suggest that episodes of conservatism interacted with a location's Counter-Reformation history to generate negative effects on science from the 18th to the 20th century. Importantly, such echoes of the Counter-Reformation were contingent—as figure 8 illustrates—what explains why some regions escaped their past faster than others.

5.3 Effects on modern city growth: 1800–1939

Leaving aside idiosyncratic events that extended the effects of the Counter-Reformation on science even into the 20th century, we can confidently state that until the 18th and 19th centuries these effects were still strong and widespread across Europe. This has an important implication: around 1800, when science-based economic growth began to spread throughout Europe, cities historically treated by the Counter-Reformation had lower, predetermined, numbers of scientists. Did these cities also grow less during the modern growth regime?

I explore this question in table 3. Panel A show OLS estimates of

$$\text{Pop. growth 1800–1939}_i = \text{Counter-Ref. proxy}_i \cdot \gamma + \text{controls}_i + \text{error}_i, \tag{3}$$

where both the treatment proxies and the controls remain the same as in table 2 but the dependent variable is now population growth of city i between 1800 and 1939—that is, between the beginnings of the modern economic growth regime and the start of World War II.[70] All estimates are significantly negative, telling us that cities treated with the Counter-Reformation grew less after controlling for initial development, education, institutions, geography, and resources.[71]

Can lower growth of Counter-Reformation cities be attributed to the decline of science? I try to answer this question in panel B of the table by jointly including scientists and the treatment proxies in an OLS "horse race." That is, regressions now take the following form:

$$\begin{aligned}\text{Pop. growth 1800–1939}_i = &\log\left(\text{Scientists p.c. born in century } x_i\right) \cdot \beta \\ &+ \text{Counter-Ref. proxy}_i \cdot \gamma \quad + \text{controls}_i + \text{error}_i, \qquad x = 18, 19.\end{aligned} \tag{4}$$

The results are ambiguous. One one hand, with the exception of columns 2 and 9, βs have substantially higher t-statistics than the γs, suggesting that much of the negative association reported in panel A is indeed running through science.[72] On the other hand, the decline of the γs is only limited: the

[70] I chose 1939 as ending date because the war dramatically reconfigured the Continent's economic, political, and ethnic map.

[71] How exogenous is the variance provided by these regressors? As discussed in section 4.3, the Spanish Empire and the imposed Catholicism within its military reach were subject to the randomness of inheritance and other contingencies. However, the strong spatial contiguity of the observations requires the inclusion of the many spatial confounders considered in the regression: the distances to the Atlantic, to the Mediterranean, to coal deposits, and to industrializing London, various crop suitability indicators, institutions, education, and fixed effects at the levels of states and languages. Inquisitorial headquarters, on the contrary, are not spatially contiguous and can be compared to adjacent, Catholic, units. However, they are subject a strong selection bias: treated cities had larger populations, more printing, more universities, and more initial scientists (table available upon request). But since these attributes correlate otherwise with subsequently *more* science and *more* city growth (tables available upon request), the effects estimated in columns 5-6 can be seen as lower bounds. Furthermore, even though the treatment was presumably more intense close to the tribunals, the control group is partially treated too: officials of the Inquisition tried to enforce their policies through the entirety of their jurisdiction, making surprise visits to remote areas (see Bethencourt, 2009). This again suggest an underestimation bias.

[72] Further, it must be noted that efficiency of the βs is inherently low, given that locations of science production (say university cities) need not coincide with location of science implementation (say mine fields). Thus, for example within a group of coreligionist cities connected through labor mobility, the Catholic dummy may capture the application of science better than the number of scientist born in each individual city, making Catholicism win the horse race even if science is the causal force.

Table 3: Post-1800 city growth explained by the Counter-Reformation

	CR proxy = Catholic city		CR proxy = Spanish 1600		CR proxy = Inquisit. headq.		Treatement = Clergy/famous C17, C18		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All cities	Northern border (50 km)	All cities	Only north of Alps	Only Catholic	Only northern Catholic	All	Only Catholic	Only Protest.
	PANEL A: city growth and the Counter-Reformation								
	Dep. var.: city's population growth 1800–1939								
Treatment (see header)	-0.29***	-0.39***	-0.30**	-0.36***	-0.24**	-0.28*	-0.15***	-0.22***	-0.11***
	(0.09)	(0.10)	(0.13)	(0.10)	(0.12)	(0.15)	(0.05)	(0.05)	(0.02)
No. of cities	1518	212	1592	899	1153	534	829	617	212
	PANEL B: effects other than science? OLS horse race								
	Dep. var.: city's population growth 1800–1939								
Log scientists p.c., born C18	0.19***	0.11	0.20***	0.17***	0.21***	0.16**	0.21***	0.24***	0.05
	(0.05)	(0.09)	(0.05)	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.09)
Treatment (see header)	-0.20**	-0.23	-0.21	-0.17	-0.14	-0.14	-0.06	0.01	-0.11
	(0.10)	(0.18)	(0.13)	(0.12)	(0.11)	(0.14)	(0.05)	(0.05)	(0.13)
No. of cities	1097	181	1119	775	764	442	643	491	152
Log scientists p.c., born C19	0.26***	0.13	0.26***	0.24***	0.29***	0.25***	0.26***	0.27***	0.12
	(0.05)	(0.09)	(0.05)	(0.07)	(0.07)	(0.10)	(0.07)	(0.09)	(0.16)
Treatment (see header)	-0.26***	-0.35***	-0.18	-0.22	-0.19	-0.19	-0.11**	-0.13*	-0.09***
	(0.09)	(0.12)	(0.13)	(0.17)	(0.12)	(0.13)	(0.06)	(0.08)	(0.03)
No. of cities	1342	204	1402	868	980	506	775	565	210
Baseline controls									
Education by 1800	✓	✓	✓	✓	✓	✓	✓	✓	✓
Institutions C18	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geography & resources	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban development by 1800	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fixed effects									
By state (ca. 1820)	-	✓	-	✓	✓	✓	✓	✓	✓
By language (ca. 1800)	-	✓	-	✓	✓	✓	✓	✓	✓

Notes: Panel A shows that cities treated by the Counter-Reformation or by more clerical power in the 18th century grew less during 1800–1939. Panel B suggests that these growth effects may not stem purely from science, since city growth is sometimes explained directly by the treatment in a horse race. Baseline controls described in table 2. To reduce the impact of measurement error due to few biographies in small cities, observations are weighted by the number of biographies available. Standard errors in parentheses, corrected for spatial aucotorrelation within 150km using the procedure of Colella et al. (2019). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Sources*: See appendix section D.3.

coefficients tend to loose their statistical significance but the point estimates often remain above 50% of their original levels, suggesting that the effects on city growth might not be driven exclusively by science.

Exploring what these alternative channels may be goes beyond the scope of this paper.[73] It becomes clear, however, that the narrative blaming Catholic backwardness on the Counter-Reformation, and its effect on science in particular, contains significant elements of truth.

6 Conclusions

This paper studies an episode that some historians believe to have been decisive in explaining Europe's scientific and economic geography: the Counter-Reformation. While the alleged effects are contested (some believe them to be nothing but propaganda), this paper presents evidence suggesting that the Counter-Reformation had important effects indeed. Before it, comparable treated and untreated cities long shared similar trends of scientists per capita. But science fell in treated cities relative to others precisely after the Counter-Reformation was effectively enforced (the timing varies, from 1521 to 1618, depending on contingencies such as military outcomes). Scientific decline is confirmed not just in southern Europe but also north of the Alps, even within a narrow band around Catholic-Protestant borders. Further, within Catholic lands, the decline was deeper where logistics allowed for more intense intellectual control—in cities with inquisitorial tribunals, cities with universities (they were easy to control), or cities subject to the powerful Spanish Empire. And whenever the treatment was weakened, science recovered.[74]

In contrast to Merton's thesis, I find that, if sufficiently strong, also 17th-century Protestantism was detrimental for science. Yet it was clearly much less detrimental than 17th-century Catholicism: while in Protestant territory the observed number of scientists per capita sometimes slowed down its growth or stagnated, in territories subject to a strong Counter-Reformation—Italy, Spain, Portugal, and Belgium—the number of scientists per capita fell back to levels not seen in two hundred years. How can we explain this enormous difference? Not by economic conditions (they played a marginal role, if any at all). And Catholics were *not* more intolerant, nor more violent, nor more anti-scientific than Protestants. However, when implementing intellectual control, they benefited from pre-established structures (such as the Spanish Inquisition, previously directed against Muslims and Jews) and from an increasingly influential clergy (whereas the Protestant clergy saw the opposite: a decline of its influence). More important still, Catholics benefited from a higher degree of coordination, which

[73] What these alternative channels may be is unclear given the wide spectrum of plausibly-affected societal variables. Recent research by Drelichman, Vidal-Robert, and Voth (2021), for example, find that historical inquisitorial intensity across Spanish municipalities correlates not only with today's income and education but also with today's trust. Yet, without the complete time series of trust beginning the 15th century (like those I show here for scientists), and given how much could have happen in 500 years, it is difficult to be sure about the causal nature of such correlation.

[74] An open question is the relative importance of the many complementary policies jointly implemented during the Counter-Reformation (censorship, restricted academic mobility, persecution) and of the many complementary mechanisms triggered by them (increased costs of scientific communication, self-censorship, conservative minds)—a difficult task, given data restrictions and strong synchronicity. Recent research by de la Croix and Morault (2020), Drelichman, Vidal-Robert, and Voth (2021), Blasutto and de la Croix (2021), Becker, Pino, and Vidal-Robert (2021), Dewitte et al. (2022) deal with some specific mechanisms, but an holistic study remains to be done.

stemmed from the unity of the Roman Church and from the military, political, and financial might of imperial Spain. Protestants, by contrast, with their weak churches and states, had little chance to block the proliferation of what they considered heresy. They often tried, but failed systematically. Had they instead been more effective at exerting intellectual control, it seems plausible that modern science would have never risen, and modern growth never taken off.

Did the Counter-Reformation affect science also long beyond the 17th century, as some scholars have claimed? While Catholics witnessed a vigorous recovery of scientific activity after 1700 (coinciding with the retreat of the Counter-Reformation's ideals and institutions), I confirm that it still took centuries to close the gap relative to Protestants. Even across closely located, coreligionist cities, those more affected by the Counter-Reformation continued to have fewer scientists than others as late as the 19th century; and across countries, the gap has not been closed yet. Why did the recovery take so long? A key driver of endurance seems to be how, centuries later, shocks triggering reactionary conservatism interacted with a city's Counter-Reformation past. In places once subject to a stronger Counter-Reformation, conservative regimes and dictators were more likely to repurpose old institutions rooted in the clericalism, dogmatism, and isolationism of the 16th century. These events coincide with sudden declines of scientific growth that hindered faster convergence. Importantly, these echoes of the Counter-Reformation were contingent; in this way they explain why some regions managed to escape their past faster than others.

Despite these interesting differences, on average, the decline of science associated with the Counter-Reformation was sufficiently large and persistent to have long-term growth effects. All things equal, heavily treated cities had a scientific disadvantage around 1800 and grew less during the modern growth period that followed. By now, if we condition on country fixed effects, this historical disadvantage has fully disappeared: in southern Europe, inquisitorial cities have long since recovered their leading position as centers of science; and in Germany and the Netherlands, not Protestant but Catholics lead in both science and income. Historically, however, the Counter-Reformation appears to have been one of the greatest and more enduring shocks to science ever recorded, and a long-lasting determinant of policy, society, and development overall.

References

Acemoglu, **Daron**, **Giuseppe De Feo**, **Giacomo De Luca, and Gianluca Russo** (2022). "War, Socialism, and the Rise of Fascism: an Empirical Exploration." *The Quarterly Journal of Economics* qjac001.

Allen, **Paul C.** (2000). *Philip III and the Pax Hispanica, 1598-1621: The Failure of Grand Strategy*. New Haven, CT: Yale University Press.

Andersen, **Lars H., and Jeanet Bentzen** (2022). "In the Name of God! Religiosity and the Transition to Modern Growth." CEPR Discussion Paper No. 16938. Center for Economic and Policy Research.

Anderson, **R. Warren** (2015). "Inquisitions and Scholarship." *Social Science History* 39 (4): 677–702.

Bairoch, **Paul**, **Jean Batou, and Pierre Chevre** (1988). *La population des villes européenes: banque de données et analyse sommaire des résultats: 800-1850*. Geneva: Droz.

Bamji, **Alexandra**, **Geert H. Janssen, and Mary Laven**, eds. (2013). *The Ashgate Research Companion to the Counter-Reformation*. Farnham, England: Ashgate.

Barro, **Robert J., and Rachel M. McCleary** (2003). "Religion and Economic Growth across Countries." *American Sociological Review* 68 (5): 760–781.

Becker, **Sascha O.**, **Francisco J. Pino, and Jordi Vidal-Robert** (2021). "Freedom of the Press? Catholic Censorship during the Counter-Reformation." Working Paper SDT 516. Universidad de Chile.

Becker, **Sascha O.**, **Jared Rubin, and Ludger Woessmann** (2021). "Religion in economic history: a survey." In: *The Handbook of Historical Economics*. Ed. by Alberto Bisin and Giovanni Federico. London: Academic Press, 585–639.

Becker, **Sascha O., and Ludger Woessmann** (2009). "Was Weber wrong? A human capital theory of Protestant economic history." *The Quarterly Journal of Economics* 124 (2): 531–596.

Bénabou, **Roland**, **Davide Ticchi, and Andrea Vindigni** (2015). "Religion and Innovation." *American Economic Review* 105 (5): 346–51.

Bénabou, **Roland**, **Davide Ticchi, and Andrea Vindigni** (2021). "Forbidden Fruits: The Political Economy of Science, Religion, and Growth." *The Review of Economic Studies* rdab069.

Bentzen, **Jeanet Sinding, and Gunes Gokmen** (2023). "The power of religion." *Journal of Economic Growth* 28 (1): 45–78.

Bethencourt, **Francisco** (2009). *The Inquisition: A Global History 1478-1834*. Trans. by Jean Birrell. Cambridge: Cambridge University Press.

Biraben, **Jean-Noël, and Didier Blanchet** (1999). "Essay on the Population of Paris and its Vicinity Since the Sixteenth Century." *Population* 11 (1): 155–188.

Bireley, **Robert** (2004). "Counter-Reformation." In: *Encyclopedia of Protestantism*. Ed. by Hans J. Hillerbrand. New York: Routledge.

Blasutto, **Fabio, and David de la Croix** (2021). "Catholic Censorship and the Demise of Knowledge Production in Early Modern Italy." CEPR Discussion Paper No. 16409. Centre for Economic Policy Research.

Boerner, **Lars**, **Jared Rubin, and Battista Severgnini** (2021). "A time to print, a time to reform." *European Economic Review* 138 (103826).

Bolt, **Jutta, and Jan Luiten Van Zanden** (2020). "Maddison style estimates of the evolution of the world economy. A new 2020 update." Maddison-Project Working Paper WP-15. University of Groningen.

Bosker, **Maarten**, **Eltjo Buringh, and Jan Luiten van Zanden** (2013). "From Baghdad to London: Unraveling Urban Development in Europe, the Middle East, and North Africa, 800–1800." *Review of Economics and Statistics* 95 (4): 1418–1437.

Buonanno, **Paolo**, **Francesco Cinnirella**, **Elona Harka, and Marcello Puca** (2023). "Books Go Public: The Consequences of Monastic Libraries Expropriation on Innovation." Unpublished manuscript. University of Bergamo.

Buringh, **Eltjo** (2021). "The Population of European Cities from 700 to 2000: Social and Economic History." *Research Data Journal for the Humanities and Social Sciences* 6 (1): 1–18.

Buyst, **Erik** (2011). "Towards Estimates of Long Term Growth in the Southern Low Countries, ca. 1500-1846." Results presented at the Conference on Quantifying Long Run Economic Development, Venice, 22-24 March.

Calvo Maturana, **Antonio** (2014). ""Is it useful to deceive the people?" The Debate on Public Information in Spain at the End of the Ancien Régime (1780–1808)." *The Journal of Modern History* 86 (1): 1–46.

Cañizares-Esguerra, **Jorge** (2004). "Iberian Science in the Renaissance: Ignored How Much Longer?" *Perspectives on Science* 12 (1): 86–124.

Cantoni, **Davide** (2012). "Adopting a New Religion: The Case of Protestantism in 16th Century Germany." *The Economic Journal* 122 (560): 502–531.

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

Cantoni, **Davide**, **Felix Hagemeister, and Mark Westcott** (2020). "Persistence and Activation of Right-Wing Political Ideology." Working Paper (mimeo). University of Munich.

Chaney, **Eric** (2023). "Religion and the rise and fall of Islamic science." Unpublished manuscript. Oxford University.

Chen, **Yuyu, and David Y. Yang** (2019). "The Impact of Media Censorship: 1984 or Brave New World?" *American Economic Review* 109 (6): 2294–2332.

Cinnirella, **Francesco, and Jochen Streb** (2017). "Religious tolerance as engine of innovation." CESifo Working Paper 6797.

Cohen, **H. Floris** (2009). "The Rise of Modern Science as a Fundamental Pre-Condition for the Industrial Revolution." *Österreichische Zeitschrift für Geschichtswissenschaften* 20 (2): 107–132.

Cohen, **H. Floris** (2015). *The Rise of Modern Science Explained: A Comparative History*. Cambridge: Cambridge University Press.

Colella, **Fabrizio**, **Rafael Lalive**, **Seyhun O. Sakalli, and Mathias Thoenig** (2019). "Inference with Arbitrary Clustering." IZA Discussion Paper Series No. 12584.

Creasman, **Allyson F.** (2012). *Censorship and Civic Order in Reformation Germany, 1517–1648: 'Printed Poison & Evil Talk'*. Farnham, England: Ashgate.

De la Croix, **David, and Pauline Morault** (2020). "Winners and Losers from the Protestant Reformation: An Analysis of the Network of European Universities." IRES Discussion Papers 2020/29. Université Catholique de Louvain.

Der Weduwen, **Arthur** (2015). "The development of the Dutch press in the seventeenth century. (1618-1700)." Dissertation. University of St Andrews.

De Vries, **Jan** (1984). *European Urbanization 1500-1800*. London: Methuen.

Dewitte, **Edgard**, **Francesco Drago**, **Roberto Galbiati, and Giulio Zanella** (2022). "Science under Inquisition: The allocation of talent in early modern Europe." Unpublished manuscript.

Dittmar, **Jeremiah** (2019). "The Economic Origins of Modern Science: Technology, Institutions, and Markets." Unpublished manuscript. London School of Economics.

Dittmar, **Jeremiah E., and Ralf R. Meisenzahl** (2020). "Public Goods Institutions, Human Capital, and Growth: Evidence from German History." *The Review of Economic Studies* 87 (2): 959–996.

Drelichman, **Mauricio**, **Jordi Vidal-Robert, and Hans-Joachim Voth** (2021). "The long-run effects of religious persecution: Evidence from the Spanish Inquisition." *Proceedings of the National Academy of Sciences* 118 (33): e2022881118.

Duffy, **Eamon** (2010). *Fires of Faith: Catholic England Under Mary Tudor*. Illustrated Edition. New Haven, CT: Yale University Press.

Eisenstein, **Elizabeth L.** (1980). *The Printing Press as an Agent of Change*. Cambridge: Cambridge University Press.

Ekelund, **Robert B.**, **Robert F. Hebert, and Robert D. Tollison** (2004). "The Economics of the Counter-Reformation: Incumbent-Firm Reaction to Market Entry." *Economic Inquiry* 42 (4): 690–705.

Epstein, **Klaus** (2015). *The Genesis of German Conservatism*. Princeton, NJ: Princeton University Press.

Espinosa, **Aurelio** (2008). *The Empire of the Cities: Emperor Charles V, the Comunero Revolt, and the Transformation of the Spanish System*. Leiden: Brill.

Feingold, **Mordechai** (2003). *Jesuit Science and the Republic of Letters*. Cambridge, MA: MIT Press.

Ferngren, **Gary B.** (2002). *Science and Religion: A Historical Introduction*. Baltimore, MD: Johns Hopkins University Press.

Frijhoff, **Willem** (1996). "Patterns." In: *A History of the University in Europe: Volume 2: 1500-1800*. Ed. by Hilde de Ridder-Symoens. Vol. 2. A History of the University in Europe. Cambridge: Cambridge University Press, 43–106.

Gascoigne, **Robert M.** (1992). "The Historical Demography of the Scientific Community, 1450-1900." *Social Studies of Science* 22 (3): 545–573.

Goodman, **David** (1983). "Philip II's Patronage of Science and Engineering." *The British Journal for the History of Science* 16 (1): 49–66.

Goodman, **David** (2005). "Intellectual Life under the Spanish Inquisition: A Continuing Historical Controversy." *History* 90 (3 (299)): 375–386.

Gorski, **Philip S.** (2003). *The Disciplinary Revolution: Calvinism and the Rise of the State in Early Modern Europe*. Chicago, IL: University of Chicago Press.

Grafe, **Regina** (2012). *Distant Tyranny: Markets, Power, and Backwardness in Spain, 1650-1800*. Princeton, NJ: Princeton University Press.

Green, **John R.** (1896). *History of the English People*. Vol. IV. London: Macmillan and Co.

Hakluyt, **Richard** (1599). *The Principal Nauigations, Voyages, Traffiques and Discoueries of the English Nation*. Ed. by Edmund Goldsmid. Vol. VIII. London: George Bishop.

Hannam, **James** (2011). *The Genesis of Science: How the Christian Middle Ages Launched the Scientific Revolution*. 1st edition. Washington, D.C: Regnery Publishing.

Henriques, **António, and Nuno Palma** (2023). "Comparative European Institutions and the Little Divergence, 1385–1800." *Journal of Economic Growth* 28 (2): 259–294.

Holt, **Mack P.** (2005). *The French Wars of Religion, 1562–1629*. 2nd ed. New Approaches to European History. Cambridge: Cambridge University Press.

Hongzhou, **Zhao, and Jiang Guohua** (1985). "Shifting of world's scientific center and scientists' social ages." *Scientometrics* 8 (1-2): 59–80.

Iannaccone, **Laurence R.** (1998). "Introduction to the Economics of Religion." *Journal of Economic Literature* 36 (3): 1465–1495.

Iaria, **Alessandro**, **Carlo Schwarz, and Fabian Waldinger** (2018). "Frontier Knowledge and Scientific Production: Evidence from the Collapse of International Science." *The Quarterly Journal of Economics* 133 (2): 927–991.

Israel, **Jonathan I.** (2002). *Radical Enlightenment: Philosophy and the Making of Modernity 1650-1750*. New York: Oxford University Press.

Israel, **Jonathan I.** (2019). *The Enlightenment that Failed: Ideas, Revolution, and Democratic Defeat, 1748-1830*. Oxford and New York: Oxford University Press.

ISTC (1998). "Incunabula Short Title Catalogue." London: British Library. URL: https://data.cerl.org/istc/_search (visited on 01/14/2021).

Iyigun, **Murat** (2008). "Luther and Suleyman." *Quarterly Journal of Economics* 123 (4): 1465–1494.

Jacob, **Margaret C., and Larry Stewart** (2004). *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687-1851*. Cambridge, MA: Harvard University Press.

Johnson, **Noel D., and Mark Koyama** (2019). *Persecution and Toleration: The Long Road to Religious Freedom*. Cambridge Studies in Economics, Choice, and Society. Cambridge: Cambridge University Press.

Jones, **Benjamin F** (2010). "Age and Great Invention." *The Review of Economics and Statistics* 92 (1): pp. 1–14.

Jones, **Benjamin F.**, **E. J. Reedy, and Bruce A. Weinberg** (2014). "Age and Scientific Genius." In: *The Wiley Handbook of Genius*. Ed. by Dean Keith Simonton. Malden, MA: John Wiley & Sons, Ltd, 422–450.

Kamen, **Henry** (2014). *The Spanish Inquisition: A Historical Revision*. New Haven, CT: Yale University Press.

Kaplan, **Benjamin J.** (2006). "Coexistence, Conflict, and the Practice of Toleration." In: *A Companion to the Reformation World*. Ed. by R. Po-chia Hsia. Malden, MA: Blackwell Publishing, 486–505.

Kelly, **Morgan** (2019). "The Standard Errors of Persistence." UCD Centre for Economic Research Working Paper Series No. WP19/13. University College Dublin, UCD School of Economics.

Kuznets, **Simon** (1960). *Modern Economic Growth*. New Delhi: Oxford and IBH Publishing Co.

Landes, **David S.** (1998). *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*. New York: W. W. Norton & Company.

Laouenan, **Morgane**, **Palaash Bhargava**, **Jean-Benoît Eyméoud**, **Olivier Gergaud**, **Guillaume Plique, and Etienne Wasmer** (2022). "A cross-verified database of notable people, 3500BC-2018AD." *Scientific Data* 9 (1): 290.

Lea, **Henry Charles** (1890). *Chapters from the religious history of Spain connected with the Inquisition*. Philadelphia: Lea Brothers.

Lea, **Henry Charles** (2010). *The Inquisition in the Spanish Dependencies: Sicily, Naples, Sardinia, Milan, the Canaries, Mexico, Peru, New Granada*. Cambridge: Cambridge University Press.

Lecce, **Giampaolo**, **Laura Ogliari, and Mara P. Squicciarini** (2021). "Birth and migration of scientists: Does religiosity matter? Evidence from 19th-century France." *Journal of Economic Behavior & Organization* 187: 274–289.

Lees, **Lynn Hollen, and Paul M. Hohenberg** (1989). "Urban Decline and Regional Economies: Brabant, Castile, and Lombardy, 1550–1750." *Comparative Studies in Society and History* 31 (3): 439–461.

Llorente, **Juan Antonio** (1822). *Historia crítica de la Inquisición de España*. Vol. 5. Madrid: Imprenta del Censor.

López Piñero, **José María** (1979). *Ciencia y técnica en la sociedad española de los siglos XVI y XVII*. Barcelona: Labor universitaria.

López Piñero, **José María**, **Thomas F. Glick**, **Victor Navarro Brotóns, and Eugenio Portela Marcos**, eds. (1983). *Diccionario histórico de la ciencia moderna en España*. Barcelona: Ediciones Península.

Lourens, **Piet, and Jan Lucassen** (1997). *Inwonertallen van Nederlandse steden ca. 1300-1800*. Amsterdam: Nederlandsch Economisch-Historisch Archief.

Luttikhuizen, **Frances** (2017). *Underground protestantism in sixteenth century Spain: a much ignored side of Spanish history*. Göttingen: Vandenhoeck & Ruprecht.

Ma, **Chicheng** (2021). "Knowledge Diffusion and Intellectual Change: When Chinese Literati Met European Jesuits." *The Journal of Economic History* 81 (4): 1052–1097.

MacKenney, **Richard** (1993). *Sixteenth Century Europe: Expansion and Conflict*. London: Macmillan.

Malta Romeiras, **Francisco** (2020). "The Inquisition and the censorship of science in early modern Europe: Introduction." *Annals of Science* 77 (1): 1–9.

Maltby, **William S.** (2002). *The Reign of Charles V*. New York: Palgrave.

Maltby, **William S.** (2009). *The Rise and Fall of the Spanish Empire*. New York: Palgrave.

McCloskey, **Deirdre** (2010). "Review of Mokyr's The Enlightened Economy." Review prepared for History Today.

McDonald, **Grantley** (2017). ""Burned to dust": Censorship and repression of theological literature in the Habsburg Netherlands during the 1520s." In: *Church, Censorship and Reform in the Early Modern Habsburg Netherlands*. Vol. 101. Bibliothèque de la Revue d'histoire ecclésiastique 101. Turnhout: Brepols Publishers, 27–52.

Merton, **Robert K.** (1936). "Puritanism, Pietism, and Science." *The Sociological Review* a28 (1): 1–30.

Merton, **Robert K.** (1938). "Science, Technology and Society in Seventeenth Century England." *Osiris* 4: 360–632.

Merton, **Robert K.** (1968). *Social Theory and Social Structure*. New York: Macmillan.

Mokyr, **Joel** (2005). "Long-Term Economic Growth and the History of Technology." In: *Handbook of economic growth*. Ed. by Philippe Aghion and Steven N. Durlauf. Vol. 1. Amsterdam: Elsevier, 1113–1180.

Mokyr, **Joel** (2007). "The Market for Ideas and the Origins of Economic Growth in Eighteenth Century Europe." *Tijdschrift voor Sociale en Economische geschiedenis* 4 (1): 3–38.

Mokyr, **Joel** (2016). *A Culture of Growth*. Princeton, NJ: Princeton University Press.

Monter, **William** (2004). "The Inquisition." In: *A Companion to the Reformation World*. Ed. by R. Po-chia Hsia. Malden, MA: Blackwell Publishing, 255–271.

Moser, **Petra, and Sahar Parsa** (2023). "McCarthy and the Red-ucators: Effects of Political Persecution on Science." Unpublished manuscript. New York University.

Murray, **Charles** (2003). *Human Accomplishment: The Pursuit of Excellence in the Arts and Sciences, 800 BC to 1950*. New York: Harper Collins.

Nexon, **Daniel H.** (2009). *The Struggle for Power in Early Modern Europe: Religious Conflict, Dynastic Empires, and International Change*. Princeton, NJ: Princeton University Press.

Norris, **Pippa** (2023). "Cancel culture: Heterodox self-censorship or the curious case of the dog-which-didn't-bark." HKS Working Paper RWP23-020. Harvard University.

Norwich, **John J.** (2003). *A History of Venice*. London: Penguin.

O'Connell, **Marvin R.** (1974). *Counter-reformation, 1550-1610*. The Rise of Modern Europe. New York: Joanna Cotler Books.

O'Malley, **John W.** (2013). *Trent: What Happened at the Council*. Cambridge, MA: Harvard University Press.

Parker, **Geoffrey** (1977). *The Dutch Revolt*. London: Penguin Books.

Parker, **Geoffrey** (2004). *The Army of Flanders and the Spanish Road, 1567-1659: The Logistics of Spanish Victory and Defeat in the Low Countries' Wars*. Cambridge: Cambridge University Press.

Parker, **Geoffrey** (2013). *Global Crisis: War, Climate Change and Catastrophe in the Seventeenth Century*. New Haven, CT: Yale University Press.

Parker, **Geoffrey** (2014). *Imprudent King: A New Life of Philip II*. New Haven, CT: Yale University Press.

Parker, **Geoffrey** (2021). *Emperor: A New Life of Charles V*. New Haven, CT: Yale University Press.

Pelseneer, **Jean** (1941). "Aspect Statistique Du Progres Des Sciences En Belgique, A Travers Les Siecles." *Isis* 33 (2): 237–242.

Prados de la Escosura, **Leandro**, **Carlos Álvarez-Nogal, and Carlos Santiago-Caballero** (2021). "Growth recurring in preindustrial Spain?" *Cliometrica*.

Putnam, **George Haven** (1906). *The Censorship of the Church of Rome and its Upon the Production and Distribution of Literature: A Study of the History of the Prohibitory and Expurgatory Indexes, Together With Some Consideration of the Effects of Protestant Censorship and of Censorship by the State*. Vol. 2. New York: The Knickerbocker Press.

Quételet, **L. Adolphe J.** (1864). *Histoire des Sciences Mathématiques et Physiques chez les Belges*. Bruxelles: Hayez.

Reusch, **Franz H.** (1883). *Der Index der verbotenen Bücher: Ein Beitrag zur Kirchen- und Literaturgeschichte*. Bonn: Cohen.

Rodriguez-Salgado, **Maria José** (2008). *The Changing Face of Empire: Charles V, Phililp II and Habsburg Authority, 1551 1559*. Cambridge: Cambridge University Press.

Rosenberg, **Nathan, and L. E. Birdzell** (1990). "Science, Technology and the Western Miracle." *Scientific American* 263 (5): 42–55.

Rubin, **Jared** (2017). *Rulers, Religion, and Riches: Why the West Got Rich and the Middle East Did Not*. Cambridge Studies in Economics, Choice, and Society. New York: Cambridge University Press.

Scibner, **Robert William** (1976). "Why was there no Reformation in Cologne?" *Bulletin of the Institute of Historical Research* 49 (120): 217–241.

Serafinelli, **Michel, and Guido Tabellini** (2022). "Creativity over time and space." *Journal of Economic Growth* 27 (1): 1–43.

Shapin, **Steven** (1988). "Understanding the Merton Thesis." *Isis* 79 (4): 594–605.

Shapin, **Steven** (1998). *The Scientific Revolution*. Chicago, IL: University of Chicago Press.

Sorokin, **Pitirim A.** (1937). *Fluctuation of systems of truth, ethics, and law*. Social and Cultural Dynamics, Vol. II. New York: American Book Company.

Stimson, **Dorothy** (1917). *The Gradual Acceptance of the Copernican Theory of the Universe*. New York: Baker & Taylor Co.

Tarrant, **Neil** (2014). "Censoring Science in Sixteenth-Century Italy: Recent (and Not-So-Recent) Research." *History of Science* 52 (1): 1–27.

Thomas, **Werner** (2014). "The Treaty of London, the Twelve Years Truce and Religious Toleration in Spain and the Netherlands (1598–1621)." In: *The Twelve Years Truce (1609)*. Ed. by Randall C.H. Lesaffer. Leiden: Brill, 277–297.

Tracy, **James D.** (1985). "With and Without the Counter-Reformation: The Catholic Church in the Spanish Netherlands and the Dutch Republic, 1580-1650: A Review of the Literature since 1945." *The Catholic Historical Review* 71 (4): 547–575.

Trevor-Roper, **Hugh** (2001). *The Crisis of the Seventeenth Century: Religion, the Reformation, and Social Change*. Indianapolis: Liberty Fund.

Valencia Caicedo, **Felipe** (2019). "The Mission: Human Capital Transmission, Economic Persistence, and Culture in South America." *The Quarterly Journal of Economics* 134 (1): 507–556.

Van Zanden, **Jan Luiten**, **Eltjo Buringh, and Maarten Bosker** (2012). "The rise and decline of European parliaments, 1188–1789." *The Economic History Review* 65 (3): 835–861.

Verger, **Jacques** (1991). "Patterns." In: *A History of the University in Europe: Volume 1: Universities in the Middle Ages*. Ed. by Hilde de Ridder-Symoens. Vol. 1. A History of the University in Europe. Cambridge: Cambridge University Press, 35–74.

Vitale, **Mara** (2022). "Scholars and Literati at the University of Salamanca (1218–1800)." *Repertorium eruditorum totius Europae* 7: 1–10.

Voigtländer, **Nico, and Hans-Joachim Voth** (2012). "Persecution Perpetuated: The Medieval Origins of Anti-Semitic Violence in Nazi Germany." *The Quarterly Journal of Economics* 127 (3): 1339–1392.

Voth, **Hans-Joachim** (2021). "Persistence – myth and mystery." In: *The Handbook of Historical Economics*. Ed. by Alberto Bisin and Giovanni Federico. Amsterdam: Elsevier, 243–267.

Wray, **K. Brad** (2009). "Did professionalization afford better opportunities for young scientists?" *Scientometrics* 81 (3): 757–764.

Wright, **Anthony D.** (2017). *The Counter-Reformation: Catholic Europe and the Non-Christian World*. New York: Routledge.

Zagorin, **Perez** (2003). *How the Idea of Religious Toleration Came to the West*. Princeton, NJ: Princeton University Press.

Ziegler, **Walter** (2008). *Die Entscheidung deutscher Länder für oder gegen Luther: Studien zu Reformation und Konfessionalisierung im 16. und 17. Jahrhundert*. Münster: Aschendorff.

Appendices

Appendix A: Four Counter-Reformation measures

Appendix B: Confounders driving the decline?

Appendix C: The Counter-Reformation revived: some case studies, 1700–1990

Appendix D: Data

Appendix E: Additional maps

Appendix A Four Counter-Reformation measures

1. Prohibited literature. One measure to counter the spread of Protestantism was the systematic and coordinated control of dangerous literature, beginning already in the 1520s but intensifying dramatically in the second half of the century.[75] A landmark in European book censorship was the publication of the first Roman (i.e. Papal) *Index Librorum Prohibitorum* in 1559, which meant to be a list of prohibited books applicable to all Catholics everywhere (Reusch, 1883, pp. 258–93; Linder, 2008, pp. 179–90). Subsequent versions of the index were eventually adopted by smaller Catholic states, such as Bavaria or the northern Italian states.[76] Spain and Portugal famously implemented their own, very extensive indexes within the jurisdiction of their independent inquisitorial systems (Bethencourt, 2009). These were the largest in Europe, since they usually included the lists of prohibitions issued elsewhere (say in Rome or Louvain) in addition to their own. Overall, the indexes included prohibitions of specific titles, lists of authors to be prohibited regardless of a book's content, and general rules—including the principle that everything not licensed by the Church is prohibited. Both the elaboration of the indexes and their enforcement were duties of the inquisitions, which counted with the support of secular authorities when needed (Lea, 2010). The inquisitions inspected printing, import, and distribution points—e.g. bookshops, presses, ports, and ships, but also universities and even private collections. In Spain, book-holders were required to keep the Inquisition informed about inventories and could be inspected without warning (Bethencourt, 2009, pp. 211–245).[77] Those who possessed unlicensed books in Spain risked the dead penalty after 1558 (Goodman, 1983, pp. 49–50, Landes, 1998, p. 180).[78]

Importantly, while indexes of prohibited literature were specifically designed to counter Protestantism, not science (and cases of scientists banned specifically due to their scientific views, as happened to Galileo in Italy, were rare), a substantial amount of scientific literature was censored nonetheless. Mostly, this was not because the contents of a book contradicted the dogma, but rather because the author was a Protestant or simply because a book was written or printed in Protestant territory (Pardo Tomás, 1991; Pettegree, 2010, p. 206). To illustrate the incidence and timing of *scientific* literature *explicitly* censored, table A1, which is restricted to Spain only, presents scientific titles and authors contained in the indexes from 1559 to 1707 (with 759 titles and 461 scientists affected in different degrees, from commentation to full prohibition). Based on the same data, figure A1 plots the date of publication of the censored titles, suggesting that the second half of the 16th century was particularly repressive. For a number of reasons, these statistics may show just the tip of the iceberg with regard to how much science was censored in practice. First, we know from a Spanish inventory of scientific titles confiscated in 1634, that 60% of them were *not* included in the latest index (table A2), suggesting that the number of prohibited scientific titles was more than twice the numbers reported in figure A1 and table A1.[79] Second, given that works could be confiscated despite not being in the indexes (there were countless edicts

[75] An example of an early implementation of book censorship is that by Cologne (Scibner, 1976); another one is that by Portugal: King Manuel I received in 1521 a letter of Pope Leo X requesting his help to counter the spread of heretical books; The king acted promptly, and his actions earned him the commendation of the pope (Rodrígues, 1980, p. 14). The dramatic intensification of censorship by the mid century is well known (Reusch, 1883, pp. 179–90; Bethencourt, 2009, pp. 221–36; Pettegree, 2010, p. 206; Landes, 1998, p. 180; Becker, Pino, and Vidal-Robert, 2021). In Spain, for example, the index of prohibited books issued in 1551 listed about 700 items, while the one issued in 1583 listed over 2,300, "draw[ing] into its ambit the whole of the European intellectual world," as Kamen (2014, p. 113) puts it.

[76] Bavaria had issued earlier prohibitions of reformatory literature in 1521, 1524, and in the 1550s, until it adopted the Papal index in 1569 (Stephan, 2012).

[77] "[W]ithout warning, [inspectors of the Inquisition] would descend on all a town's bookshops at once, place seals on the premises and forbid entry to everyone, including the owners," who had to submit on oath a list of their books (Bethencourt, 2009, p. 223). And after 1605, all booksellers were required to submit such lists independent of visitations—a requirement that was extended to private libraries in 1627 (Bethencourt, 2009, p. 223).

[78] However, to the best of my knowledge, there seems to be no evidence on people executed for possessing unlicensed literature.

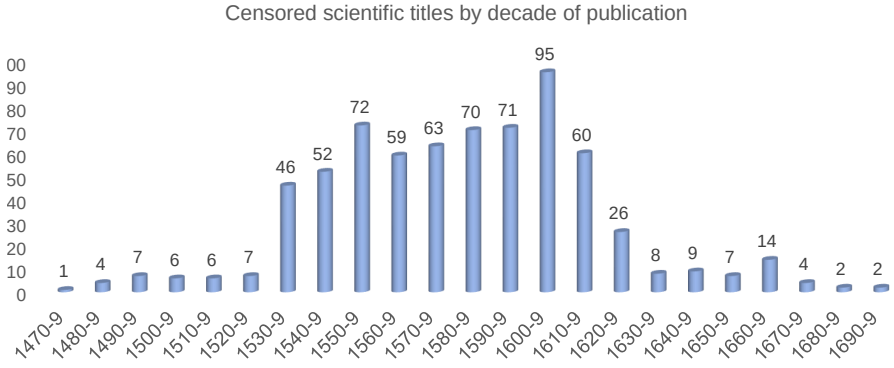
[79] In a sample of 255 distinct confiscated items by the Spanish Inquisition in 1634, 152 (i.e. the majority) were not at all

Table A1: Explicitly censored scientist and scientific titles in some Spanish indexes (1559–1707)

	Censored titles					Censored authors		
	Titles	Type of censorship				Authors	Author class†	
Index	added	Commented	Expunged	Prohibited	Proh. until exp.⋆	added	First	Second
1559	22	0	0	22	0	33	26	7
1584	63	22	20	20	1	76	57	19
1612	70	13	44	10	3	77	62	15
1632	454	154	125	53	122	-	-	-
1640	76	56	5	15	0	221‡	176‡	45‡
1707	74	3	15	50	6	54	28	26
Sum	759	248	209	170	132	461	349	112

Notes: Based on Pardo Tomás (1991, pp. 105, 123). ⋆ Prohibited until expunged. † Authors in the first class where totally prohibited, meanwhile those in the second class had specific works commented, expunged, or prohibited. ‡ Since data of the 1632 index is missing, authors may have been added in the indexes of 1632 or of 1640.

Figure A1: Scientific books censored by the Spanish Indexes of 1559–1707



Notes: The figure hints at the timing of scientific censorship in Spain. It hows that most scientific titles censored in the Spanish indexes of 1559–1707 are publications of the period 1540-1620. Many of them had been banned in countless edicts prior to their inclusion in the index. *Sources*: Based on Pardo Tomás (1991, p. 141).

prohibiting literature in addition to the indexes and their general rules, making it hard for dealers to comply, see Pardo Tomás, 1991, pp. 317–328), precautionary self-censorship took place. This must have affected scientific works disproportionately, since confiscation risks were two or three times higher than for non-scientific titles.[80] Overall, the risks and hurdles faced by publishers, sellers and holders were substantial, possibly explaining the sudden decline of all book-related industries: Spain, which by 1550 had perhaps the most literate population in Europe, and which had adopted the printing press much faster than Britain or Scandinavia, had barely a book industry in the late 17th century. Lastly, even though some prohibited works were smuggled, those who read them could not build on them—not at least publicly, lest face the accusation of heresy. This means that prohibited scientific developments were sterile: even if known by some in private, they could not be taught, nor

included in the index of 1632. See Pardo Tomás (1991, pp. 317–328). A possible explanation is that many prohibitions were not written in the indexes, but in the countless edicts prohibiting books which were issued between the indexes in order to cope with the continuous emergence of dangerous literature across the Continent.

[80]Scientific titles usually make over 10% of confiscated books (table A2), yet their share in the indexes is well below 5%.

Table A2: A draw of confiscated books in 1634

Tribunal	(1) All titles	(2) Scientific titles	(3) % of (1)	(4) Not in the index	(5) % of (2)
Toledo	129	14	11%	8	57%
Murcia	493	59	12%	31	53%
Cuenca	199	30	15%	13	43%
Llerena	90	6	7%	4	67%
Logrono	176	16	9%	6	38%
Sevilla	137	16	12%	9	56%
Granada	259	25	10%	10	40%
Zaragoza	831	91	11%	48	53%
Valencia	557	73	13%	29	40%
Barcelona	150	26	17%	16	62%
Distinct items		255		152	60%

Notes: Based on Pardo Tomás (1991, pp. 320, 332). The number of titles is based on reports sent by local inquisitorial courts to the Supreme Court listing all the books gathered in their archives at that time (we do not know since how long), either because they had been prohibited by edicts or by various catalogs, or because they were pending expungement, or because for any other reason they had come into the hands of the Holy Office. The fact that 60% of the scientific books confiscated were not explicitly mentioned in the index of 1632 suggest that statistics of censored titles in table A1 captured less than half of scientific works actually censored.

quoted, nor used as recognizable input for producing novel ideas and literature (Bethencourt, 2009, p. 233). Only censors themselves (say the Jesuits) were partly allowed to access dangerous literature, explaining why they discussed it within their circles, albeit in "speculative" terms to avoid heresy. The recent study of Becker, Pino, and Vidal-Robert (2021) finds that the various indexes implemented across European cities were effective in reducing printing of the censored books—but also in reducing knowledge and development.

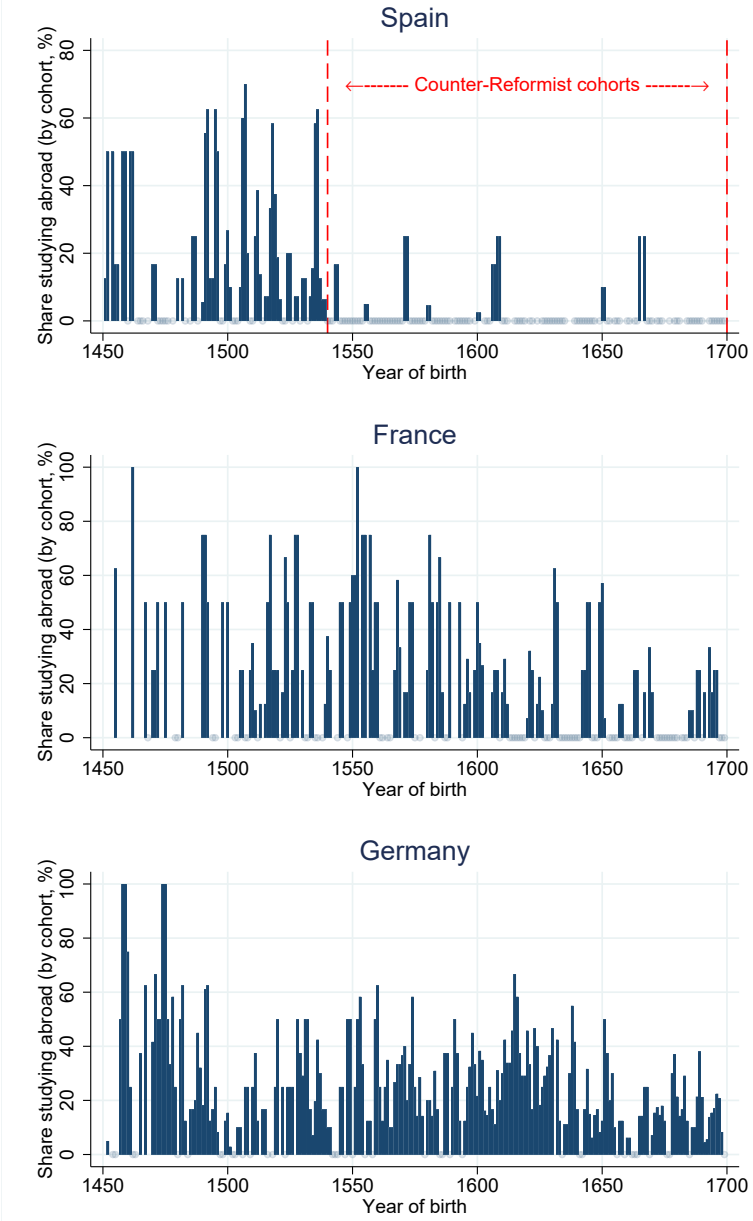
2. Control of academia. Authorities in Catholic Europe saw universities as dangerous spots where and from which Protestantism could propagate, making them one of the major targets of isolationism. Although universities were certainly not fully "reduced to centers of indoctrination," as Landes (1998) would have it, it is known that they were frequently controlled by ecclesiastical authorities.[81] And they were also used for indoctrination indeed (Protestants did the same), especially where confessions struggled for control, as it is evidenced by the abnormal number of universities founded close to the confessional frontiers after 1600 (Parker, 2013, p. 542). A notorious example of how isolationism was imposed on academia can be found in the Spanish ban to visit foreign universities. In 1559—evidently in reaction to the shocking discovery of various Protestant cells within Spain—Philip II forbade his Castilian subjects from studying, teaching, or staying in foreign schools and universities (except for a few save places: Rome, Bologna, Naples, and Coimbra) and required them to return home within four months, lest face deportation and expropriation (Goodman, 1983, p. 50; Landes, 1998, p. 180).[82] Whether this measure was effective or not has been disputed among historians.[83] But its effectiveness seems supported by the evidence of figure A2, which shows the share of famous Spaniards, Frenchmen, and Germans studying abroad (by birth-cohort), according to own computations based on Wikidata. The figure tells a clear story: Spaniards, much like Germans and Frenchman, used to study abroad prior to the restrictions; after them, however, they did not study abroad anymore. This finding is consistent with López Piñero (1979),

[81] For example Vanpaemel (2003) documents how this kind of pressure appears to have generated self-censorship in Belgian universities.

[82] The official reason stated is that resources were drained from Castile, but a letter of Philip to his sister Juana reveals real motive: "experience has shown how much harm has been done, and continues to be done, to religion and custom by study abroad" (Goodman, 1983, p. 50). The ban imposed first on Castilians was extended to the citizens of Aragon in 1568. Similar prohibitions were implemented in the Spanish Netherlands too (Goodman, 1983; Kamen, 2014).

[83] See, e.g., López Piñero (1979) and Landes (1998) versus Goodman (1983) and Kamen (2014).

Figure A2: Share of local notables studying abroad (by cohort, %)



Notes: Bars correspond to the percentage of notable people within a cohort and with known place of study that studied abroad. Circles intersecting the zero x-axis means that all notables born in that year studied within the country. *Source*: own computations based on Wikidata.

who studied international interactions of Spanish researchers and identified two "clearly differentiated phases," divided by the aforementioned panic of 1557-58 (the discovery of Protestants within Spain): before 1559, about half of Spanish researchers had visited foreign universities; thereafter, the share fell to virtually zero (p. 141). This decline of academic mobility was strongest in Spain, yet affected Europe as a whole during the 17th century (table D2). Similar effects were recently found by de la Croix and Morault (2020), who analyze mobility of early modern researchers and find that the decline of connectivity was particularly strong in Southern European universities during the Counter-Reformation.

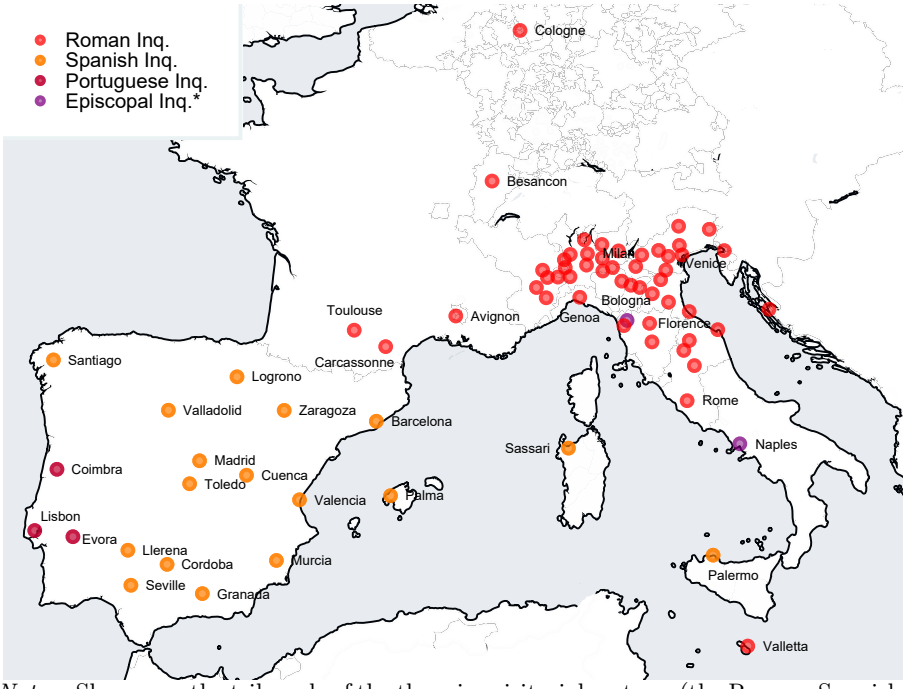
3. Post-tridentine dogmatism. Because Catholicism underwent major changes after the Council of Trent (1545—63), both in terms of doctrine and practice, it is important to the reforms' impact on science—either positive or negative. On the positive side one must mention the improvements of clerical education through the introduction of so-called seminaries. Given that clergymen made around 30% of the scientists by 1550 (figure D3), the post-tridentine clergy—better educated and paid, and of higher social status—may have augmented the pool of possible scientists. Also the increasing presence of the Jesuits Order in the Catholic world after Trent must have been at least in part a positive development, given their philosophical refinement, their interest in scientific matters, and the vast number of high-quality schools and university that they founded (Feingold, 2003a, Frijhoff, 1996, Ma, 2021). On the negative side, however, it must be noted that one of the key reforms of Trent was the introduction of a revised dogma that convincingly addressed the doctrinal ambiguities of the time (see O'Malley, 2013 for details on doctrinal debates). And this new dogma, some historians claim, was rapidly followed by dogma*tism*: Not only did it allow the emergence of an orderly censorship system, now taking shape in the indexes of prohibited literature, but it elevated the teachings of the established philosophical canon—above all Aristotle, but also other classics such as Galen, which had been made compatible with Catholicism throughout the Middle Ages—to truths that shall better not be questioned. As O'Connell (1974, p. 339) puts it:

> Everything made sense within the [Aristotelian] overall world view. Logic, psychology, ethics, physics, politics, poetics, and even Christian theology all fit snugly and comfortably in the same Weltanschaung. But the coherence which gave strength could also be a weakness, for to discard one part of the interlocking system of ideas was to threaten the rest of it. Let it begin to unravel at one point, and there was no telling how far the process might go.

A similar point—that fear of a falsehood, like a mathematical error at the beginning of proof, which would inevitably lead to wrong conclusions, possibly to heresy—is made by Alexander (2015) with regard to the Jesuit resistance to infinitesimal mathematics, or by López Piñero (1979, pp. 421–24) when discussing how Spanish physicians were reluctant to accept criticisms to the teachings of Galen, as expressed by Juan de Cabriada in 1687, who complained about "outdated doctrines of the first masters of antiquity" that were "idolized to the detriment of the truth." The argument should not be overemphasized—Protestants leaders like Luther or Calvin were rather more dogmatic, and arguably less philosophically sophisticated that most Catholic thinkers. However, the effects of this new and consistent dogma on the intellectual environment must be understood in a context where it acts in combination with the powerful and coordinated indoctrination system of a unified Catholic world.

4. Reformed Inquisitions. Another measure to counter the spread of Protestantism was the reorientation or creation of inquisitorial tribunals specifically for this purpose (Bethencourt, 2009; Kamen, 2014). As mentioned above, inquisitors played a key role in enforcing dogmatic conformity. They decided over what to censor, they monitored intellectual activity, and they acted as a judiciary power. Inquisitions had existed since the middle ages to counter heresy, and now provided a useful apparatus against the new threat. The Spanish Inquisition, created in the late 15th century to suppress underground Islam and Judaism in Spanish territory, had proven effective, and provided a model for the establishment the Portuguese Inquisition in 1536 and the restructuring

Figure A3: Tribunals of the Inquisitions



Notes: Shown are the tribunals of the three inquisitorial systems (the Roman, Spanish, and Portuguese). * Naples and Lucca were episcopal headquarters closely cooperating with the Roman Inquisition. Tribunal locations are based on Bethencourt (2009).

of the Roman Inquisition in 1542, which was explicitly directed against Protestantism (Bethencourt, 2009, p. 47). The jurisdiction of these tribunals did not always overlap with the limits of sovereign territories (figure A3). The Spanish Inquisition was active in all of peninsular Spain and some of the Spanish dependencies: Sicily, Sardinia, and the Americas. But its introduction failed in the Spanish Netherlands, Naples, and Milan, where it was fiercely resisted by the local populations. This should not be interpreted as an absence of the Counter-Reformation, however. These territories remained subject to the inquisitorial competence of the bishops, who had their own so-called (arch)episcopal inquisitions dating back to the Middle Ages, and who enjoyed cooperation with secular authorities.[84] The jurisdiction of the Roman Inquisition extended over virtually all of Italy, Malta, the Venetian colonies (in the Balkans and Greece), Cologne in Germany, and Toulouse, Besancon, Carcassonne, and Avignon in what is now France.[85] Figure A3 shows the location of the tribunals. According to Bethencourt (2009, p. 86), their geographical distribution, with almost 80% of Italian tribunals located north of Florence, "reveals a clear sense of being under siege from the 'threat' from the north" (i.e. Protestantism).[86] Also "the dates of creation of the tribunals are also worthy of note," he adds, since "more than half were established after the reorganization of the Roman Inquisition," revealing the "impact of the centralized Council, coupled with the religious alignment with Rome of regional and local powers."

[84]For the situation in Belgium, see Gielis and Soen (2015). For "the Kingdom of Naples and the Republic of Lucca, [where] the inquisitorial competence was entrusted to the bishops" (Verardi, 2021), see Lea (2010) and Santarelli et al. (2017).

[85]Although the actual power of the tribunals in France is contested. As Verardi (2021) writes in his review of Santarelli et al. (2017): In France, "[t]he survival of the inquisitorial courts of Toulouse, Carcassonne, and Besançon was purely nominal," "while that of Avignon, the only one truly active on French soil, resided in territory formally belonging to the papal states."

[86]He further stresses: "It is true that this map has to be related to two different ecclesiastical structures in Italy, the medium-size dioceses in the centre-north and the microdioceses in part of the Pontifical States and the Vice-Royalty of Naples, but this is not enough to explain the marked difference."

Appendix B Confounders driving the decline?

B.1 Economic development and calamities?

The 17th century is often associated with a "general crisis" (Hobsbawm, 1954) that had different effects across the Continent. Parts of Catholic Europe were severely affected by depopulation (Brabant, Castile, and Lombardy in particular; see Lees and Hohenberg, 1989), increased violence (Parker, 2013, ch. 9), and plagues (Alfani, 2013). The general crisis has therefore been often proposed as an alternative explanation for the scientific decline of Catholic Europe.[87]

Yet the evidence in this paper suggests that neither declines in income nor calamities can explain the Catholic decline of scientist per capita. First, regarding country-level variance, while the collapse of Spanish science during the Counter-Reformation has been said to reflect Spain's deteriorating economic conditions, figure B1 shows that comparable episodes of GDP decline in other countries during early modernity are not associated with a comparable decline of scientists per capita. Second, regarding city-level variance within countries, scientific decline associated with the Counter-Reformation and its intensity holds after controlling for well-being indicators. In table 1 we saw this from a static perspective (it controls for population growth and other prosperity measures) and figure B2 confirms it from a dynamic one: it presents the time-varying estimates α_{1t} of the rolling-t cross-sectional regression

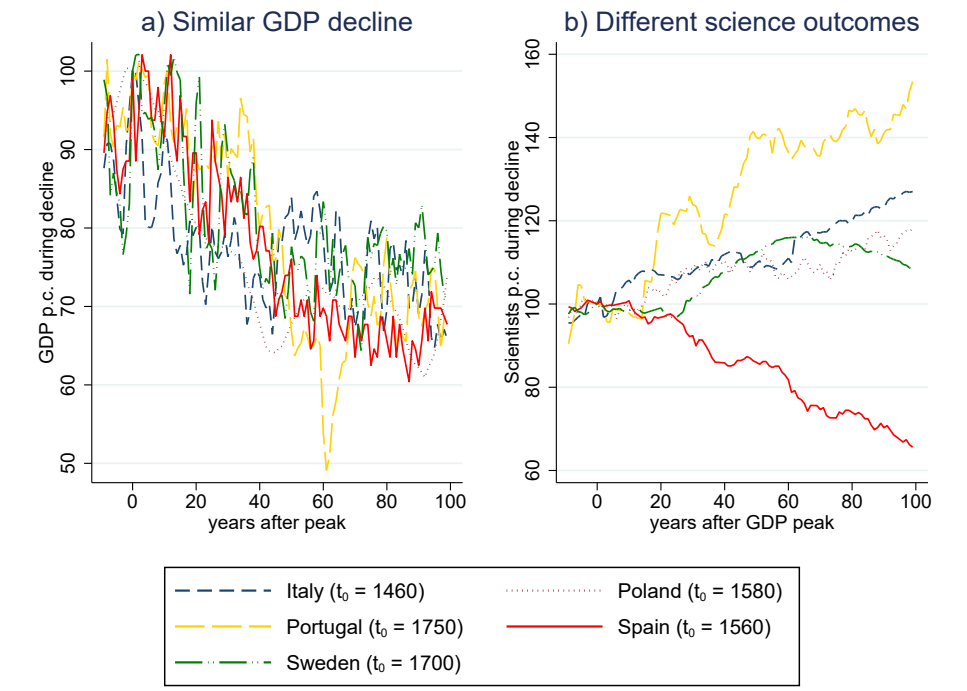
$$\ln\left(\frac{\text{Researchers aged 20-70}_{it}}{\text{Population}_{it}}\right) = \alpha_{0t} + \alpha_{1t} D(\text{CR-proxy}_i) + \text{controls}_{it} + \text{error}_{it}. \tag{5}$$

Controls are dynamic. They include, in each rolling year, population growth during the last 50 years, the distance to the Mediterranean and to the Atlantic (acting as dynamic proxies for rising Atlantic trade), language fixed effects (acting as dynamic proxies of cultural regions), and a university dummy. Notice that, due to the yearly language dummies (which include, for example, Castilian, Basque, and Catalan) average decline of countries such as Spain, Italy, and Portugal is fully absorbed each year. The "treatment" dummy is equal to one if: (a) the city was predominantly Catholic by 1700 (restricting the sample to a 100km confessional border); (b) the city hosts a tribunal of the Roman or Iberian inquisitorial systems; and (c) if the city either hosts one of those tribunals or if it is an episcopal seat (in order to cover the Inquisition in places like Belgium or Austria), but excluding France, "where, outside of the Papal territory of Avignon, the king would not allow the Inquisition to exercise its power" (Jacob and Stewart, 2004, p. 4). All three plots provide a similar picture: the coefficient α_{1t} experiences a dramatic decline from the late 16th century until about 1700, independently of the dynamic controls.

Also violence or epidemic outbreaks seem not systematically correlated with the scientific decline. Figure B3 plots the incidence of battles, sieges, and revolts. Any strong statistical association of these events with the time series of scientists at the country level (figures D1-D2) can be rejected at plain sight: the Thirty Years' War of central Europe (1618-48), the Italian Wars (1494–1559), and the first phase of the Dutch Revolt (1566–1603) were among the most dramatic conflicts of the time, yet they coincide with periods of good (per

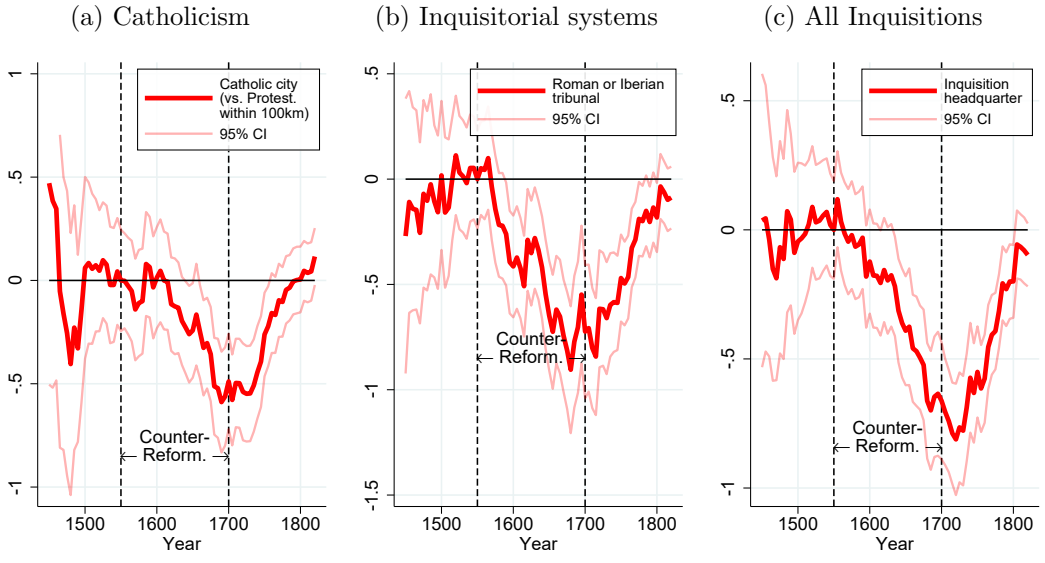
[87] When López Piñero (1979) concludes that intellectual repression of the Counter-Reformation caused the scientific decline of Spain, he does so with following qualification (p. 372): "It hardly goes without saying that the trajectory of scientific activity was conditioned by the economic, social, and political crisis of what Henry Kamen has called the 'Iron Century.' The crisis affected all of Europe, but it was particularly early and intense in our country [Spain], which not only ended up losing its hegemonic position, but also suffered a regression in every possible aspect, something that [leading historian] Domínguez Ortiz came to consider as an authentic 'degenerative process'." Similarly, when discussing the view of Quételet (1864) that science in Belgium was "completely extinguished by shortsighted Spanish [Counter-Reformation] governors," Dupré et al. (2015) criticises that Quetelet "did not put much emphasis on the disturbing military situation" (p. 9). And Alfani (2013) finds that plagues "affected southern Europe much more severely than the north," especially in Italy, causing "a shock to the economy of the Italian peninsula that might have been key in starting its relative decline compared with the emerging northern European countries."

Figure B1: Economically driven scientific decline?



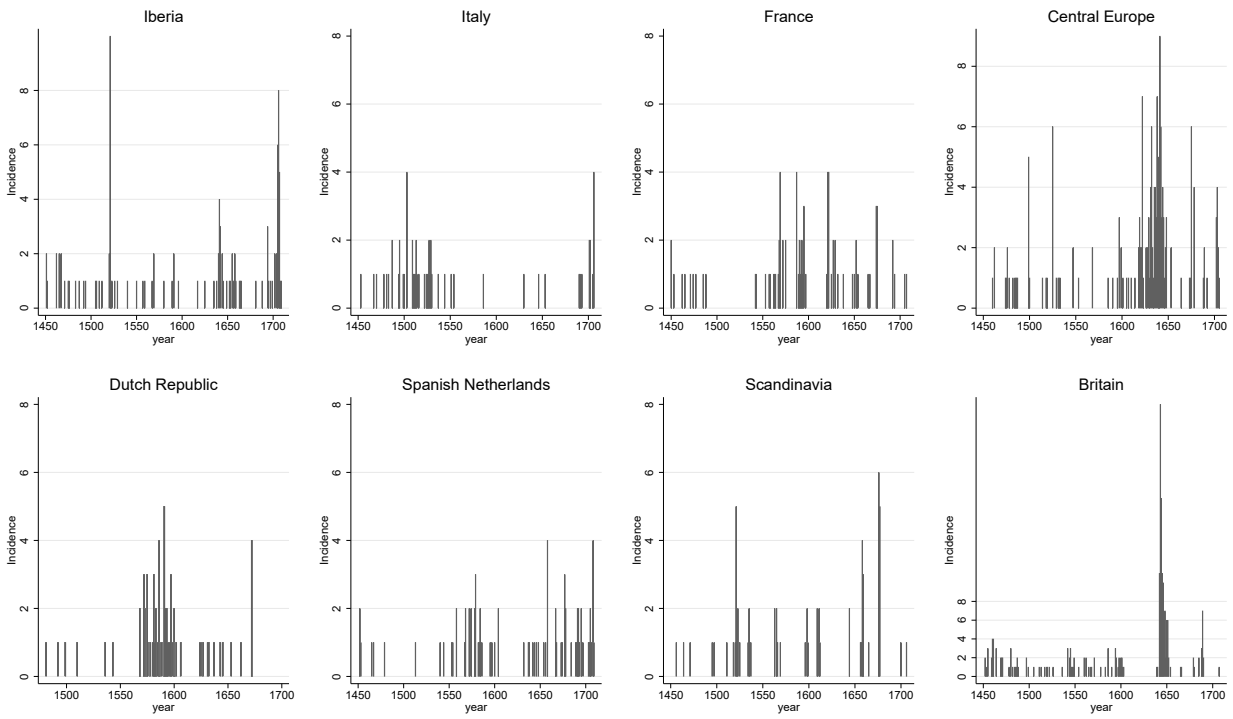
Notes: While the collapse of Spanish science during the Counter-Reformation has been said to reflect Spain's economic decline, we observe that comparable episodes of GDP decline, plotted in (a), are not associated with a comparable decline of scientists per capita (aged 20-60), plotted in (b). *Sources*: GDP figures are from Prados de la Escosura, Álvarez-Nogal, and Santiago-Caballero (2021), Malanima (2011), Palma and Reis (2019), Malinowski and van Zanden (2017), and Schön and Krantz (2015).

Figure B2: Dynamics of the decline – with moving geographic, economic, & ethnic controls



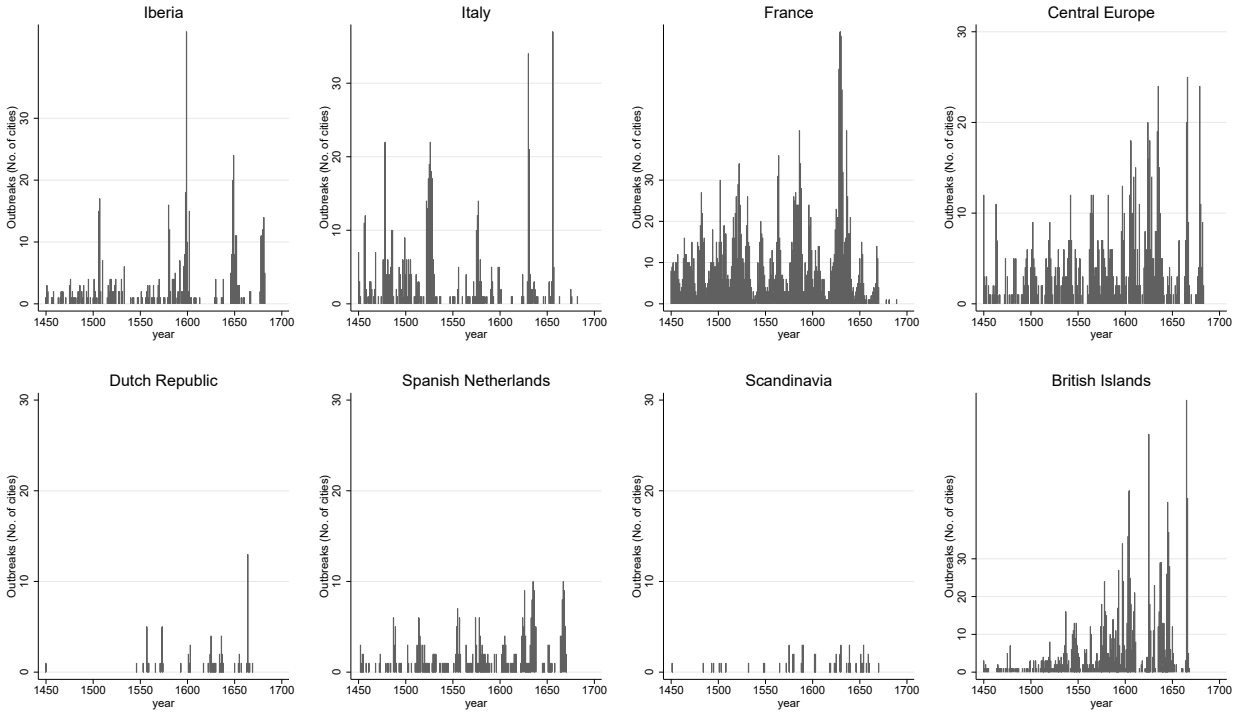
Notes: The plotted estimates of α_{1t} of equation (5) confirm that the scientific decline associated with proxies for the Counter-Reformation and its intensity coincides in time with the relevant period. Estimates control for *dynamic* proxies for well-being. See text for details.

Figure B3: Battles, sieges, and revolts



Notes: Number of battles, sieges, and revolts per year within the territory. *Source*: own calculations based on Wikidata.

Figure B4: Plague outbreaks



Notes: Number of cities with plague outbreak per year within the territory. Notice different scaling. *Source*: Biraben (1975), Annexes III and IV.

capita) scientific performance in the affected areas. A similar argument can be made with regard to the incidence of plague outbreaks shown in figure B4: France, for example, was particularly affected by outbreaks, especially in the first half of the 17th century, but this coincides with a particularly good scientific performance (recall figure 6d); meanwhile in Spain, where outbreaks were rare, science was rapidly declining. In sum, the timing of epidemics across the Continent shows little connection to the 1550–1700 decline of science associated with the Counter-Reformation. Overall, scientific activity (per capita) seems quite independent of economic hardships during early modern times.[88] Moreover, as can be seen in figure B5 below, the emergence of the Modern Economic Growth regime around 1800 is *not* associated with higher growth of scientists per capita in Europe as a whole. All these results are consistent with Serafinelli and Tabellini (2022), who find that, between the 11th and 19th centuries, the densities of creative clusters in European cities seem not driven by prosperity, measured either by population size or by wages.

B.2 Science triggered by Protestantism?

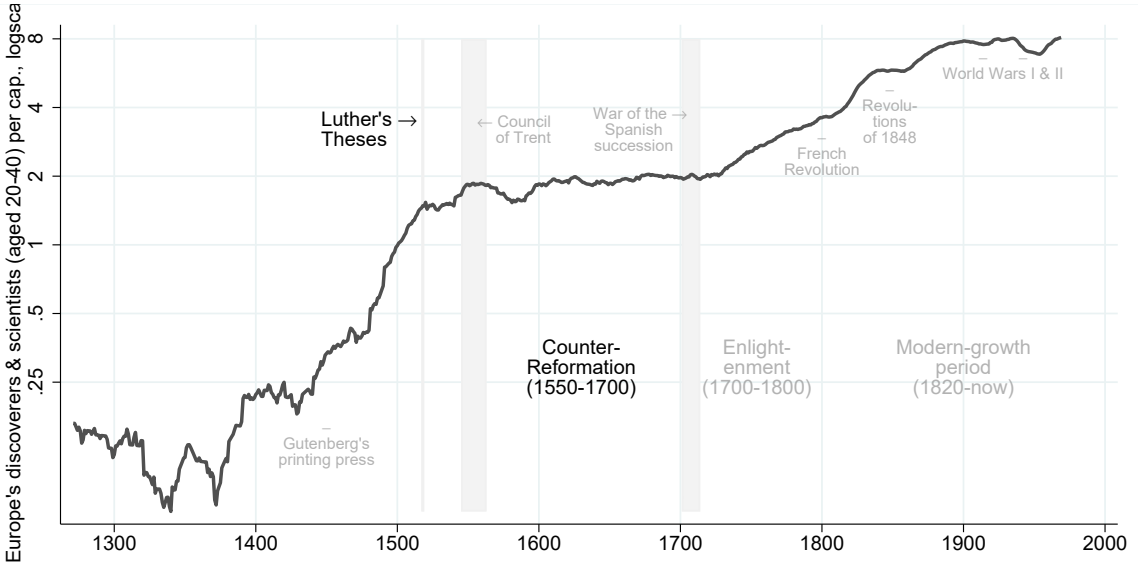
Overall, the scientific gap favoring Protestants over Catholics emerges *only after* the Counter-Reformation, and especially where it was strongest, suggesting that the causal forces explaining this gap are to be found not in the features of Protestantism, but rather in those of the Catholic reaction.[89] Further, as discussed in the main text (section 4.4), a positive impact of Protestantism (and Calvinism in particular) on 17th-century science alleged by Merton (1936; 1938; 1968) and others is not confirmed in the data. Instead, cities fully-controlled by Calvinist had fewer scientists (table 1) and events of intensified asceticism like the late-17th century Dutch Republic or post-Elizabethan Puritan England are periods of relative stagnation or decline (figure D2). The record in Germany is not much better: the rise of Pietism—a Protestant revival peaking around 1750, clearly visible in figure 7b—correlates with rather unimpressive growth of Protestant scientists per capita (figure 6a), especially if compared to the stunning acceleration experienced by their Catholic counterparts in the same period.

Mokyr (1990, p. 76) notes that "the Reformation, and its natural sequel the Counter-Reformation, made Europe a more bigoted place than it had been since the Crusades," having implications for innovation. This view seems confirmed in figure B5, which shows that the growth of (known) researchers per capita in Europe as a whole abruptly stopped between Luther's writing and the end of Confessionalism and the Counter-Reformation around 1700. Only with the rise of the Enlightenment in the 18th century—a period of dramatic secularization of science (figure D3)—does the density of researchers resume its positive growth. To be sure, we cannot be fully confident about the comparability of trends across very distant periods (recording technologies have changed over time, possibly affecting the number of surviving biographies). Nor can we be confident about a counterfactual history without Luther's attack on papal authority (alternative shocks triggering a conservative reaction by Rome seem plausible). Those caveats aside, the figure would suggest that the emergence Protestantism was, as a whole, detrimental for science during a remarkably extended period. Had Luther never been born (and no

[88] If there is a contemporary correlation between scientists *per capita* and well-being in early modern times, it seems to be rather negative, especially after calamities. This may indicate that (usually well-off) scientists were less affected by hardship than the rest of the population.

[89] Why science declined more among Catholics than among Protestants, despite their shared interest in combating heresy, has already been proposed: namely due to logistic advantages. Catholics in southern Europe (unlike Protestants, but also unlike Catholics in Poland, Austria, and France) benefited from high degrees of centralization and coordination (organized around Spain's empire and the Vatican) and had a longer experience dealing with heresy (due to their historical coexistence with Islam and Judaism). Thus, they were endowed with time-proven institutions, such as the inquisitions, which once more proved effective tools granting social control. The side-effect of imposing this control, now also aided by wide-ranging book censorship and restricted mobility across educational institutions, was intellectual isolation and decline. From this perspective, the most important consequence of Protestantism was that it activated the reactionary (and much more effective) forces of the Counter-Reformation.

Figure B5: The Luther-shock and scientists in Europe



Notes: This figure suggests that Europe's growth of scientists per capita stopped after the rise of Protestantism in 1517, and especially during the implementation of the Counter-Reformation (ca. 1550–1700). Population based on the Maddison Project Database 2020 (Bolt and Van Zanden, 2020), Prados de la Escosura, Álvarez-Nogal, and Santiago-Caballero (2021), Malanima (2011). Scientists and Discoverers are from Laouenan et al. (2022), based on Wikidata.

confessional struggle taken place in Europe), the Enlightenment and the resulting industrialization may perhaps have happened some 200 years *earlier* than they actually did.[90] Or had instead Protestantism develop into a more unified and coordinated orthodoxy, supported by a "Protestant Spain of the north," it seems plausible that modern science may have not risen at all.

B.3 Democratic political institutions?

Communes and parliaments. Political institutions and religion are related during the early modern period. Protestantism emerged first within the highly decentralized Holy Roman Empire;[91] And, as noted by van Zanden, Buringh, and Bosker (2012), "Protestantism—most certainly Calvinism and other more radical forms of the Reformation such as Puritanism—tended to be rather 'democratic', stressing individual belief, and the governance of the (local) churches from the 'bottom up'." "Catholicism," by contrast, "in particular post-Counter-Reformation Catholicism," was "often associated with absolutism." Indeed, the Counter-Reformation coincides with a fundamental change in the history of European parliamentarism (van Zanden, Buringh, and Bosker, 2012, Rubin, 2017): Iberia, which had been both the cradle of European parliamentary democracy and the most active region in terms of parliamentarism between the 12th and the 15th centuries began to experience a rapid decline of parliamentary activity thereafter.[92] A similar process of "modernization" (centralization was seen as progress) took place in other Catholic regions such as Poland and France. Conversely, in territories

[90] This is of course under the assumption that no other shock would have triggered similar reactive forces in the absence of Luther. Had such a shock occurred without the political fragmentation brought about by Protestantism, the effects could have been even worse.

[91] Indeed, the term Protestantism derives its name from how German princes, which enjoyed substantial political autonomy, refused to obey the will of the Emperor. On the relationship between religion and political autonomy, see also MacKenney (1993) and Nexon (2009).

[92] Iberian parliaments remained strong at least until the early 17th century, however. See Henriques and Palma (2023) and Espinosa (2008).

that eventually adopted Protestantism, the once poor parliamentary activity increased rapidly during the same period. Does declining parliamentarism explain declining science? Did more democratic institutions foster science? Some studies point in this direction. In a recent paper, Serafinelli and Tabellini (2022) find a significant association of creativity (measured, like in the present paper, as the per capita number of notorious people at the city level) with a city's self-governance indicator (measured by the variable 'local participative government', i.e. 'commune' of Bosker, Buringh, and van Zanden, 2013). For these reasons table 1 controls for local participative government (i.e. 'commune') and for parliamentary activity in the 17th century.

Protestants church ordinances. In another closely related study, but restricted to German cities only, Dittmar and Meisenzahl (2020) conclude that legislative changes triggered by the Reformation lead to a subsequent influx and production of upper-tail human capital. They further conclude that it is via this mechanism that urban development was stronger in Protestant Germany. The specific indicator of legislative change studied by them is the adoption of so-called "Protestant Church Ordinances," which filled the regulatory vacuum (including regulations of public goods) that emerged when Protestant territories no longer recognized the jurisdiction of the Vatican.[93] Table B1 provides regressions of the scientific and intellectual decline in the 17th century, controlling for the existence of Church Ordinances and other institutional or otherwise relevant factors. Interestingly, the variable of Dittmar and Meisenzahl (2020) remains significant after controlling for Catholicism. But also Catholicism remains significantly associated with less scientists and intellectual after all these institutional controls. And, like in table 1, we confirm that also within Germany the association with universities is not positive but negative under Catholicism.

B.4 Literacy, universities, and early printing?

Literacy. A popular theory says that Protestantism spurred literacy by stressing reading the Bible.[94] Another, less popular one, says that Counter-Reformation Catholicism depressed literacy, either directly (defunding education), or indirectly, by depressing the book-market through censorship.[95] Since literacy is almost surely beneficial to science, we have to ask whether our observed relative decline of Catholic science may be driven by differential levels of literacy.[96] Is, for example, the particularly dramatic decline of Spanish science explained by unfavourable development in literacy? According to our best estimates of Spanish literacy by 1600—the study of Nalle (1989) based on the inquisitorial archives of the Diocese of Cuenca—the answer is no (at least

[93] Church Ordinances (*Evangelische Kirchenordnungen*) were issued in many but not all Protestant cities (usually in the largest), and touched on issues plausibly related to long-term development such as the secularization of public services previously controlled by the Church.

[94] For example, Becker and Woessmann (2009) find that in late-nineteenth-century Prussia Protestants had higher levels of income and literacy than Catholics. Their suggested interpretation of this finding is that "Protestant economies prospered because instruction in reading the Bible generated the human capital crucial to economic prosperity."

[95] As Eisenstein (1980, p. 333) puts it: "Protestant doctrines which stressed Bible-reading as necessary for salvation did generate unusual pressures toward literacy; while the Catholic refusal after Trent to authorize alternatives to the Latin Vulgate worked in the opposite direction."

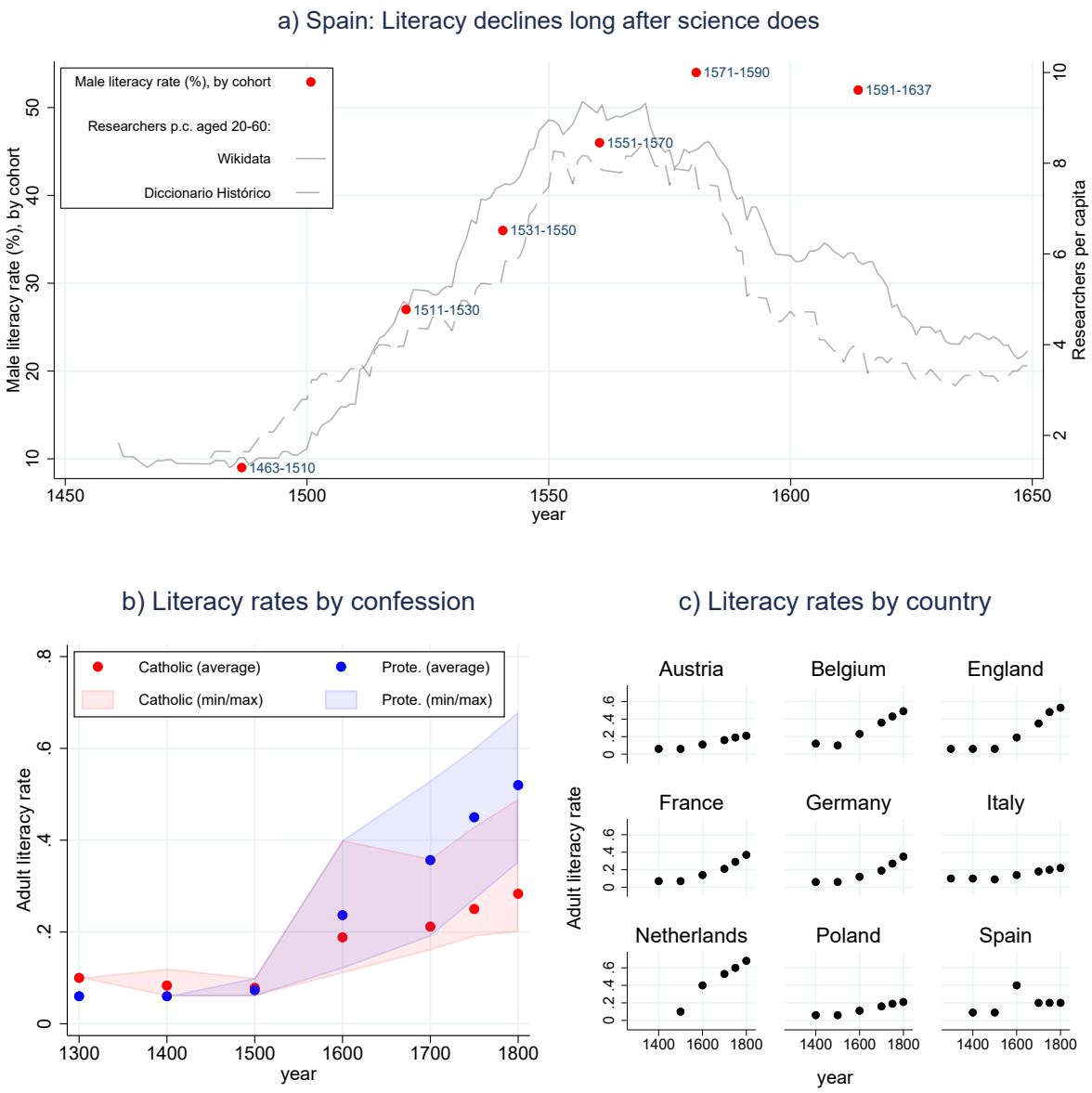
[96] In the Early Modern period, so Houston (2002, p. 168), "Protestants tended to be more literate than Catholics within areas where they co-existed, and countries where the Reformed faith was the official religion were usually more advanced in literacy than Catholic neighbours." But a causal link between bible-reading and literacy is not well established. "In the Reformation of the sixteenth century," write Gawthrop and Strauss (1984), "the policies and intentions of Lutheran authorities do not allow us to suppose a chain of causation linking Protestantism, Bible reading and literacy." Part of the observed correlation is due to reverse causality. "[Protestants] were recruited disproportionately from the most literate sections of society"—this being especially true "among Calvinist minorities in Catholic countries such as Poland and France, ... principally because of [the Calvinist] policy of targeting important nobles and gentlemen who could espouse and protect the faith" (Houston, 2002, p. 168). But also the few Lutherans in Iberia and Italy, for example, were part of the literate elites (Luttikhuizen, 2017), showing that self-selection is an issue. (Yet Southern Europeans were less inclined to adopt Protestantism overall, even despite their high initial levels of literacy. Why? One reason is that they had developed stronger positive sentiments towards the Catholic Church, which they saw as a symbol of unity in the context of a centuries-long struggle against the neighboring Muslims.)

Table B1: Institutional controls (German data)

	Dependent variable							
	Scientist p.c. born 17th century				Intellectuals p.c. born 17th century			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Confessional								
Catholic	-0.75***	-0.65***	-0.68***	-0.61***	-0.77***	-0.78***	-0.68***	-0.68***
	(0.16)	(0.17)	(0.16)	(0.18)	(0.17)	(0.17)	(0.18)	(0.19)
Catholic × university 1700			-0.61	-0.61			-0.99**	-0.94**
			(0.42)	(0.42)			(0.47)	(0.48)
Prot. Church Ordinance	0.29*	0.37**	0.29*	0.37**	0.42***	0.43***	0.43***	0.47***
	(0.16)	(0.16)	(0.17)	(0.17)	(0.14)	(0.14)	(0.15)	(0.16)
Institutional controls								
Representative bodies for citizens	0.16	0.14	0.21	0.19	-0.03	-0.04	-0.02	-0.04
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.13)	(0.14)	(0.13)
Participatory elections	0.09	0.10	0.04	0.06	-0.03	-0.04	-0.03	-0.03
	(0.14)	(0.14)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.13)
Guild representation	-0.08	-0.06	0.07	0.08	-0.08	-0.10	0.10	0.07
	(0.14)	(0.14)	(0.15)	(0.14)	(0.12)	(0.12)	(0.13)	(0.12)
Other controls								
Scientists/Intellectuals p.c. C15-C16	0.43***	0.43***	0.28***	0.29***	0.49***	0.49***	0.40***	0.39***
	(0.07)	(0.07)	(0.09)	(0.09)	(0.06)	(0.07)	(0.08)	(0.08)
University Pre-1517			-0.80	-0.74			0.26	0.34
			(0.78)	(0.78)			(0.73)	(0.71)
University in 1700			1.61**	1.52**			0.48	0.45
			(0.73)	(0.74)			(0.73)	(0.72)
Printing press by 1517			0.19	0.20			0.05	0.11
			(0.21)	(0.20)			(0.19)	(0.19)
Hanseatic league			0.20	0.18			0.25	0.20
			(0.16)	(0.16)			(0.17)	(0.15)
Navigable river			-0.03	0.00			0.14	0.13
			(0.15)	(0.15)			(0.12)	(0.12)
Free-Imperial City			-0.06	-0.06			-0.26	-0.22
			(0.19)	(0.18)			(0.17)	(0.16)
Log pop. 1600			-0.29***	-0.27***			-0.15	-0.18**
			(0.09)	(0.09)			(0.10)	(0.09)
Population weights	no	yes	no	yes	no	yes	no	yes
Observations	155	155	155	155	196	196	196	196
R-squared	0.34	0.34	0.42	0.44	0.44	0.46	0.48	0.51

Notes: Cross sectional city-level regressions with heteroskedasticity-robust standard errors in parenthesis. Researchers per capita in logterms. Population weights (if indicated) correspond to levels of 1600. Constants omitted from the table. The protestant dummy correspods to Cantoni (2012). Indicators of Church Ordinances and other institutional and geographic indicators are from Dittmar and Meisenzahl (2020). Universities in 1700 and 1800 are based on Bosker, Buringh, and van Zanden (2013). City population is based on Bairoch et al. (1988), with missing population imputed by a cross sectional OLS fit. The number of scientists is based on Wikidata (see appendix for details). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure B6: Does literacy explain scientific decline?



Notes: Panel a shows that literacy rates of Spaniards, which were among the highest in Europe, begin to decline slowly in the cohorts born after 1600 (which reached adulthood around the mid 17th century), meanwhile science started to decline about 100 years earlier. *Sources*: Literacy rates in B6a are from a study on the Diocese of Cuenca by Nalle (1989) and those in B6b and B6c are from Allen (2003). Researchers per capita are computed using biographical data from Wikidata, the *Diccionario Histórico* (López Piñero et al., 1983), and interpolated population from the Maddison Project (Bolt et al., 2018).

not until the mid-17th century). As shown in figure B6a, Spanish literacy expanded continuously during the 16th century, from 27% to 54%; only the cohorts born in the first third of the 17th century show a slight decline down to a literacy rate of 52%—still one of the *highest rates in Europe* at the time (compare with figure B6c). This generation reached its *floruit* around the mid-17th century, which is too late to explain the sharp scientific decline observed in Spain after 1559. Overall, differences in literacy between Catholics and Protestants were still small by 1600 (some 80 years after the Reformation, some 50 years after Trent), and only became notorious between 1700 and 1800 (which is when science was growing faster among Catholics!). Thus, changes in literacy cannot be the *main* drivers of changes in science.[97] That said, literacy may explain part of them, such as late-17th-century declines in Spain or the decline of Antwerp relative to Amsterdam during the 17th century, which coincides with a relative (and absolute) decline of Antwerp's literacy (and numeracy) in the course of that century (Verhoeven, 2014, p. 232). It is worth emphasizing that more than (supposedly) *positive* effects of Protestantism, what we see here are the *negative* effects of the Counter-Reformation. Much of Antwerp's cultured elite left the city after falling under Spanish control. And Catholics across Europe, it has been argued, had less incentives to invest in literacy if there were less books to read *because* of censorship. According to Eisenstein (1988) and Pettegree (2010) censorship depressed the printing and book-selling industries in a time when "printing spurred the spread of literacy" (Eisenstein, 1980, p. xiv). Moreover, the same reasons that impulsed Counter-Reformation censorship also generated doubts in the elites regarding the benefits of having a literate population. "Towards the end of the [16th] century," writes Nalle (1989), "some [Spaniards] began to voice the opinion that reading, even under controlled circumstances, could lead to heresy: therefore it was better to be an illiterate, but orthodox peasant." The rise of "recreational reading by the middle and lower ranks of society . . . alarmed moralists and theologians, who offered sharp warnings regarding the potential effect of unregulated reading." These concerns led to a series of reactions, including "a law in 1623 that limited popular access to Latin schools." In Castile, "[o]f the four thousand Latin schools counted at the beginning of the century, fewer than a hundred survived a century later." The leaders of the Counter-Reformation, which initially welcomed literacy as way to counter heresy, now saw it as a burden. To be sure, in other parts of Europe the Jesuit missions of the Counter-Reformation must have had a positive effect on literacy. But in Spain, "[a]fter a century of expansion, by 1600 the phenomenon of popular reading was coming under vigorous attack for endangering society's religious and moral health" (Nalle, 1989). Overall, the literacy gap that starts to emerge between Catholics and Protestants seems to be not so much the result of new Bible-reading Protestants: for one, rising literacy trends precede the Reformation, and the so-called "Second Reformation," the Pietist movement of the later half of the 17th century, is not associated with abnormally high growth of scientists in the affected areas (recall section B.2).[98] Instead, the gap seems largely the product of a *decline* in Catholic literacy, partially driven by the Counter-Reformation.

Higher education. Because Protestantism spread more rapidly among the intellectual elites, universities were nodes theoretically facilitating the spread Protestantism (and were therefore targeted by the Counter-

[97] It is well known that the correlation between education and scientific indicators is very high in the present. However, the degree of correlation in early modernity seems much lower. The difference is emphasized by Mokyr (2005) and exploited empirically by Squicciarini and Voigtländer (2015), who study the distinct growth effects of broad education (literacy) and elite education (science) in the context of 19th century France. The Dutch, which had by far the highest levels of literacy during the 18th century, did not exhibit higher densities of researchers than low-literacy countries such as France. A similar example is of a science-literacy disconnect the experience of the Ashkenazi Jewish population. The "utter absence of [Ashkenazi] Jewish names in the roster of intellectual innovators in the Scientific and Industrial Revolutions", Mokyr (2017) writes, "is particularly striking in view of the enormous investment in human capital that Jews made in the education of their children". "Only in the nineteenth century,"—he continues—"when Jews became assimilated in a secular culture did their contribution become proportional to the massive amount of human capital they had accumulated."

[98] On the so-called Second Reformation and how it dramatically boosted literacy, see Gawthrop and Strauss (1984) and van Horn Melton (1988)

Reformation). However, universities seem not to be driving the Catholic scientific decline. The existence and emergence of universities is controlled for in tables 1 and B1. Further, university education remained strong in Counter-Reformation Europe. For example, according to Parker (2013, p. 542), "[b]y the 1630s, perhaps one young Englishman in forty, and perhaps one young Castilian in twenty, attended university—proportions that would remain unequalled until the later twentieth century."

Early printing. The printing press is also seen as one of the factors allowing the spread of Protestantism (MacKenney, 1993, pp. 124–8) and the confessional propaganda struggle is considered a catalyst of the book industry, especially in Protestant territory (Pettegree, 2010, pp. 91–129). Because of this symbiotic relationship and the fact that the book was the key transmission devise of scientific ideas, *inertia* of early printing (say of printing activity between 1450 and 1550) may explain part of the depressed printing during the Counter-Reformation and exaggerate our results. In order to isolate the role of early printing, table 1 controls for the existence of printing presses up to 1500, using data from the *Incunabula Short Title Catalogue* (ISTC, 1998). Unfortunately, these data on printing locations miss post-1500 developments (say until 1550) that would be informative. That said, the study German printing by Crofts (1985) suggest that we should not expect any substantial change of the results, since he finds that between 1525 and 1545 "the number of Catholic publications was surprisingly high, nearly matching the total of the reformers" and that "[i]f Luther's works are excluded from the reformers' total, the Catholics outpublished their opponents."

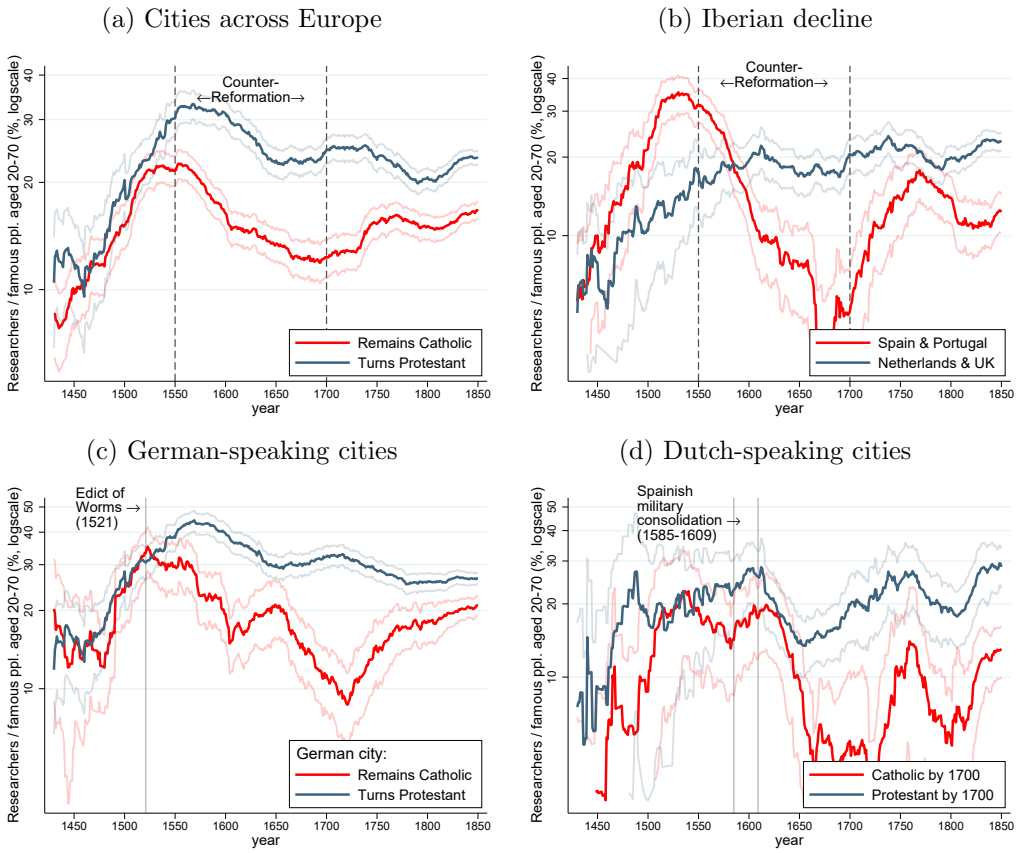
B.5 Biased number of biographies?

Since we do not observe the actual number of scientists at a point of time and space, but simply observe the record of *known* scientists, it is imperative to ask whether the overall finding that the Counter-Reformation depressed science may be driven by sampling biases in treated cities (despite controlling for language, states and other geographical factors). Many points, however, speak against this concern. Suppose first a bias against Catholics, stemming from a systematical underrepresentation of Catholics by Protestant biographers. While such bias could partly explain an increasing gap between Catholic and Protestant cities in Germany, for example, or between Catholic and Protestant countries in general, it cannot explain why, among Catholic cities, the decline was larger in Inquisition-cities than in other adjacent cities (recall also the dynamic estimates of figure B2). Nor can it explain why the relative decline begins in 1521 in Catholic Germany, but only in the 1560s in Italy and Spain, for example.[99] Nor is there any reason why such bias should increase precisely during events such as the revival of the Spanish Inquisition in response to the French Revolution. Moreover, in the case of Spain at least, as we have seen by comparing the data to that of López Piñero et al. (1983), the body of biographies originates from the local archival records studied by Spaniards themselves, meaning that the observed absolute decline cannot be explained by foreign, time-dependent sampling biases.

Further, that sampling biases against Catholics or Southern Europeans may drive the results seems contradicted by figure B7 and columns 9–10 of table B2, which divide the number of known researchers not by urban

[99] The same arguments that apply to Catholicism apply as well to Spanish occupation, which may be subject to biographical survival biases as well. As pointed by Cañizares-Esguerra (2008): "Anyone who has done work on the early modern Spanish empire has surely noticed that works often circulated in manuscript, not print. One answer to this puzzle lies in the bureaucratic culture of secrecy that the monarchy fostered, *arcana imperii* (state secrets)." See also Portuondo (2009). Or as John Elliott writes: "The cultural vitality of the new Spain may also have helped encourage a reassessment of traditional assumptions about the country's intellectual stagnation and its scientific and technological backwardness in earlier periods. Closer examination of the evidence suggested that early modern Spaniards, faced with the immense challenge of controlling, understanding, and interpreting the New World of America, developed preoccupations, concerns, and interests that were not necessarily those of their European contemporaries. Their contributions to the scientific enterprise had therefore tended to be ignored or underplayed by historians of science and philosophy primarily interested in identifying those features of early modern European civilization that served as more obvious signposts on the road to 'modernity."'

Figure B7: Results due to survival biases? Dividing researchers by famous people instead of urban population

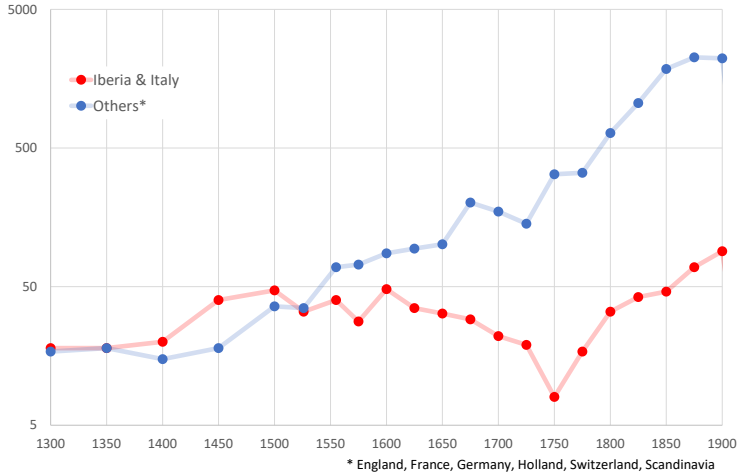


Notes: By dividing researchers over the totality of known biographies, the figures show that the *per-city-population* gap between Catholic and Protestants (or more generally between heavily treated cities and others) suggested in figure 1 and 6 cannot be merely the outcome of a biographical survival bias against Catholics or Southern Europe. Researchers and other famous people are taken from Laouenan et al. (2022). For ease of replicability, 'researchers' in these graphs means 'scientists & discoverers' as defined by Laouenan et al. (2022). Thus, unlike in the data used in the main text, here some degree of inflation prior to 1550 occurs among Iberians due to the 'discovery' of the Americas.

population but instead by all available biographies. Here the time series are subject to sampling biases in both the numerator and denominator. While these biases need not be the same (important events like wars or revolutions will tend to increase the denominator without changing the numerator), the message of the plots is that the overall results are confirmed through this approach. The same applies to the rescaled baseline regressions presented table B2, columns 9–10.

And last, while we cannot be confident about the precise *size* of these overall changes, we can be sure about their *existence*, thanks to alternative hitoriographical evidence, such as the accounts of contemporary witnesses. Consider the rise and fall of Iberian scientists. In 1599, Richard Hakluyt explained why Spain and Portugal, in contrast to his natal England, had been able to build such large oversea empires: "these two worthy Nations had those bright lampes of learning (I meane the most ancient and best Philosophers, Historiographers and and Geographers)" (Hakluyt, 1599). The extent to which Iberia was a European leader in some aspects of science and technology in the 16th century is documented extensively by López Piñero (1979), García Tapia (2003), and Goodman (2002), among others. The University of Salamanca had been among the first in Europe adopting Copernicanism, Castile was exporting hydrographers to the rest of Europe, and Spain became a forerunner in

Figure B8: Important discoveries and inventions (Sorokin, 1937, p. 150)



Notes: These statistics, based on Sorokin (1937, p. 150), support the picture of an overall reversal of fortune suffered by the centers of the Counter-Reformation—Iberia and Italy—beginning around the mid 16th century and stabilizing around the 18th century.

state-led research institutions of applied science, such as the *Casa de Contratación* of Sevile (founded in 1503) the *Academia de Matemáticas* of Madrid (founded in 1582). It has been even argued that Francis Bacon—who Mokyr identifies as the key intellectual figure leading to the British industrialization—was inspired as late as the 1620s by the Spanish Empire when describing ideal state-sponsored science in *New Atlantis* (Cañizares-Esguerra, 2004). Yet, Iberians, who in the 16th century "confidently saw themselves as the first 'moderns,' superseding the ancients," (Cañizares-Esguerra, 2004) became equally aware of their scientific decadence by the late 17th century.[100] The Valencian physician Juan de Cabriada expresses this perception with clear words in 1687 (see López Piñero, 1979, pp. 421–24). He points to the fanatic defense of "outdated doctrines of the first masters of antiquity, which must be praised and respected, but which should not be idolized to the detriment of the truth." He further points to scientific isolation: "How shameful that we have to be the last to receive the [knowledge] spread across Europe, as if we were Indians." And he tells that even high quality scientists of the scattered Spanish imperial dependencies were ignored in the Peninsula, advocating the urgency of an academy of science in order to bring them together to the king's court. Carbiada was writing when the leading voice of anatomy in Valencia was Matías García (†1691), who fervently opposed William Harvey's theory of blood circulation in favor of the classical view of Galen. This context must be contrasted with the fact that the most notable precursor Harvey within Europe was yet another Spaniard from Aragon, Miguel Servet (†1553)—this bluntly illustrates how drastic the scientific decline appears to be. A similarly dim state of science is described within Belgium by the Liège mathematician René François de Sluse in 1667: "[Scientific] studies languish among us, and learned men devote their efforts to law and other branches of knowledge more highly valued by the crowd. There are some who pursue chemistry either for money or for medicine's sake. I know no one who

[100] Evidence points at a change occurring by the mind century: As discussed by Goodman (2005), it has been documented that the "Valencian Inquisition up to 1530 had not been a harsh censor of literature; it had permitted the unorthodox medieval philosophy of Ramón Llull which had been condemned by the pope, permitted the works of Erasmus which had been censored by theologians the University of Paris, and even permitted erotic literature." And the "library of Jaume Torres, a sixteenth-century physician, showed 'full contact with the most advanced sciences in Europe.' ... But a very different picture of the Inquisition was then conveyed by research focused on the late sixteenth century, [when] the Inquisition had imposed surveillance on printing presses, on the movement of books through ports and across borders, and pounced on bookshops and libraries." See also López Piñero (1979).

explores the secrets of nature merely in the interest of knowledge" (Vanpaemel, 2003, p. 424). This has to be contrasted with the vivid scientific community that Belgium had in the 1500s, which included many of the most influential minds of the time, such as Mercator, Andreas Vesalius, Rembert Dodoens, and Simon Stevin.

B.6 Other robustness checks

Table B2 confirms that the baseline results of table 1 hold after choosing alternative measurements of scientific and intellectual decline, different specification for spatially autocorrelated errors, and different weighting. The reference baseline estimate considered here is column 9 of table 1, now replicated in column 1 of table B2. Column 2 confirms statistical significance with autocorrelated standard errors within 50 km instead of 250 km. Columns 3–4 confirm similar results after weighting observations by a city's number biographies of famous people (more biographies mean better measurement of the dependent variable), again using both a 250-km and a 50-km radio to estimate spatial-autocorrelation-robust standard errors. (An alternative weighting by population would produce very similar results.) Column 5–10 then compare the results using alternative dependent variables: first, columns 5–6 confirm the decline associated with the Counter-Reformation using "intellectuals" (as defined in section D.1.2) instead of scientists; columns 7–8 then confirm the decline in terms of "researchers," i.e. as individuals tagged within the category "science and discovery" in Laouenan et al. (2022); and columns 9–10 confirm scientific decline after scaling the number of scientists not by urban population but instead by a city's number of biographies of notable people. The only qualitative difference with respect to table 1 corresponds to the loss of significance of the fully-Calvinist coefficient in columns 9–10: now already a Calvinist majority is associated with scientific decline, but Calvinism appears less detrimental overall. Overall, the main results of scientific and intellectual decline associated both with the Counter-Reformation and its intensity are robust throughout the specifications.

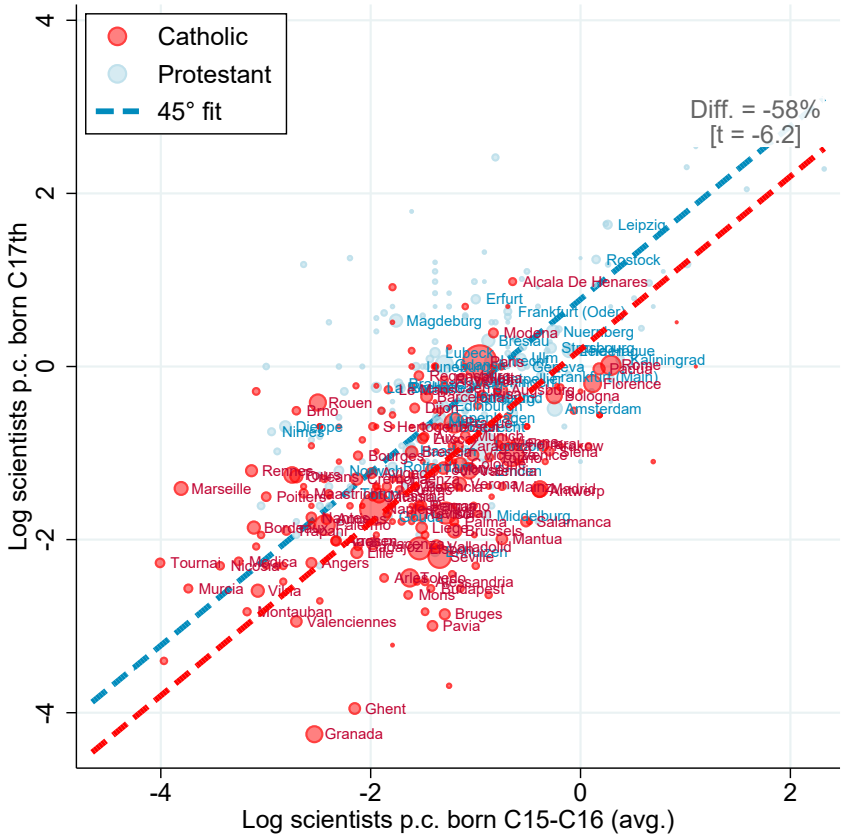
Do these negative associations also hold without controls? Yes. Figures B9, B10a, and B10b confirm a raw negative association of Catholicism with the growth of scientists per capita across Europe and within regions. And figure B11 confirms a raw negative association of the presence of Inquisitorial tribunals with the growth of scientists across both Catholic cities and Italian cities.

Table B2: Variants of column 9 of table 1

	Dependent variable: Change in from 16th to 17th century of ...									
	...scientists per capita				...intellectuals per capita		...researchers p.c. (Laouenan et al., 2022)		...scientists per biography	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Counter-Ref. proxy										
Catholic by 1650 = 1	-0.37***	-0.37***	-0.55***	-0.55***	-0.62***	-0.62***	-0.77***	-0.77***	-0.31***	-0.31***
	(0.14)	(0.10)	(0.13)	(0.12)	(0.14)	(0.11)	(0.17)	(0.12)	(0.08)	(0.11)
Spanish by 1600 = 1	-0.47***	-0.47***	-0.63***	-0.63***	-0.51***	-0.51***	-0.58**	-0.58***	-0.34***	-0.34**
	(0.13)	(0.12)	(0.13)	(0.15)	(0.14)	(0.14)	(0.23)	(0.17)	(0.11)	(0.15)
Inquisit. tribunal = 1	-0.40***	-0.40***	-0.43**	-0.43***	-0.32**	-0.32***	-0.49**	-0.49***	-0.29***	-0.29***
	(0.14)	(0.11)	(0.18)	(0.12)	(0.15)	(0.12)	(0.23)	(0.17)	(0.11)	(0.10)
Counter-Ref. interactions										
Catho. × University 1600	-0.58***	-0.58***	-0.43**	-0.43**	-0.31**	-0.31	-0.34*	-0.34	-0.31***	-0.31**
	(0.12)	(0.15)	(0.18)	(0.20)	(0.14)	(0.19)	(0.20)	(0.24)	(0.07)	(0.13)
Catho. × New Uni. C17th	-0.91***	-0.91***	-1.03***	-1.03***	-0.87***	-0.87***	-0.91**	-0.91***	-0.71***	-0.71***
	(0.21)	(0.20)	(0.34)	(0.28)	(0.28)	(0.26)	(0.41)	(0.32)	(0.19)	(0.21)
Controls										
University in 1700	0.65***	0.65***	0.64***	0.64***	0.57***	0.57***	0.48***	0.48**	0.37***	0.37***
	(0.13)	(0.14)	(0.18)	(0.19)	(0.13)	(0.17)	(0.18)	(0.21)	(0.07)	(0.09)
Calvinist presence (> 1%)	0.06	0.06	0.05	0.05	-0.05	-0.05	-0.01	-0.01	0.13**	0.13*
	(0.09)	(0.08)	(0.07)	(0.09)	(0.10)	(0.08)	(0.11)	(0.09)	(0.05)	(0.07)
Calvinist majority	0.03	0.03	-0.17	-0.17	-0.10	-0.10	0.02	0.02	-0.20***	-0.20**
	(0.16)	(0.15)	(0.21)	(0.18)	(0.22)	(0.18)	(0.28)	(0.21)	(0.05)	(0.10)
Fully Calvinist (> 80%)	-0.29**	-0.29*	-0.44***	-0.44**	-0.44***	-0.44***	-0.32***	-0.32**	0.08	0.08
	(0.12)	(0.16)	(0.10)	(0.18)	(0.12)	(0.15)	(0.11)	(0.15)	(0.30)	(0.30)
Dist. to Atlantic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dist. to Mediterranean	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Initial researchers p.c.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Printing volume (pre 1500)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pop. growth 1600–1700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pop. growth 1500–1700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Parliament meetings C17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Loc. particip. govt. C17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ethno-linguistic FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fluv. catchment region FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Standard errors within	250 km	50 km	250 km	50 km	250 km	50 km	250 km	50 km	250 km	50 km
Biography weighted	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	563	563	560	560	732	732	535	535	559	559
R-squared	0.52	0.52	0.68	0.68	0.64	0.64	0.64	0.64	0.47	0.47

Notes: The table presents robustness checks of the baseline estimates of scientific decline. Column 1 replicates the baseline results, i.e. column 9 of table 1. Column 2 confirms statistical significance with autocorrelated standard errors within 50 km instead of 250 km. Columns 3–4 confirm similar results after weighting observations by a city's number biographies of famous people. Columns 5–6 confirm the decline measured by intellectuals instead of scientists. Columns 7–8 confirm the decline measured by "researchers," i.e. as individuals tagged within the category "science and discovery" in Laouenan et al. (2022). Columns 9–10 confirm the decline after scaling the number of scientists not by urban population but instead by a city's number of biographies of notable people. Spatial-autocorrelation-adjusted standard errors in parentheses, based on the procedure of Colella et al. (2019). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

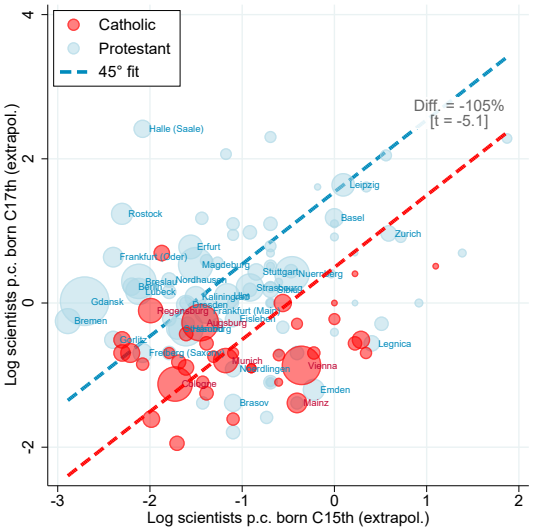
Figure B9: 17th-century scientific decline in Counter-Reformation cities



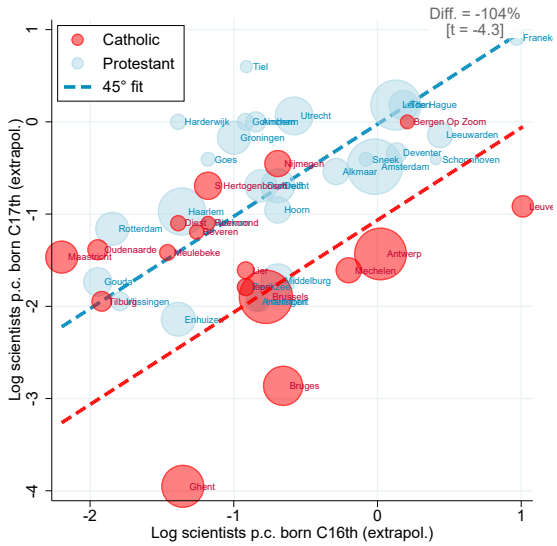
Notes: Dot size represents population in 1600. The number of scientists is based on Wikidata and population is based on Bairoch, Batou, and Chevre (1988) (see section 3).

Figure B10: Religion and science in the 17th century within multiconfessional regions

(a) German cities



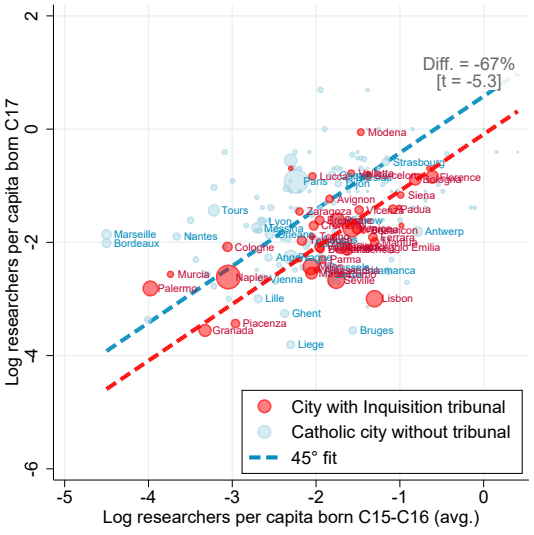
(b) Low Countries



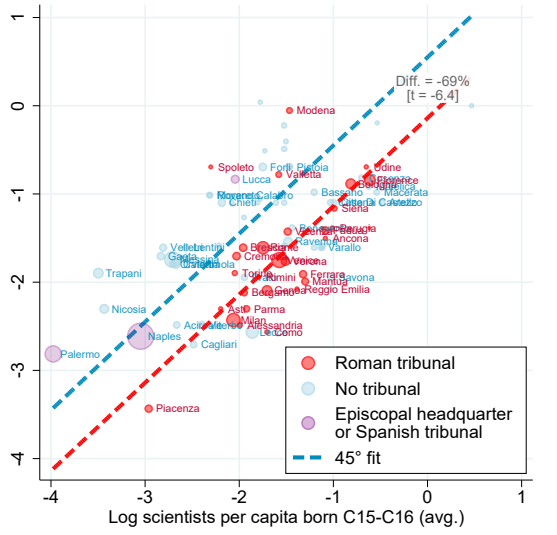
Notes: Compared to Protestant cities, Catholic ones saw a decline of scientists per capita in multiconfessional regions. The 45° fit is the population-weighted OLS estimate of the log-difference with respect to a constant and a dummy indicating Catholicism (weighted by population in 1600). Dot size represents population in 1600. The number of scientists is based on Wikidata, see section 3.

Figure B11: Science fell more next to inquisitorial tribunals (intra-Catholic sample)

(a) Catholic cities



(b) Italian cities



Notes: Tribunal locations are based on Bethencourt (2009). The 45° fit is the OLS estimate of the log-difference with respect to a constant and a dummy indicating a tribunal in the city. Naples and Lucca are considered as having a tribunal, although they were not tribunals but headquarters of the Episcopal Inquisition. Dot size represents population in 1600. The number of scientists is based on Wikidata, see section 3.

Appendix C The Counter-Reformation revived: some case studies, 1700–1990

C.1 Example: Spanish Inquisition revived

Although not definitively abolished until 1834, the Spanish Inquisition went through a long period of decline after the mid-17 century and descended into virtual inactivity during most of the 18th century (Bethencourt, 2009, Kamen, 2014, Drelichman, Vidal-Robert, and Voth, 2021).[101] With the extinction of the last Habsburg ruler in 1700 and the takeover by the more modern-minded French Bourbon dynasty, 18th-century Spain witnessed profound changes in the spirit of the Enlightenment—including the weakening of the clergy and of the Inquisition.[102] However, even though the Bourbons reduced the power of an already moribund Inquisition, they "kept the institution in reserve" because "it might come in useful" (Pérez, 2005, p. 212). Indeed, useful it came in with the outbreak of the French Revolution in 1789. In an episode known as the "Floridablanca panic," the regime immediately revived the Inquisition's power to establish social control and isolate Spain from revolutionary ideas—probably triggering the decline of scientist observed in figure 8.[103] Not satisfied with the efficiency of censorship, in 1804 the regime called "attention to the laws of 1554, 1558, 1627 and 1752, the strict observance of which was emphatically enjoined" (Lea, 1890, p. 168). These events highlight how dormant laws and institutions—originally designed during the Counter-Reformation in order to isolate society from external ideas—were revived centuries later.

If the conservative backlash generated by the French revolution was strong, the one generated by Napoleon's military occupation of Spain between 1808 and 1814 seems even greater.[104] The Spanish resistance was dominated by "deeply conservative landowners and clergy who were supported by an equally conservative peasantry [who] had disliked the Bourbon reforms and were almost wholly untouched by the ideas of the Enlightenment" (Maltby, 2009, p. 171). Spanish liberals, although important among the elites, saw their influence virtually nullified from 1790 to 1833. A new attempt to abolish the Inquisition in 1812 (now by the *cortes* of Cádiz) was overruled the following year by the restored monarchy, positioning conservatives and censorship back on power.[105] Liberals shortly regained power by force in 1820–23 and again abolished the Inquisition, but France—

[101] In a recent paper, Drelichman, Vidal-Robert, and Voth (2021) estimate that trials per year were at their peak during 1550–1600 (coinciding with the initiation of the Counter-Reformation) but fell abruptly during 1600-1650 and continued a secular decline during 1650–1800 (see their appendix figures A1 and A2). Own calculations based on trial activity reported by Vidal-Robert (2013) show that if we exclude trials to Jews, Muslims, and Protestants—that is trials against Catholics suspect of heresy, i.e. the kind of trials that may harm science—the yearly rate of trials was halved from 1570–1620 to 1621–1700 and further fell to one third of the latter during 1700–1808. "During its last century"—writes Kamen (2014, p. 223)—"the Inquisition emerged out of virtual inactivity in only one famous political case."

[102] "The Bourbon kings demonstrated exemplary piety at all times but wanted greater control over ecclesiastical appointments, the universities, and the Inquisition. ... The Concordat of 1753, negotiated between the ministers of Ferdinand VI and the papacy, enlarged the crown's control over ecclesiastical appointments and ended certain clerical exemptions from taxation [and] greatly strengthened royal authority over the church." (Maltby, 2009, p. 158). The expulsion of the Jesuits in 1767 provided a further blow to clerical power.

[103] The so-called "Floridablanca panic" is described by Calvo Maturana (2014) as "the radicalization of civil and inquisitorial censorship carried out by the minister Floridablanca to avoid the spread of the French Revolution." See Calvo Maturana (2014) and Lea (1890, pp. 168–73).

[104] A contemporary French lieutenant deployed in Spain tells us how Napoleon's abolition of the religious orders and of the Inquisition backfired: "[It] only augmented the violent hatred ... by the clergy and its numerous followers. The monks of all orders, who had been turned out of the convents, dispersed themselves through the country and preached against us wherever they went" (de Rocca, 1815, p. 81). The result: an insurmountable "religious crusade against the French" (p. 91). de Rocca also emphasizes the contrast to Prussia, where he had previously served: "The clergy in Prussia had but little ascendancy over the people; the Reformation had destroyed, among the protestants, that power which the priests preserve, even in our day, in some catholic countries; and especially in Spain" de Rocca (1815, p. 5).

[105] Israel (2019) pp. 712–13: "Follow-up measures included cancelling press freedom and the education reforms, releasing the church, by decree of 24 June 1814, from all contributions imposed by the Cortes, and reinstating the Jesuit order in

now a member of the monarchist powers fighting against liberalism—intervened militarily to restore the Spanish monarchy. This restored regime issued in 1824 what Henry Charles Lea describes as a "proclamation which was a worthy echo of the law of 1558, showing that the spirit of the sixteenth century was dominant." One can hardly disagree:

> All books, pamphlets, papers or prints, issued or imported between [1820 and 1823], of whatever nature, and also everything prohibited by the Church or the Inquisition, of whatever date, were to be delivered by their owners to their parish priests within thirty days. ... [B]ooksellers were required every six months to submit ... an inventory of all foreign books in stock, and the president of the Council, the regents of the Chancellerías and Audiencias, and the bishops in their diocese, were authorized, personally or through deputies, to examine and register all libraries, public and private. (Lea, 1890, p. 179)

Another similar law came in 1830, now reestablishing the death penalty and extending the censoring apparatus. "The press," so Israel (2019, p. 713), was "decimated to a degree unparalleled in Europe." But the king dies in 1833 and liberals take over again. They proclaimed the definitive abolition of the Inquisition and established freedom of the press, inaugurating a decades-long period of liberal rule.

In short, Spain went through a process of enlightenment and embryonic liberalism from 1700 to 1790, through an unstable but overwhelmingly conservative period from 1790 to 1833, and through liberal rule after 1834.[106] The correlation between this back and forth from liberalism to conservatism and the growth of Spanish scientists reported in figure 8 is striking: science grows under liberal-secularizing rule and falls during conservative-clerical rule.

In order to explore whether city-level evidence supports the interpretation of reactive conservatism—and the revival of the Inquisition in particular—playing a role in the Spanish scientific decline of 1790–1833, column 1 of table C1 shows the results of the city-year panel regression

$$\begin{aligned}\text{Log intellectuals per capita}_{c,t} = \beta_0 + t \times (&\beta_1 + \beta_2 \times \text{Revived Inquisition}_t \\ &+ \beta_3 \times \text{Revived Inquisition}_t \times \text{Inq. tribunal}_c \\ &+ \beta_4 \times \text{Inq. tribunal}_c) + \text{controls}, \end{aligned} \tag{6}$$

where c stands for a city and t stands for a year, with $1650 \leq t \leq 1850$. Whether the tribunal-dummy here stands for the location of renewed censorship itself or, more generally, for the location of ingrained support for conservatism (resulting from the historical presence of the institution) stands open. Independently of the exact interpretation, we expect that a revived Inquisition (or revived conservatism) reduced intellectual growth in all Spanish cities ($\beta_2 < 0$); that cities hosting a inquisitorial tribunal will be those more affected by the revival ($\beta_3 < 0$); and that cities where the presence of a tribunal artificially depressed science during the Counter-Reformation should be cities experienced particularly rapid intellectual growth in the periods *without* inquisitorial activity ($\beta_4 > 0$), reflecting a process of catching up to their "natural level" (one given by population size, research institutions, geographical connectivity, etc.). All these expected signs are confirmed in column 1

Spain and its empire as a bulwark of Counter-Revolution. Exalting the resumed alliance of throne and altar, Fernando ordered restitution of all the seized properties of Spain's monasteries and convents. ... [O]n 21 July 1814, Fernando proclaimed the end of private freedom of conscience and restoration of Spain's Inquisition tribunals with all powers intact."

[106] Enlightenment and liberalism have so much in common that they may be regarded as the same current in different time periods. As pointed by Israel (2019, p. 20), "'liberalism' as a distinctive label customarily applied by historians to the early nineteenth century becomes a somewhat superfluous term for the Enlightenment's late phase, a powerful continuing tendency operative at a time when 'nationalism' and socialism, still relatively weak, were not yet major ideological rivals."

Table C1: Counter-Reformation revived: reactions to the French Revolution

	Dep. var.: city's intellectuals p.c. aged 20-60 (logs)			
	Spanish Empire in 1600		Rest of Europe	
	(1) Spain	(2) Dependency (Europe)	(3) Catholic	(4) Not Catholic
Time trend ×				
Post-revolutionary conservatism (1790–1830)				
× All cities	-1.0e-04***	-6.0e-05**	-3.7e-05**	4.6e-05***
	(3.3e-05)	(2.6e-05)	(1.5e-05)	(1.1e-05)
× City with inquisitorial tribunal	-.0997***	-.0802***	-.09***	
	(.0213)	(.0183)	(.0127)	
Otherwise (1650–1790, 1830–1850)				
× City with inquisitorial tribunal	.0026***	.0063***	9.2e-04***	
	(2.2e-04)	(1.7e-04)	(1.3e-04)	
Controls				
Trend × University suppressed during 1790–1820$_{i,t}$	✓	✓	✓	-
Trend × Jesuits suppressed$_{i,t}$	✓	✓	✓	-
Trend × Jesuits suppr.$_{i,t}$ × inquisi. tribunal	✓	✓	✓	-
Country trend	✓	✓	✓	✓
City FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	12164	19210	68185	82767

Notes: These city-year panel estimates of equation (6) show how the pan-European conservative reaction to the French Revolution generated the strongest intellectual decline where the Counter-Reformation had been more intense: in Catholic cities and more so within former Spanish domains and in Spain itself, especially if the city once hosted a tribunal of the Inquisitions. Furthermore, before and after the conservative backlash of 1790-1830, cities that once had an Inquisitorial tribunal (the Inquisition was inactive during these years) had particularly rapid intellectual growth, suggesting that they were recovering from the effects of the Inquisitions. Meanwhile, non-Catholic cities experience no significant intellectual decline after the revolution. The results suggest that vestiges of the Counter-Reformation depressed science when they interacted with conservative rule. Locations of inquisitorial tribunals are from Bethencourt (2009); suppression of universities during 1790-1820 as in Frijhoff (1996, pp. 81–9) and Israel (2019, pp. 627–8); dates of Jesuit suppression are from Roehner (1997), assuming that, besides suppressions by the states, all catholic cities were subject to the suppression by the papacy between 1773–1814, except for Bohemia and territories controlled by Prussia (up to 1776) and Russia (Shore, 2020); urban population and numbers of intellectuals as described in the data appendix. Regression are population-weighted. Standard errors in parenthesis. Significance levels denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

at statistically significant levels.

To be sure, historians cognizant of the intellectual declined suffered by Spain at the time have mentioned alternative explanatory factors besides the revival of the Inquisition: specifically, the disruptions generated by the French occupation (including the closure of several universities) and the temporary expulsion of the Jesuits (1759–1814).[107] Yet neither factor seems particularly relevant. The suppression of the Jesuits and its interaction

[107] A further one is schooling. Viñao (1998) has shown that school attendance in Spain fell from 23% in 1797 to 15,2% in 1822—due, he writes, to a "period of political, economic, cultural, and educational crisis" that was "initiated in 1808" with the French invasion. The author shows that school attendance recovered to 25% in 1830 and then rose again to 34% and 40% in 1846 and 1855 respectively—a pattern that resembles the observed evolution of scientists in figure 8. That said, the role of education explaining science overall is poor in early modern times. During the Counter-Reformation, for

with tribunals are controlled for in the regressions. And universities suppressed by Napoleon are controlled for in interaction with the trend-decline of 1790–1830. More generally, it seems that neither French occupation nor wars or military occupations in general are associated with intellectual declines in other countries (recall Austria and Belgium shown in figure 8). Furthermore, the remaining regressions of table C1—to be discussed in the next section—confirm similar results outside Spain.

C.2 Compared reactions to the French Revolution

A conservative reaction to the French Revolution and to Napoleonic occupation was not unique to Spain—the backlash was *European-wide*. Fearing that French-like reforms would not only eradicate the established privileges of clergy and nobility, but also bring chaos and violence—back then seen as the outcome of the Enlightenment's disrespect for authority, religion, and tradition—all of Europe saw "a revivified and strengthened Counter-Enlightenment movement both Catholic and Protestant (and in eastern Europe, Jewish) resolutely and aggressively opposing Enlightenment core concepts and values on the basis of faith, political loyalism, and tradition" (Israel, 2019, p. 22).[108] The timing of this reaction, which largely manifested itself though censorship and intellectual repression, is captured by Austrian censorship intensity of figure C1: reactive censorship explodes during the Revolution itself (1789-99), is interrupted during the period of Napoleon's occupation, but resumes bewteen the Congress of Vienna (1815) and the liberal revolts of the 1830s—a period often referred to as the "conservative world order."[109] During this international political arrangement, the great monarchies of Europe—Britain, Russia, Prussia, Austria, and France—colluded to prevent further revolutions across the Continent and jointly supported "a new kind of interdenominational Protestant–Catholic–Orthodox social reactionary religious 'orthodoxy' that was assuredly emphatic in exalting throne, altar, and divinely sanctioned government" (Israel, 2019, p. 772). In other words, the historical differences between aristocracy and clergy, as well as those between rival kingdoms and religions, were strategically put aside in order to jointly restore the time-proven formula of religious legitimization—the "divine right of kings"—on which established power rested and that seemed so jeopardized by the ideas of the French Revolution.

How did this common shock—the rise of conservatism triggered by fears of a French-like revolution—interact with the local (pre-Enlightenment) traditions that conservatism tried to revive? We saw that Spain revived the Inquisition and censorship laws dating back to the Counter-Reformation. Similarly, "in Austria, Leopold II (1747–1792) issued a press decree in 1791, which explicitly cited the relevant provisions of the decrees of the imperial diets from the 16th century" (Wilke, 2013). Are such revivals systematic? Did territories once subject to the Counter-Reformation revive elements of it, possibly affecting intellectual activity?[110] This hypothesis

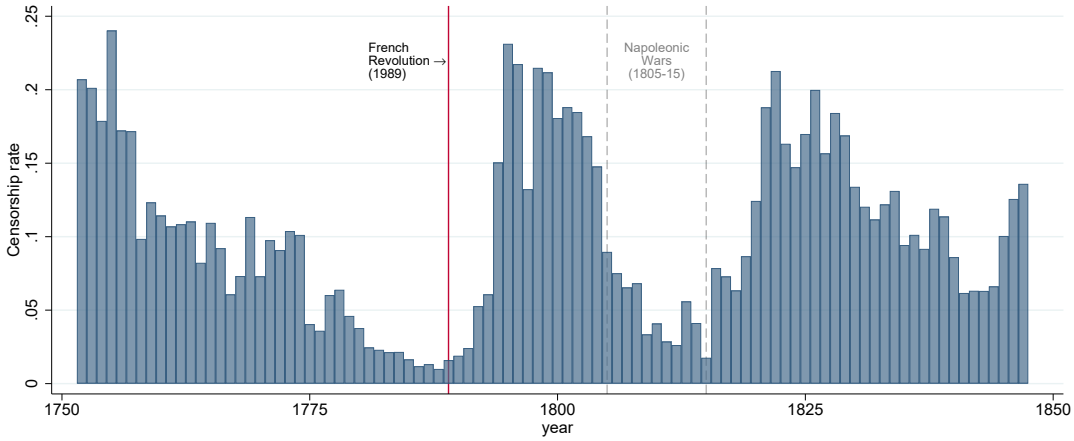
example, Spanish science fell despite levels of literacy and higher education remaining high, at par with those in England and France.

[108] The works of Edmund Burke in Britain ("Reflections on the Revolution in France," 1790) and Joseph de Maistre in France ("Considerations on France", 1797)—largely regarded as the founding intellectual fathers of European conservatism—reflect the widespread sentiment of dissatisfaction with the ideas of the Enlightenment. For similar intellectual reactions in Germany and Austria, see Epstein (2015). For Britain, see Bernstein (1945). For an international comparison, see Israel (2019).

[109] For a summary of the historiographic consensus, see the section "The conservative reaction" in Britannica's "History of Europe." For a detailed treatment see Israel (2019) and Epstein (2015).

[110] Conservatism, simply defined as the "political doctrine that emphasizes the value of traditional institutions and practices" (Britannica), will naturally vary from place to place depending on the local traditions. In Germany, for example, "the Reactionaries of the period of the French Revolution glorified the *ancien régime* or, going back farther, the medieval *Standestaat*" (Epstein, 2015, p. 10). It Italy, by analogy, reactionaries would seek to reestablish the Catholic order that had reigned during the long years of the Counter-Reformation. There the conservative backlash came largely in form of religiously-motivated peasant uprisings. One was the *Armata della Santa Fede* ("Army of the Holy Faith"), which destroyed the French-backed Parthenopean Republic of Southern Italy in 1799. Another was the *Viva Maria* ("Long Live the Virgin Mary") uprising, which reestablished Tuscany's old aristocratic and clerical order that same year. It seems that in Italy, much like in Spain, centuries of effective Counter-Reformation had permeated society with

Figure C1: Austrian censorship revived after the French Revolution



Notes: The figure shows that censorship in Austria was revived in reaction to the French Revolution (with an interruption during Napoleonic occupation). The censorship rate is computed as the number of prohibited titles (Bachleitner, 2022) divided by the approximate universe of books (proxied by the number of titles in the yearly Leipzig Fare; Schwetschke, 1850; Schwetschke, 1877).

is tested in columns 2 to 4 of table C1 through panel estimates analogous to the previous specification (6). Different now are the geographical samples and the interpretation of the inquisition dummy: tribunals were not officially revived outside Spain (few exceptions aside), so that the dummy indicates rather a legacy in form of, for example, the tradition-rooted power of the clergy or similar historically-grounded logistic capabilities. The estimates of column 2 are restricted to formerly Spanish-controlled cities (roughly southern Italy, Belgium, and Portugal). Those in column 3 are restricted to other Catholic cities, and those in column 4 are restricted to non-Catholic cities. Controls are country-specific trends, city and time fixed effects, a time-trend interaction with the city-level suppression of universities after 1790, and the time of suppression of the Jesuit order in different countries (also in form of interaction with inquisitorial tribunals), given that Jesuits were "men of letters" and that, like in Spain, the suppressions partly overlap with the 1790–1830 dummy.[111]

Like in the case of Spain, columns 2 and 3 show that post-revolutionary conservatism of 1790–1830 is associated with lower intellectual growth in Catholic cities across Europe ($\beta_2 < 0$). This decline was largest in Spain itself, followed by cities in former Spanish dependencies, but only insignificant in the remaining Catholic cities. Moreover, the decline was particularly pronounced in cities that once hosted an inquisitorial tribunal ($\beta_3 < 0$). However, and consistently with the proposed hypothesis, intellectual growth was higher in these cities with tribunals during the secularizing and liberalizing periods of 1650–1790 and 1830–1850 ($\beta_4 > 0$). Meanwhile, in non-Catholic cities (column 4), intellectual growth was even faster during the conservative, post-revolutionary period 1790–1830. Overall, the estimates support the hypothesis that a stronger Counter-Reformation legacy, proxied by formerly being part of to Spanish Empire or by formerly hosting of an inquisitorial tribunal, is associated with *less* intellectual growth during the conservative revival of 1790–1830; but also with *more* intellectual

ingrained fidelity to religiously-legitimized rule (especially among lower classes, which were largely out of touch with the Enlightenment), giving "throne and altar"-conservatism a powerful base of popular support. By contrast, other places *also subject* to what Israel (2019, p. 773) calls "[h]ardcore repressive and reactionary monarchies"—e.g. post-1817 Prussia—may have *not* enjoyed the same level of effectiveness in repression given their different traditions, especially with regard to religious legitimization of political centralization (a defining characteristic of the Spanish Empire) and acceptance of repressive institutions (as in cities once hosting tribunals of the inquisitions).

[111] See Feingold (2003b) on the cultural sophistication of the Jesuits. In 1774 the enlightened Prussian king Frederick the Great wrote:"I view [the Jesuits] only as men of letters, whose place in the instruction of youth it would be difficult, if not impossible to supply" (Shore, 2020, p. 24).

growth when the inquisitorial activity was relaxed or nonexistent.

C.3 Example: Europe's reaction to the Bolshevik Revolution

Just like the French Revolution panicked Europe's established political and religious power, triggering an international wave of reactionary conservatism, so did the Bolshevik Revolution of 1917. And once more—as I will show in this section—scientific activity declined asymmetrically, depending on a country's Counter-Reformation past

In Eastern Europe, the Bolshevik Revolution of 1917 paved the way for future Soviet-oriented states. In the West, by contrast, it triggered a wave of fiercely anti-communist dictatorships: Mussolini in Italy (1922–1943), Primo de Rivera and Franco in Spain (1923-30, 1939-74), Smetona in Lithuania (1926–1940), the *Ditadura Nacional* and Salazar in Portugal (1926–1974), Dollfuss, Schuschnigg, and Hitler in Austria and Germany (1933–1945), Metaxas and Papadopoulos in Greece (1936–41, 1967–73) and many others, including the multiple Nazi-collaborationist regimes in France, Belgium, the Netherlands, Denmark, Norway, Slovakia, Ukraine, and elsewhere, which were supported by local constituencies of anti-communist collaborators.

Did the threat of Bolshevism really *cause* these dictatorships? This interpretation sparked some degree of controversy during Germany's *Historikerstreit* (a historians' debate of the 1980s), where it came to be associated with the polemic views of Nolte (1966). However, more recent scholars tend to agree on a strong causal effect. In their study of Italian Fascism, Acemoglu et al. (2022) find that, across municipalities, the "red scare" triggered a "powerful fascist response." From an international perspective, it is said that "[t]he threat from the left"—as Morgan (2002) calls it—"was both the reason and opportunity for the emergence of fascist movements" (Morgan, 2002, p. 11). For one, these regimes were explicitly anti-communist, were supported by different anti-communist segments of society, and consistently repressed left-wing movements.

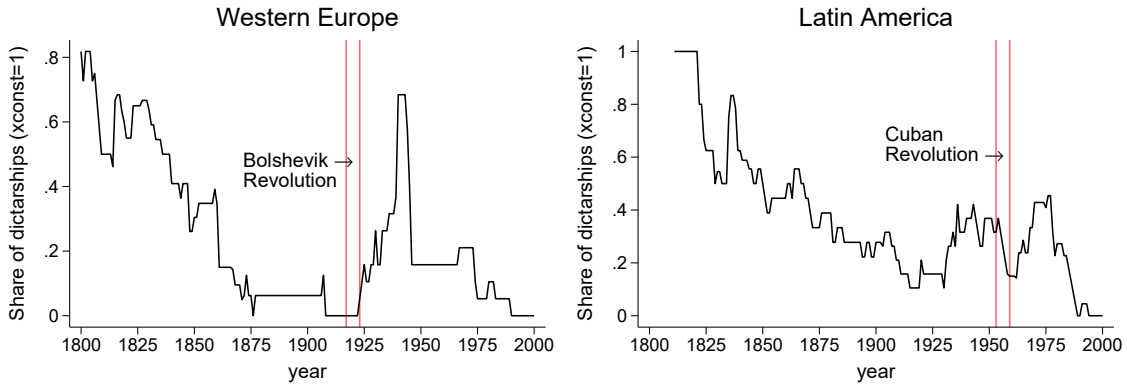
The responsive nature is also supported by the timing. As shown in the left-hand-side plots of figure C2, the Bolshevik Revolution marks a clear, 180-degree turning point in the democratization trend of Western Europe, either measured as the share of dictatorships (xconst = 1, using the polity database; upper panel) or as the degree of unconstrained executive power (7 - xconst; lower panel). Prior to the red scare, Europe had been in a consistent trend towards democratization.[112] But this trend was abruptly interrupted after the Bolshevik Revolution and especially after Lennin's founding of the (Third) Communist International in 1919, which was aimed to spread the communist revolution worldwide. Notice that, according to these figures, the revival of authoritarianism lasts until the mid 1970s—a date that we will use later, in our quantitative exercise.

Further support for this causal interpretation comes from Latin America and the way in which the democratization trend was interrupted there—in reaction to an additional, local shock: the Cuban Revolution of 1953–1959. As shown in the right-had side of figure C2, the Latin American trend towards increasing democratization first mirrored that of Europe and was also followed, after the Bolshevik Revolution, by increased authoritarianism from 1920 to 1940. But later, when the Latin American republics seemed on the way of recovering their democratization path during the 1940s and 1950s, the recovery was abruptly interrupted again (yet more vigorously) by the shocking news of the Cuban Revolution. The swift emergence of anti-communist dictators in response to this regional shock reinforces our interpretation of what happened in Europe before.

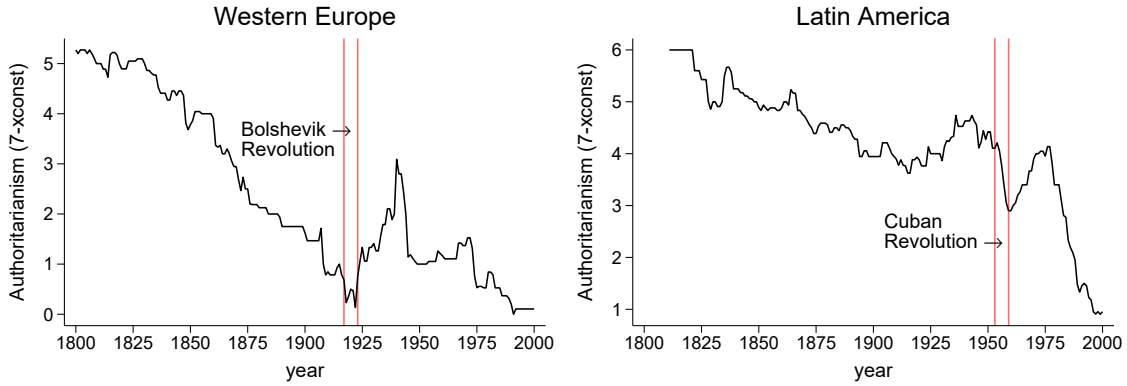
[112] This trend was characterized by a shift towards left-wing politics. During the early 20th century, "mass electoral politics allowed socialist parties to make significant political gains, and across Western and Northern Europe, from Norway to Spain, socialist parties entered government for the first time" (Morgan, 2002, p. 10). Yet, in the 1930s, parliamentary democracies "had largely disappeared in Southern, Central and Eastern Europe, giving way to fascist dictatorships in Italy and Germany, authoritarian rule in Portugal, Spain, Austria, Yugoslavia, Bulgaria, Romania, Lithuania, Latvia and Estonia, and to limited democratic systems in Hungary, Poland and Greece." And by 1942, at the zenith of fascist military expansion, "only Britain, Ireland, Iceland, Sweden, Switzerland and Finland were democracies" (Morgan, 2002, p. 8).

Figure C2: Triggered authoritarianism

a) Share of dictatorships



b) Average executive power



Notes: The figure illustrates the rise of anti-communist authoritarianism as a reaction to the Bolshevik and Cuban revolutions. The indexes in both (a) and (b) are averages across non-communist sates. *Source*: Polity 5 data version 2018.

For all these reasons, from Mussolini to Franco, the period 1920–1975 in Europe can be seen as the right-wing reaction to the leftists revolutionary threat stemming from Bolshevism, just like the period 1790–1830 was a reaction to the revolutionary threat stemming from French revolutionary ideals.[113]

How far did these dictatorships revive old practices, in analogy to how conservative regimes did it after the French Revolution? That censorship was revived during these dictatorships is obvious enough and does

[113]It is hard to overlook the many parallels between the reactions to the revolutions of 1789 and 1917 (and before that, the Catholic reaction to the Protestant "revolution"). An important one is the ideological and intellectual nature of the enemy. After the French Revolution, the enemy was a set of ideologies—democracy, liberalism, anti-clericalism, egalitarianism—produced by the intellectuals of the Enlightenment during the 18th century. After the Bolshevik Revolution, the identified enemy was again a set of dangerous ideologies—communism, socialism, atheism—now derived from 19th-century liberal thought. (Moreover, not only were these ideologies dangerous enough, they were supported by powerful nations as well: France after 1789, especially during Napoleon's rise; and Russia after 1917, especially after the founding of the Third International in 1918 and the establishment of the USSR in 1923. Thus, in both cases, the combination of military and ideological threats made intellectual repression particularly appealing to the establishment.) Another parallel is given by the threatened groups, composed again by the ruling elites, conservatives, and the clergy, all aligned with whatever movement fought with them against their common enemies. Yet another parallel is the response: much like the response to the French Revolution, the one to the Bolshevik Revolution was characterized by *revived* elements of the *ancien régime*: authoritarianism, censorship, and religious legitimization, regardless of the denomination (Catholic, Protestant, and Orthodox; see Feldman, Turda, and Georgescu, 2013).

not need further elaboration. What is more noteworthy is how the ancient formula of *religious legitimization*, long eroded by the 18th-century Enlightenment and 19th-century liberal democracy, was revived as well. This revival came about as a marriage of convenience. The clergy and the faithful, on their side, found in right-wing autocrats the powerful ally needed in order to defend faith not only against communism but, more generally, against the democratic, liberal, and secular world order that produced communism and other forms of "social decay" in the first place (Pollard, 2007, pp. 434–436; Griffin, 2008, pp. 8–12). Right-wing dictators, on the other side, if not particularly pious, tactically exploited the alliance with the Churches in order to gain popular support in a time preceding mass secularization. For example, Mussolini—the model dictator for subsequent right-wing autocrats—tactically endorsed Catholicism (despite his initial socialist and anti-clerical stance) and eventually was strongly supported by the pope, who saw him as "the Man sent by providence" to prevent the socialist takeover of Italy (Kertzer, 2015). Similar alliances emerged throughout most of Europe, regardless of the religious denomination, from Iberia to the Balkans and to Scandinavia.[114]

Did renewed religious legitimization produce effects on science that were again specific to countries once subject to the Counter-Reformation? This question is studied using a country-year panel in table C2. Column 1 estimates following equation,

$$\begin{aligned}\text{Log scientists per capita}_{i,t} = \; & \gamma \cdot \text{Log scientists per capita}_{i,t-5} + \text{ country-specific time polynomial} \\ & + \text{time FE} + \text{country FE} \\ & + \phi_{\textbf{French}} \cdot 1_{[1790,1830)}(t) \cdot 1_{\text{Spanish Empire 1600}}(i) \\ & + \phi_{\textbf{Bolshevik}} \cdot 1_{[1920,1975)}(t) \cdot 1_{\text{Spanish Empire 1600}}(i) \\ & + \text{other controls}, \end{aligned} \tag{7}$$

where the indicator function of the Spanish Empire by 1600 includes Spain, Portugal, Belgium, Luxembourg, and Italy.[115] The coefficients of interest are $\phi_{\textbf{French}}$ and $\phi_{\textbf{Bolshevik}}$, which capture how science reacted differently to the revolutions depending on a country's Counter-Reformation past (proxied by the imperial dummy) after controlling for time-dependency, a country-specific nonlinear trend, and for common time effects.[116] The coefficient $\phi_{\textbf{French}}$ is negative and significant, confirming our previous city-level results pointing at the particularly large drag on science within former Spanish-controlled territory. A similar negative and significant result is obtained for $\phi_{\textbf{Bolshevik}}$, telling us that former Spanish domains tended to show a relative scientific decline during the post-Bolshevik authoritarian backlash as well. Columns 2 to 8 confirm the results after changing the lag structure, controlling for Catholicism, or using intellectuals instead of scientists. Overall, these results support the interpretation that cultural or institutional vestiges rooted in the Counter-Reformation, which was much stronger within the Spanish Empire, affected science negatively when revived under conservative rule.

[114] In Austria, fascism first took the form of the ultra-Catholic Fatherland Front of Dollfuss and Schuschnigg from 1934 to 1938, before the Austrian Catholics Church issued a public statement endorsing the faithful to join Hitler's Third Reich, which had so forcefully averted the "danger of atheistic, destructive Bolshevism" (Kertzer, 2015, p. cxvi). Meanwhile, in Germany, the influential theologian Paul Althaus proclaimed that "[German] Protestant churches have greeted the turning point of 1933"—Hitler's seizure of power—"as a gift and miracle of God" (Ericksen, 1985, p. 85). A similar form of Lutheran clerical fascism emerged Finland, with the Lapua Movement in 1929, which lasted until its failed coup d'état in 1932. In Sweden, "fascists perceived the evangelical Nordic Faith to be not only profoundly Christian, but the pure, true and original form of Christianity" (Feldman, Turda, and Georgescu, 2013, p. xvi). Also Christian Orthodox countries developed forms of "clerical fascism" during the interwar period—in Greece, Romania, Croatia, Serbia, and in Ukraine (Feldman, Turda, and Georgescu, 2013).

[115] 67% of the Italian cities included in the Bairoch dataset were part of the Spanish Empire in 1600. And the rest, even if nominally independent, were heavily under Spanish influence either directly or indirectly via the (largely Spanish-controlled) Vatican.

[116] Notice that the non-interactive effects of the dummies $1_{\text{Spanish Empire 1600}}(i)$, $1_{[1790,1830)}(t)$, and $1_{[1920,1975)}(t)$ is already controlled for by perfectly collinear time and country fixed effects.

Table C2: The past interacting with conservative revivals (Europe, 1650-2000)

	Dep. var.: Scientists aged 25-50 p.c.				Dep. var.: Intellectuals aged 25-50 p.c.			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Conservative reactions:								
Post French Revolution (1790-1830)								
× Spanish Empire 1600	-0.05***	-0.06***	-0.04***	-0.04**	-0.04***	-0.04***	-0.02*	-0.01
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
× Catholic			-0.01	-0.02			-0.02	-0.04**
			(0.01)	(0.02)			(0.01)	(0.02)
Post Bolshevik Revolution (1920-1975)								
× Spanish Empire 1600	-0.04***	-0.07***	-0.07***	-0.11***	-0.05***	-0.09***	-0.07***	-0.12***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
× Catholic			0.04***	0.06***			0.04***	0.05***
			(0.01)	(0.01)			(0.01)	(0.01)
Controls								
GDP growth (lags 0 to 10)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. var. (t-5)	Yes	-	Yes	-	Yes	-	Yes	-
Lagged dep. var. (t-10)	-	Yes	-	Yes	-	Yes	-	Yes
Country-specific time polynomial (order 4)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Communism	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7247	7242	7247	7242	7256	7256	7256	7256
R-squared	0.99	0.98	0.99	0.98	0.99	0.98	0.99	0.98

Notes: These country-year panel estimates of equation 7 study two episodes of widespread conservatism across Europe—the conservative reactions to the French Revolution and to mid-20th century Fascism—finding that countries once subject to the Spanish empire suffered an abnormally large reduction of scientists and intellectuals per capita during these episodes. Scientists and intellectuals are in logs and per capita. Italy is coded as part of the Spanish Empire. Observations are country-year. Standard errors in parenthesis. Significance levels denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

How did these vestiges look like in practice? The Spanish case provides again some clear examples. After winning the Spanish Civil War, Franco dissolved Spain's main institution promoting scientific research since 1907, and replaced it by one that "questioned Western science ... and aspired to *return* to traditional Spanish science, the science of the Empire *prior to the Western scientific revolution*" (Canales, 2020, p. 80, my emphasis). "The objective was to undo the damage wrought by Western thinking over (at least) the last three centuries" and to "overcom[e] the clash between faith and reason that had existed since the scientific revolution" (p. 87).[117] Judged by figure 8, the outcome of this policy was not beneficial for science. The density of scientists stagnated during the Franco regime and only began to catch-up to the rest of Europe after his death in 1975.

The desire to counter the "clash between faith and reason" was not unique to Spain; it was advocated by the Vatican too. In 1864 the pope had promulgated the encyclical *Quanta Cura* with an attached *Syllabus Errorum* (Pius IX, 1865), which was aimed at correcting the "errors" of the faithful.[118] Among these errors

[117] Franco dissolved Spain's main institution promoting scientific research since 1907, the Board for Advanced Studies and Scientific Research (JAE, which stands for *Junta para la Apliación de Estudios e Investigaciones Científicas*), and replaced it by the Higher Council for Scientific Research (CSIC, for *Consejo Superior de Investigaciones Científicas*). See Canales (2020, p. 80).

[118] For the official encyclical in Latin and Italian, see https://www.vatican.va/content/pius-ix/it/documents/encyclica-quanta-cura-8-decembris-1864.html.

Table C3: Positions of the Catholic Church since the Counter-Reformation

Ecumenical Council	Important changes
Trent (1545-65)	· Condemnation of Protestantism. · First Roman Index of Prohibited Books. · Flourishing of inquisitorial activity.
Vatican I (1869-70)	· Condemnation of rationalism, liberalism, and materialism. · Papal primacy and infallibility.
Vatican II (1962-65)	· Declaration on Religious Freedom. · Endorsement of democracy (*Pacem in Terris* encyclical). · Abolition of the Index of Prohibited Books (1966).

Notes: Own work based on Bethencourt (2009), Linder (2008), Sigmund (1987); Sigmund (1994), Philpott (2004), and Oftestad (2019).

was the believe that the Vatican could "tolerate the errors of philosophy, leaving to philosophy the care of their correction" (Error XI) and that "the Roman Pontiff can and ought ... reconcile himself to, and agree with progress, liberalism, and civilization as lately introduced" (Error LXXX). In other words, philosophy and progress—science included—were, "as lately introduced," not compatible with faith, and they should not be allowed to develop freely; instead, they should be subjugated to the Catholic dogma. This hard-line position of the Church remained largely unchanged until the Second Vatican Council of 1962-65—a landmark change in the Vatican's position, which for the first time endorsed liberal principles such as democracy and religious freedom (table C3).[119] Until then, the principles of the Catholic church were based on the dogmas and the dogma*tism*—the condemnation of free though—established during the Counter-Reformation. A notorious product of that era, the Index of Prohibited Books, was not abolished until 1966 (Vatican and Congregation for the Doctrine of the faith, 1966)—showing how some 16th-century dogmas and regulations designed to counter Protestantism in the 16th century were still binding in the 20th century, four hundred years later.[120] Parts of Catholic Europe, especially Iberia, carefully followed these dictates.[121]

C.4 Example: Dictators worldwide and the Counter-Reformation legacy

Reactions to the French and Bolshevik revolutions came partly in form of increased authoritarianism. The reader may thus infer that it is only authoritarianism *per se*—say, dictatorships being more likely within former Spanish imperial domains—what explains the differential effects on science. Yet this is not the case. Table C4 studies the interaction of dictatorships with a country's Counter-Reformation past. It finds that the Counter-Reformation (again proxied by the Spanish empire in 1600) is associated with scientific decline *conditional* on authoritarian rule. More specifically, we obtain a statistically significant negative interaction coefficient

[119] See Sigmund (1987), Sigmund (1994), Philpott (2004), and Oftestad (2019).

[120] More precisely, in 1966 the Vatican announced: "the Index remains morally binding[;] But, at the same time, it no longer has the force of ecclesiastical law with the attached censure." See https://www.vatican.va/roman_curia/congregations/cfaith/documents/rc_con_cfaith_doc_19660614_de-indicis-libr-prohib_en.html As late as 1966, the Index included titles of key authors in the history of science, such as Blaise Pascal, Thomas Hobbes, René Descartes, Francis Bacon, Baruch Spinoza, John Locke, Voltaire, Denis Diderot, Jean le Rond d'Alembert, David Hume, Jean-Jacques Rousseau, Immanuel Kant, and John Stuart Mill.

[121] The degree to which the Vatican's view affected Catholic Europe varies across countries. In Portugal, like in Spain, the dictators relied heavily on religious legitimization and endorsed the Vatican's anti-modernist view. In Italy, where the relationship between Mussolini and the pope were complex due to the historical enmity and power struggle between the Italian state and the Vatican, the latter saw its influence increasingly diminished.

$\phi_{\textbf{Dictator}\times\textbf{Counter-Ref.}}$ when estimating panel regressions of the form

$$\begin{aligned}\text{Log scientists per capita}_{i,t} = {} & \text{country-specific time polynomial} + \text{time FE} + \text{country FE} \\ & + \phi_{\textbf{Dictator}} \cdot 1_{\text{Dictatorship}}(i,t) \\ & + \phi_{\textbf{Dictator}\times\textbf{Counter-Ref.}} \cdot 1_{\text{Dictatorship}}(i,t) \cdot 1_{\text{Spanish Empire 1600}}(i) \\ & + \text{other controls}, \end{aligned} \tag{8}$$

using country-level panel data from the year $t = 1870$ to the year $t = 2000$. Columns 1 to 6 in the table restrict the sample to Europe. Column 1 shows that dictatorships have a rather neutral effect on science. Column 2 finds that the effect becomes negative when interacting with Catholicism. Column 3 shows that this negative association is mostly due to countries once forming part of the Spanish Empire (a proxy for the Counter-Reformation). Columns 5 and 6 show that this negative association is robust to adding an autoregressive term and to dropping Communism and GDP growth as controls.

Do we find similar effects in an alternative, non-European sample? This is indeed confirmed in columns 7 to 9, which restrict the sample to countries outside Europe. They show a quantitatively-similar negative interaction of dictatorships with the Spanish Empire of 1600 (which back then included the Portuguese dependencies). The finding is consistent with case studies, such as the Argentinian dictatorships, which (like their Iberian counterparts), "mistrusted science and scientists" because of "the principles and ideas that were meant to govern scientific practice, ... which challenged aspects of the military authoritarian mentality and especially conflicted with the religious fundamentalist reactionary thought" (Gómez, Canales, and Balmer, 2020, pp. 9–10).

Overall, these results suggest that dictatorships need not always be bad for science—the dictator coefficient $\phi_{\textbf{Dictator}}$ is often positive and the one of Communism is consistently positive—but they suggest that dictatorships tend to depress science systematically in countries once subject to the strong Counter-Reformation imposed by the Spanish Empire. This finding is consistent with the interpretation that dictatorships—which are, historically seen, a *regressive* form of government—tend to be associated in these countries with an *idiosyncratic* regressiveness towards the specific kind of religiously-legitimized authoritarianism experienced historically during the long centuries of the Counter-Reformation. The Francoist regime would be an example. Its official stance was that "for several decades academia [has] been influenced and almost monopolized by dissolving ideologies and institutions, in open opposition to the national wit and tradition"—a "national wit and tradition" that "was placed in the Spanish Golden Age, that is, the sixteenth century and first two thirds of the seventeenth century" (González Redondo, 2020, pp. 61-62).

Table C4: The Counter-Reformation, recent dictatorships, and science. Country-year panel estimates, 1870–2000

	Dependent var.: Scientists aged 30–40 per capita (logs)								
	Europe						World (excl. Europe)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dictatorship									
Yes	-0.01	0.03	0.03*	0.02	0.01	0.01	0.00	0.04**	0.04*
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Yes & Catholic		-0.07***	-0.03						
		(0.02)	(0.03)						
Yes & Spanish Empire 1600			-0.07*	-0.09***	-0.08***	-0.09***	-0.08***	-0.10***	-0.10***
			(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Controls									
Communism	0.04**	0.05**	0.05***	0.05***	0.07***			0.05	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)			(0.04)	(0.04)
GDP growth (lags 0 to 10)	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes
Country time polynomial (order 4)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. var. (t-10)	-	-	-	-	Yes	-	Yes	-	Yes
Observations	2771	2771	2771	2771	2771	2810	2800	5401	5041
R-squared	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Notes: In support of the proposed persistence mechanism, these panel regressions find that an intense Counter-Reformation past (proxied by whether the country was part of the Spanish Empire in 1600) is associated with declining densities of scientists during recent dictatorships. A dictatorship is defined as a value of 1 in the xconst variable of the Polity5 dataset version 2018. Italy, Portugal, and Portuguese colonies are coded as part of the Spanish Empire. Observations are country-year. Standard errors in parenthesis. Significance levels denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D Data

D.1 Biography-based count of researchers

D.1.1 Queries

As a first step, I used Wikidata's query service (https://query.wikidata.org/) to retrieve attributes of a large quantity of persons who *may* be considered "scientists" or "intellectuals" (as defined below in D.1.2). Given that the "occupation" (wdt:P106) and "field of work" (wdt:P101) of a person can be very general (e.g., "physics") or very specific ("Type IIA string theory"), I retrieved biographical information of all persons having at least one of the following attributes:

- The "field of work" (wdt:P101) is an instance of "science" (wd:Q336), or of one the nearly 10,000 instances that are subcategories of "science," or subscategories of a subcategory of "science," and so on. While this approach allows to identify persons in rare fields of science (e.g., "flexible organic light-emitting diode" or "Demographics of Eswatini"), it has the disadvantage that some of the subcategories are rather unscientific (e.g., "tennis terminology"), making it necessary to filter as explained below.
- The "occupation" (wdt:P106) is an instance of "researcher" (wd:Q1650915), or of one the nearly 1,000 instances that are subcategories of "researcher" (e.g., "scientist" or "mathematician"), or subcategories of a subcategory of "researcher" (e.g., "behavioural scientist" or "biomathematician"), and so on.
- The "field of work" (wdt:P101) is an instance of "academic discipline" (wd:Q11862829).
- Either the "occupation" or the "field of work" is associated with branches of protoscience, such as alchemy, astrology, or cosmography.

Due to download limits imposed by Wikidata, the data were downloaded piece-wise through multiples queries between 2019 and 2022.

D.1.2 Filtering of "scientists" and "intellectuals"

After joining the data of several queries, I performed three steps:

1. I identified strings related with scientific or intellectual activity in a person's "description" and in a person's "occupation" and "field of work" attributes. Following the common scientometric practice applied to early modernity, I included branches of protoscience such alchemy, astrology, and numerology.
2. I identified strings *un*related with scientific or intellectual activity in a person's description and in a person's occupation and field attributes.
3. I kept persons matching 1 and erased any person matching 2. The exclusion of 2 erases for example a famous politician that happens to be a physician as well. Additionally, in order to avoid a spurious pre-Counter-Reformation spike in Iberia driven by a unique contingency, namely the discovery and exploration of the Americas, I also erased explorers from the dataset.

Table D1 provides a snapshot of nearly 4.000 individuals born in the 16th century engaged in popular research activities in the data. The table illustrates the distinction between "scientists" and broader category "intellectuals," which also includes theologians—who along other clergymen played an important role in the scientific debates until their rapid decline in science after 1700 (see figure D3)—, influential non-fictional writers, and poorly-described scholars (those with an ambiguous descriptions such as "Italian professor" or "German polymath").

Table D1: Distribution 16th-century-born scientists and intellectuals across popular categories

Known as	(Scientist, intellectual)	Born during the 16th century in: France	Germany	Iberia	Italy	Low Countries	Total
Historian	(1,1)	99	106	119	125	61	510
Physician	(1,1)	94	113	49	98	52	406
(Nat.) Philosopher	(1,1)	60	67	57	99	29	312
Mathematician	(1,1)	54	113	28	69	37	301
Technician	(1,1)	30	13	13	68	25	149
Cosmographer	(1,1)	26	35	31	31	61	184
Astronomer	(1,1)	16	59	12	62	26	175
Botanist	(1,1)	21	22	10	25	19	97
Protoscientist	(1,1)	13	31	7	14	5	70
Physicist	(1,1)	9	23	1	16	9	58
Chemist	(1,1)	15	25	1	6	4	51
Economist	(1,1)	4	2	13	8	1	28
Scientist		427	527	341	549	278	2122
Writer	(0,1)	248	334	382	192	109	1265
Theologian	(0,1)	166	545	102	114	114	1041
Scholar	(0,1)	116	578	75	71	137	977
Jurist	(0,1)	66	117	20	19	31	253
Erudite	(0,1)	13	24	13	27	17	94
Intellectual		723	1313	698	763	436	3933

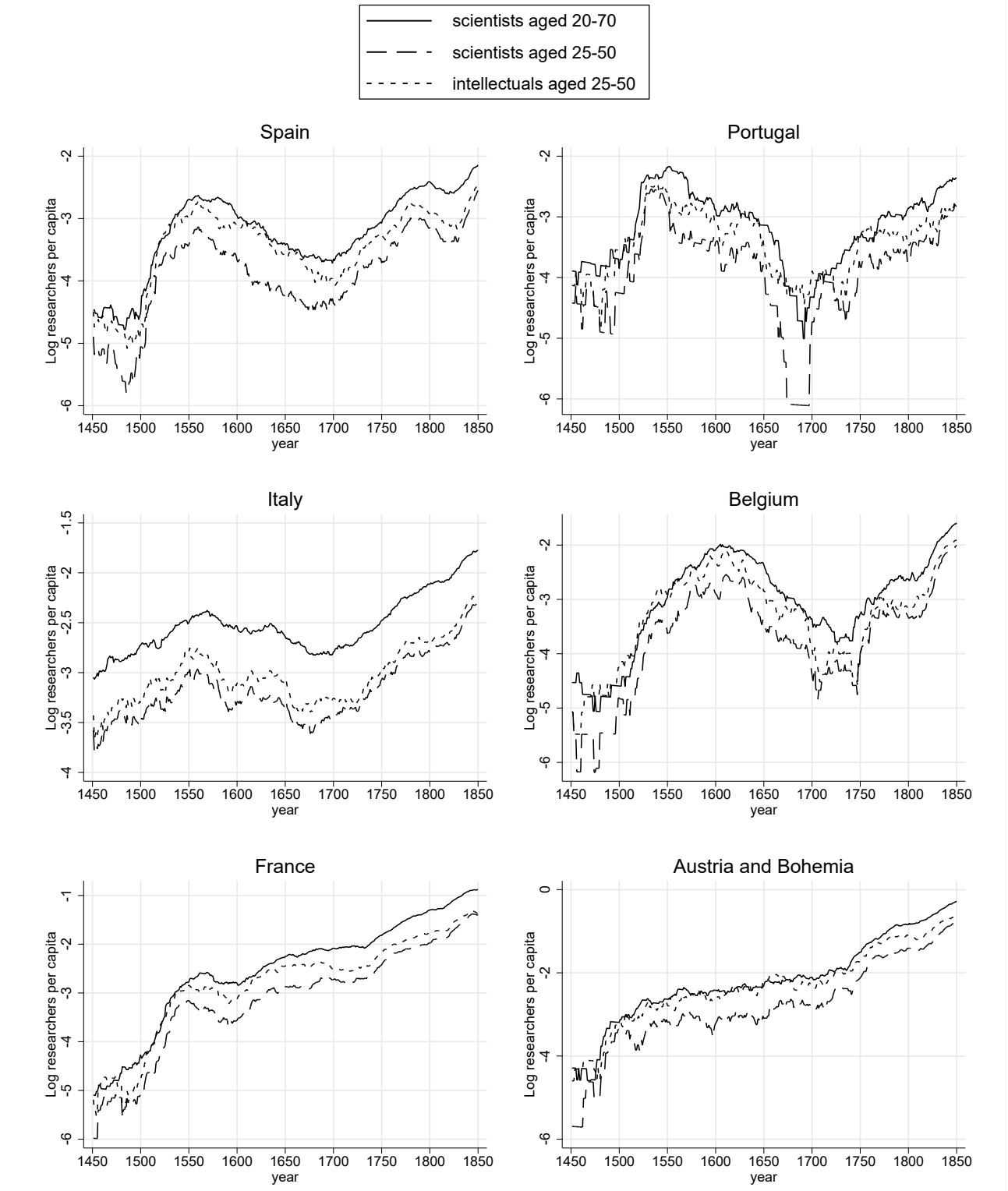
Notes: The table shows the most popular of many occupational categories used to identify scientists and intellectuals through Wikidata queries. Totals by activity exceed totals by countries because individuals may be active in more than one area. Philosophers and natural philosophers lumped together due to lacking distinction in the database. Cosmographers include geographers, cartographers, geophysicists and antropologists. Technicians include engineers, inventors, architects, builders and innovators. Protoscientists are alchemists, astrologers, and numerologists. Scholars include professors and lecturers. Writers include authors with unspecified field. Erudites include intellectuals, savants, and humanists, with unspecified specialization. Explores (the majority of which would be Iberians) are excluded from the data for the identification reasons explained in the main text. *Source*: Own computations based on Wikidata.

Table D2: Distances to death (km)

Century born	Scientists: Percentiles (km) p50	p75	p90	p99	Obs.	Intellectuals: Percentiles (km) p50	p75	p90	p99	Obs.
14th	0	102	493	2,086	325	0	52	387	1,732	667
15th	0	204	619	7,766	919	0	165	457	3,579	1,796
16th	9.6	197	585	7,591	2,831	0	179	491	5,926	5,420
17th	0	149	481	5,495	4,464	0	137	422	5,300	7,457
18th	9.4	213	615	7,543	14,648	5.7	187	564	7,300	20,950
19th	13.9	301	1,042	9,026	78,637	13.9	294	990	8,893	85,803

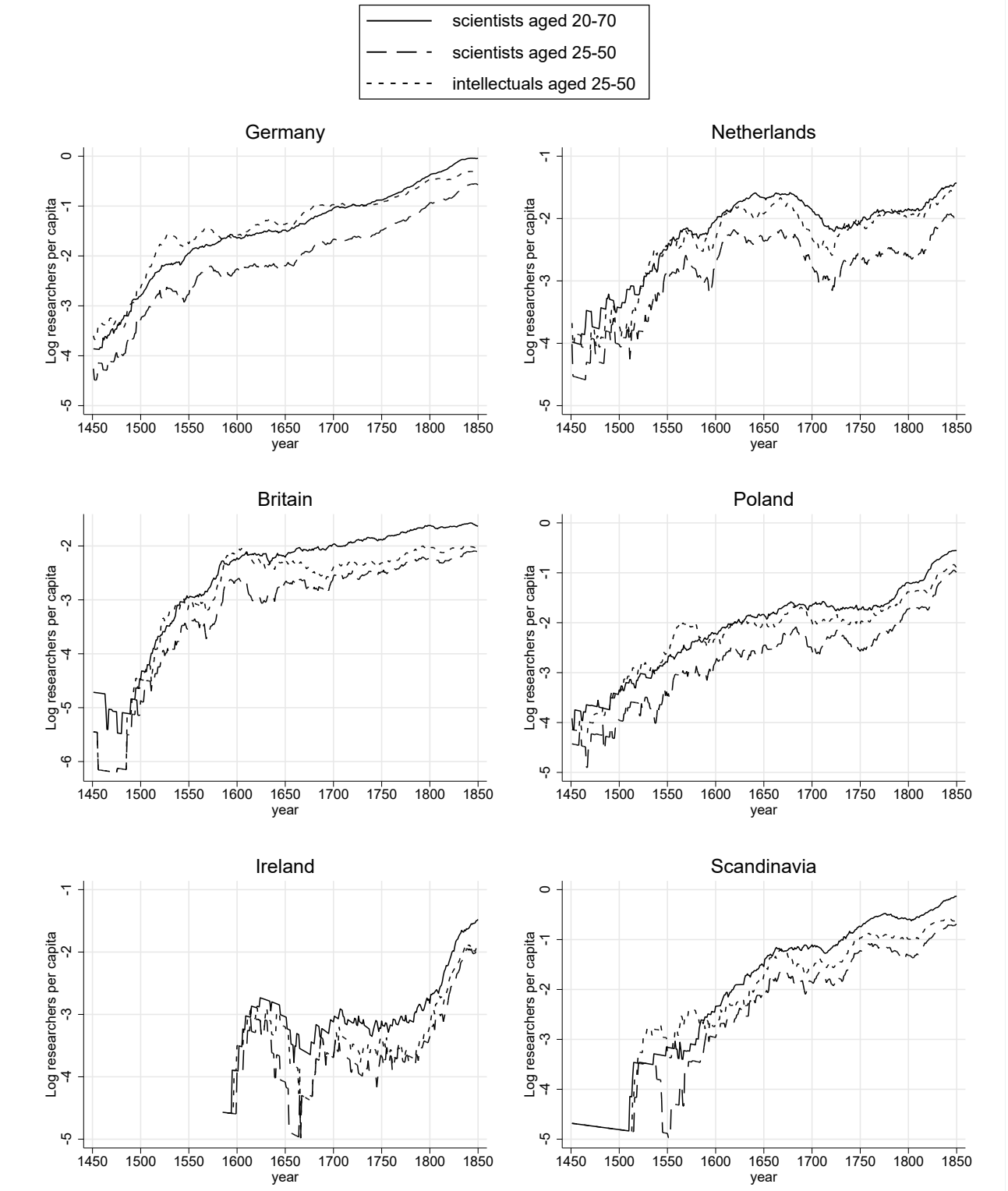
Notes: The table shows the distance, in kilometers, between the location of birth and the location of death of individuals born in different centuries. If we interpret these distances as a proxy for mobility, two noteworthy messages emerge: (i) mobility was very low for the median scientists and intellectuals; and (ii) academic mobility declined from the 16th to the 17th century. *Source*: Own computations based on Wikidata.

Figure D1: Different specifications, same overall trends



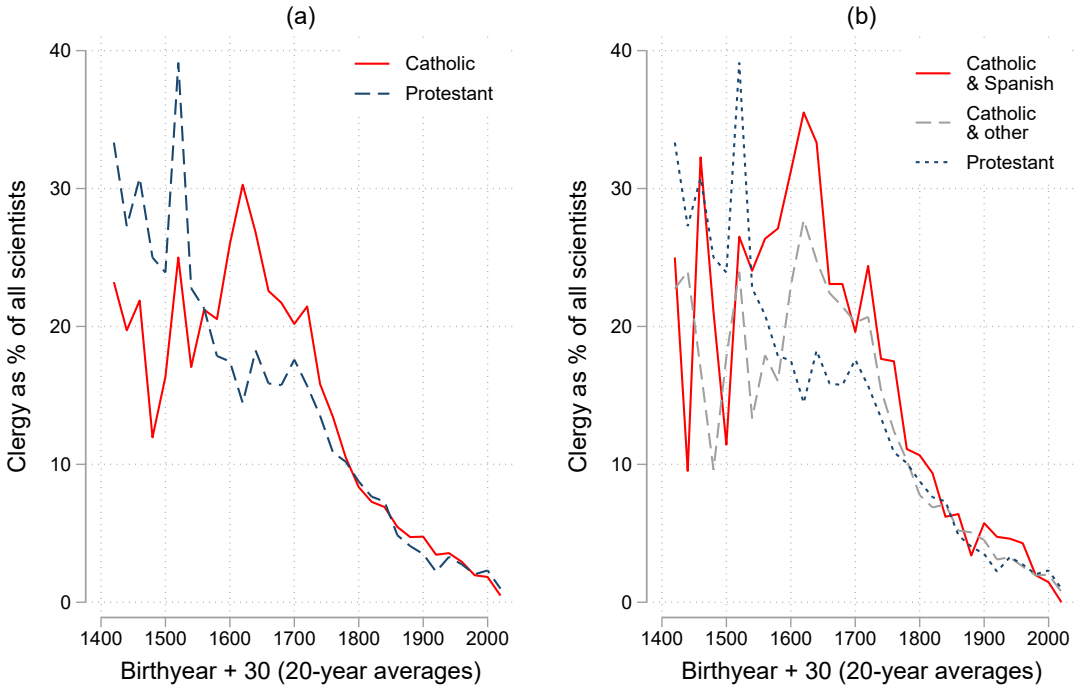
Notes: Allocation to countries by birthplace using current boundaries.

Figure D2: Different specifications, same overall trends (cont.)



Notes: Allocation to countries by birthplace using current boundaries.

Figure D3: Patterns in the secularization of science



Notes: The figures provide multiple messages. First, they evidence how the share of clergymen among researchers declined abruptly during the Enlightenment of the 18th century, both in Protestant and in Catholic Europe. Second, they show that since the late 18th century also levels of secularization have been comparable between Protestant and Catholic scientists. However, from 1500 to 1700 we observe stark differences between Protestants and Catholics. Compared to Catholics, Protestant scientists had a larger share of clergymen during the 15th century, yet they experienced a swift process of secularization immediately after the Reformation. This process came to a halt during the 17th century. On the contrary, Catholic scientists, which were more secularized prior to the mid 16th century, experienced a rapid increase in the share of clergymen until the early 17th century, i.e. as a result of the Counter-Reformation. Lastly, panel (b) shows that, in cities once belonging to the Spanish Empire, the speed of secularization decreases during waves of conservatism (e.g., the French Revolution, the Restoration, and 20th-century Fascism) more than it did elsewhere, suggesting a revival of the cultural and/or institutional legacy of the Counter-Reformation. *Source*: Own computation based on Wikidata.

D.2 Other constructed variables

D.2.1 Urban population 1400–1850

I construct yearly urban population time series based on Bairoch, Batou, and Chevre (1988) and within-century observations from Lees and Hohenberg (1989), de Vries (1984), Biraben and Blanchet (1999), some anecdotal evidence on the impact of plagues and wars (Alfani, 2013, Hays, 2005, p. 103, and Britannica entries), and early censuses (e.g., Seville's 16th-century censuses reported by Mira Caballos, 2002). If not available, a population in 1400 and 1500 is either extrapolated backwards using the latest known observation in Bairoch, Batou, and Chevre (1988) or taken from the estimates by Voigtländer and Voth (2012). I then fill missed yearly values though log-linear interpolations between the available observations. Figure D4 plots the resulting time series for selected cities. Note that some of them are based on detailed 16th and 17th evidence (e.g., Antwerp and Seville), others are mere log-linear interpolations between centuries (e.g., Prague).

D.2.2 Urban population in 1939

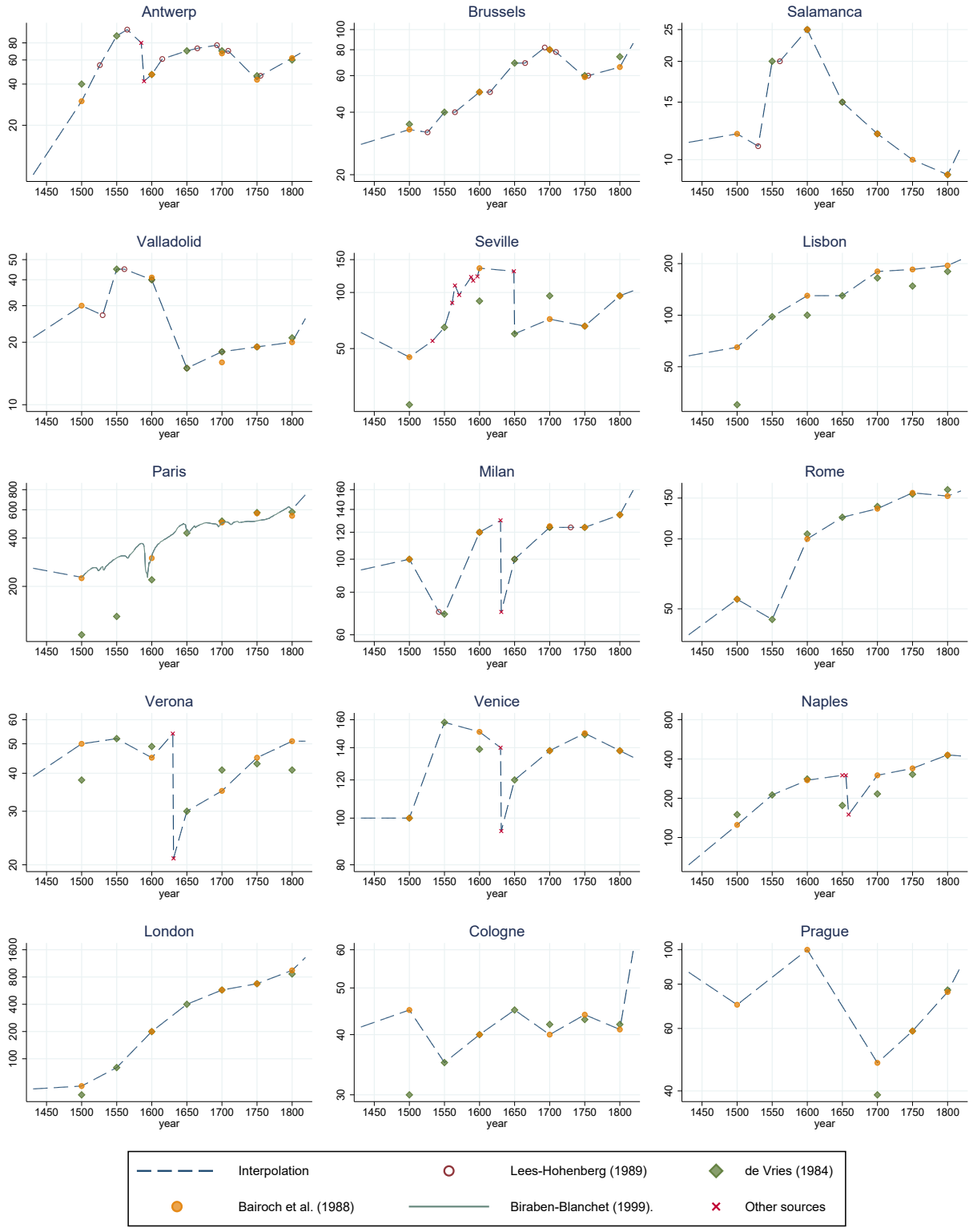
Population in 1939 is based on following sources:

- The *Statistisches Jahrbuch für das Deutsche Reich* of 1939/40, which covers Germany and German-controlled cities in today's Austria, Poland, Czechia, Russia, Slovakia, Lithuania, Estonia, and Latvia.
- The Italian census of 1936 and the retrospective values for 1921. Population in 1939 is extrapolated using annualized growth of 1921–1936.
- The Spanish census data of 1780–1930, harmonized by the URBES study (`https://www.urbes.unican.es/`). Population in 1939 is extrapolated using annualized growth of 1900–1930.
- The Belgian censuses of 1930 and the reported regional growth since 1920. Population in 1939 is extrapolated using annualized growth of 1920–1930.
- The Dutch census of 1930 and the 1900 value reported by Buringh (2021). Population in 1939 is extrapolated using annualized growth of 1900–1930.
- The Polish census of 1931 and the 1900 value reported by Buringh (2021). Population in 1939 is extrapolated using annualized growth of 1900–1931.
- The French census of 1936 for the 62 largest French cities, as reported in *Des villages de Cassini aux communes d'aujourd'hui* (`http://cassini.ehess.fr/fr/html/`). For other cities, population in 1939 is extrapolated using annualized growth of 1850–1900 reported by Buringh (2021).
- For Britain, Scandinavia, and Portugal, population in 1939 is the constant-growth-rate interpolation between 1900 and 1950 based on Buringh (2021).

D.2.3 Catholicism

The Catholic dummy is an indicator of the religious situation by the late 17th century (map E2). A city is coded as Catholic if the majority of individuals with known religion and born in the city between 1600 and 1750 was Catholic according to Wikidata (see map E3). In the case of small towns with insufficient statistical data to confidently determine the fraction of Catholics, religion is inferred from the political borders. More precisely, all Iberian and Italian cities are coded as Catholic, as well as all cities of current-day Belgium and Luxembourg. German cities are coded according to Cantoni (2012) unless I statistically reject the religious affiliation based on biographic data obtained from Wikidata: if the empirical share of Catholics in a city suggest the opposite of

Figure D4: Estimated population dynamics in selected cities



Notes: See section D.2.1.

Cantoni's coding at the 10% significance level I correct the city's religious affiliation accordingly. Similarly, cities in Austria, Poland, and in their respective imperial domains are Catholic unless statistically rejected. Dutch data are complemented with the Dutch census of 1849 (http://www.volkstelling.nl/nl/volkstelling/jaarview/1849/index.html). Protestant cities in Hungary and Transilvania are identified with the help of Posselt (1956), Langhans (1904), the Austro-Hungarian census of 1910, and the Hungarian population census of 2011.

France is coded as entirely Catholic for regressions covering the years after 1700 (e.g., in tables 2 and 3) but as multi-confessional when studying the Counter-Reformation as a 17th-century shock (e.g., table 1). This is because, while Protestants rarely made up most of a city's population in the 17th century (they made up about 10% of the kingdom's population in the mid century), they nonetheless exerted considerable political and military control over extensive territories. In regressions covering the 17th century, the Catholic dummy is set equal to zero in France if a city exhibits a density of Protestants by 1670 over the 75th percentile (using the count of Protestants published by Squicciarini and Voigtländer, 2015) or if the city is within the Huguenot military strongholds by 1598, the year of the Edict of Nantes (Nexon, 2009; Schilling, 2007) Among French cities coded as non-Catholic, the average share of Catholics is about 80% and less than a quarter of them have a protestant majority.

D.2.4 Calvinism

The indicators of Calvinism (broadly defined) are based on the empirical distribution of Calvinist population obtained from to Wikidata and plotted in map E5. The obtained geographical distribution is roughly consistent with that suggested in many other studies (Murdock, 2000, Dowley, 2015, MacKenney, 1993, p, 196, or Schilling, 2007), showing that Calvinism was particularly strong in Scotland, the Netherlands, Switzerland, and the region around Debrecen which spans from eastern Hungary into Transylvania. In addition we see pockets of Calvinism in Germany, Poland, France, and the eastern Baltic.

D.2.5 Literacy by 1800

Estimates of European literacy rates at the city level are presented in figure E6. The estimates correspond to own work based on the country-level comparisons offered by Allen (2003) and Reis (2005) and the within-country variation that can be inferred from recent studies and from the first censuses that appeared around the mid-century. I base on Ciccarelli and Weisdorf (2019) for Italy, Squicciarini (2020) for France, Becker and Cinnirella (2020), Ogilvie and Küpker (2015), and van Horn Melton (1988) for Germany, Beltrán Tapia and Martínez-Galarraga (2015) and the 1860 census for Spain, Akçomak, Webbink, and ter Weel (2016) for the Netherlands, Stephens (1990), Clark and Gray (2014), and Reclus (1881, p. 472) for the British Isles, and van Horn Melton (1986), van Horn Melton (1988), Stollberg-Rilinger (2017), and the 1880 census of the Austrian Empire for its corresponding domains. In the case of Prussia, for example, I take the schooling rate of the 1820 census as a proxy for literacy, first, because the schooling-literacy correspondence is very high in later censuses and, second, because 1820 schooling closely matches the regional levels of literacy by 1800 reported in Reis (2005). In the case of Austria, I infer regional variation from the census of 1880 and adjust it linearly to the lower levels of literacy prevailing previous to the Theresian reforms. We known that in the Archdiocese of Vienna schooling went from 40% in 1780 to 94% by 1807 due to these reforms (Stollberg-Rilinger, 2017, p. 714) and that rural Hungary had a literacy rate of 6% (Reis, 2005). Therefore, I linearly transform the 1880 data to match a literacy rate by 1800 of 50% in Vienna, only 10% in Graz, and as low as 6% in parts of Hungary. Similar exercises are conducted to infer regional variation within the UK, Spain, the Netherlands, and Belgium.

D.2.6 Languages 1500–1800

Language fixed effects are shown in map E8. They include Portuguese, Catalan, Castilian, Basque, French, Italian, German, English, Irish, Dutch, Czech, Slovak, Hungarian, Polish, Romanian, Ukrainian, Serbo-Croatian, Slovenian, Albanian, Greek, Bulgarian, Swedish, Danish, Norwegian, Russian, Belorussian, Lithuanian, Latvian, Estonian, Finish, and the Celtic minorities in France and the British Isles. Sources: Own work based on Parker (1977), Kiepert (1869), Freytag (1910), and Magocsi (2018).

D.2.7 States around 1820

Fixed effects at the state level are shown in map E7. They try to capture long-term state influence (despite continuously shifting boundaries) through the following dummies: Prussia, Saxony, and smaller northern German States according to limits of 1816; the Netherlands, Belgium, France, the Papal States, and Kingdom of the two Scicilies according to limits of 1830; Britain, Austria, and the Ottoman Empire correspond to limits of 1820; the remaining states according to limits established in the Congress of Vienna of 1815 (based on Britannica, 2023).

D.3 Sources for tables 2 and 3

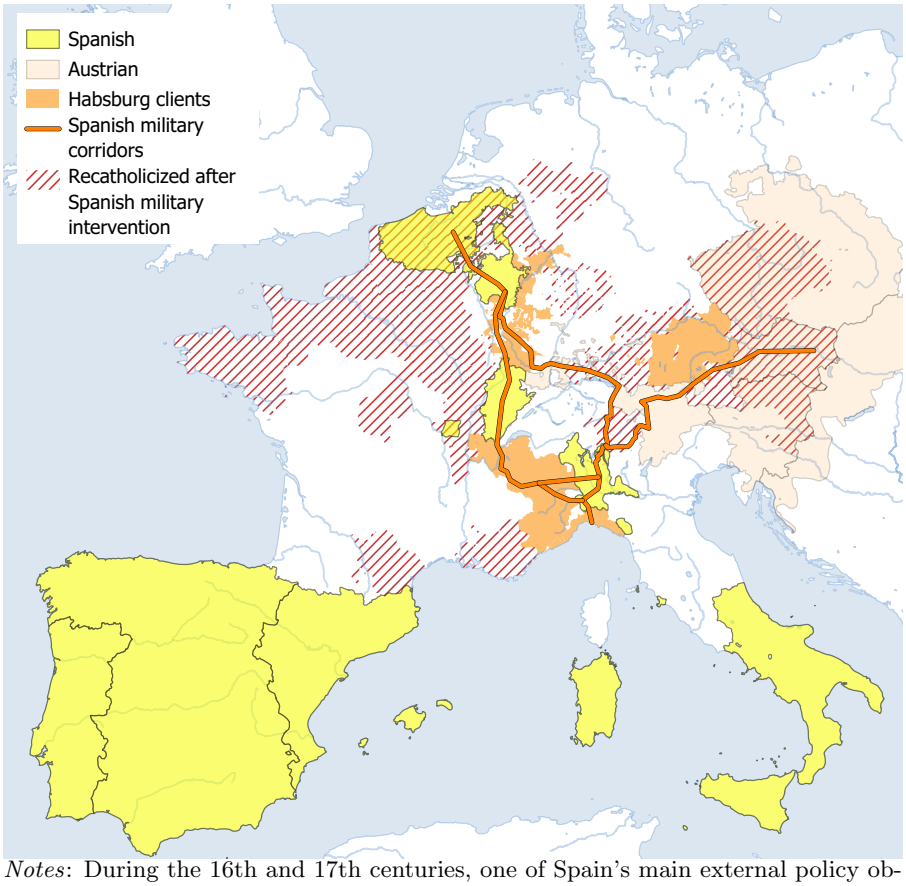
Dependent variables. Number of scientists: as in section D.1, scaled by population using Bairoch, Batou, and Chevre (1988) and extensions by Buringh (2021). City population in 1939: see section D.2.2.

Treatment variables. Catholic dummy: as in section D.2.3, treating France as entirely Catholic. Spanish empire by 1600: based on Parker (1977), Parker (2014), Maltby (2009), and adapted vector data of Nuessli (2011) (see map E1). Inquisitorial headquarter dummy: tribunal locations as in Bethencourt (2009), seats of bishops and archbishops partly based on Bosker, Buringh, and van Zanden (2013). Share of clergymen: based on Laouenan et al. (2022).

Controls. Literacy rates by 1800: see section D.2.5. Active university in C18th: based on Verger (1991) and Frijhoff (1996). Active parliament dummy and number of parliamentary meetings in C18th: based on van Zanden, Buringh, and Bosker (2012), Bosker, Buringh, and van Zanden (2013), and Henriques and Palma (2023), imputing values to cities within same political boundaries by the end of the century (with adapted vector data of Nuessli, 2011). Representative government (commune) in C18th: based on Bosker, Buringh, and van Zanden (2013), again imputing values to cities within same political boundaries by the end of the century. Distances to coal fields: Fernihough and O'Rourke (2021). Distances to the Atlantic, to the Mediterranean, to water transportation ways: Fernihough and O'Rourke (2021). Indicators of crop suitability (potato, wheat, and oats): Fernihough and O'Rourke (2021). City population in 1500, 1600, 1800, and 1900: Bairoch, Batou, and Chevre (1988) and Buringh (2021). Fixed effects by states: see section D.2.7. Fixed effects by languages: see section D.2.6.

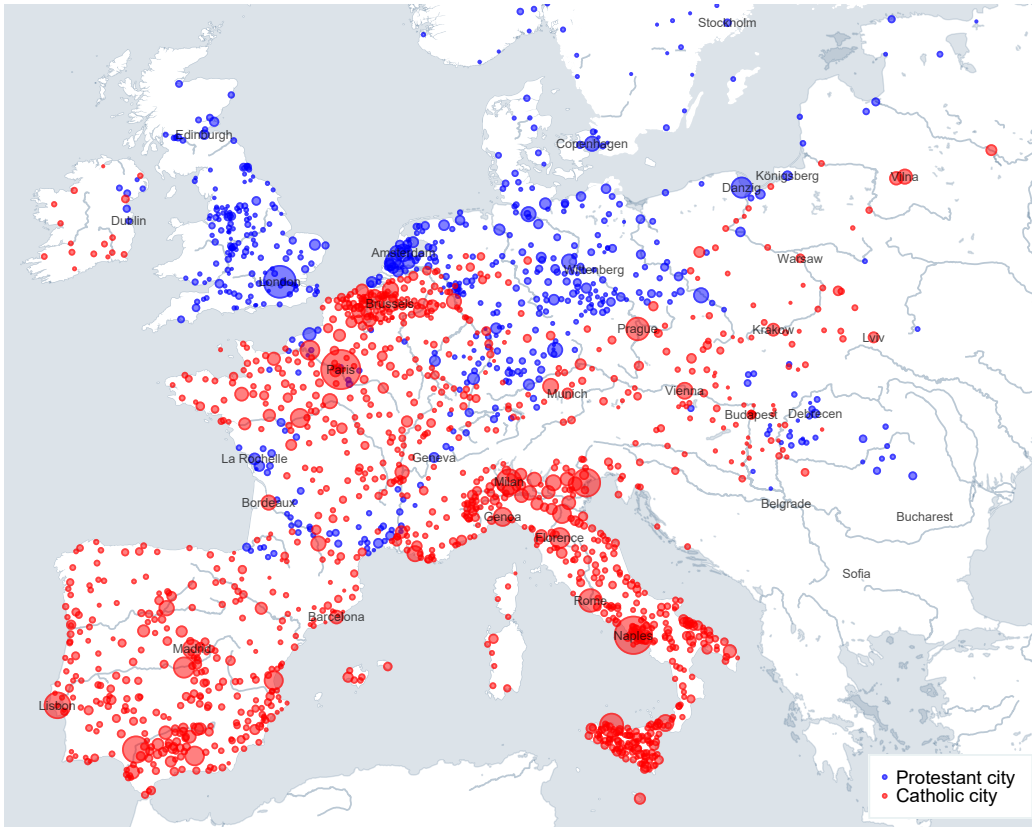
Appendix E Additional maps

Map E1: Recatholicization and military logistics by 1600



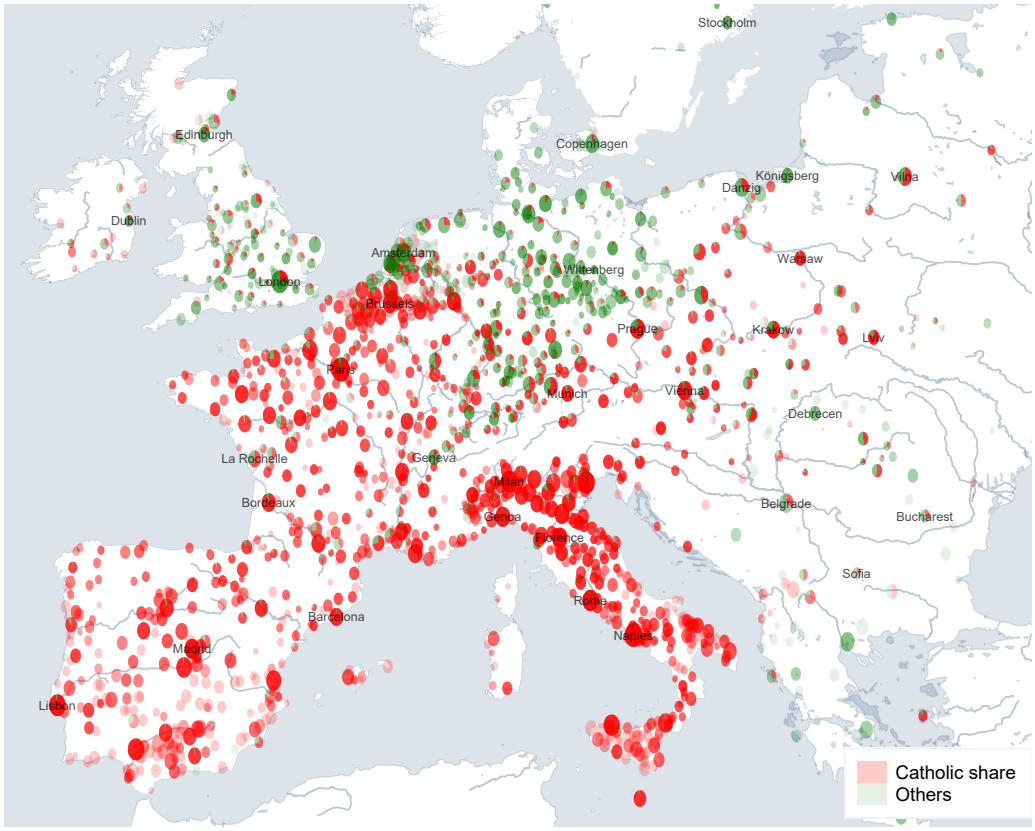
Notes: During the 16th and 17th centuries, one of Spain's main external policy objectives was to prevent the spread of Protestantism. Many areas that were easily accessible to the Spanish military were recatholicized after Spanish military intervention. *Sources*: Own work based on Parker (1977), Parker (2004), Maltby (2009), Kamen (1997, pp. 297–300), Parker (1997), Nexon (2009), and Schilling (2007), as well as vector data from Nuessli (2011).

Map E2: Catholic dummy (17th century)



Notes: Dot size reflects population in 1600.

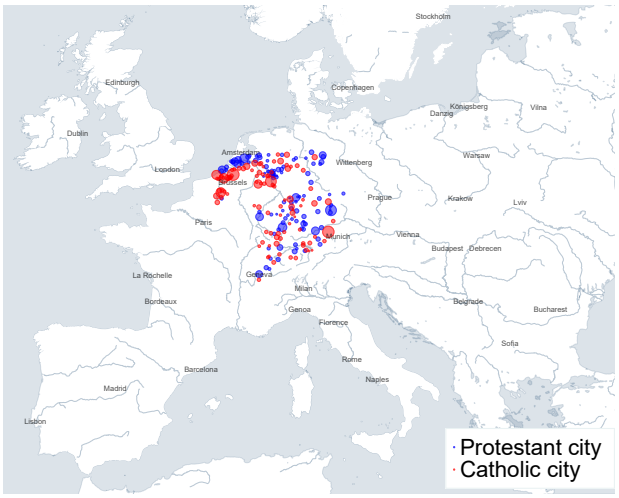
Map E3: Empirical share of early modern Catholics per city



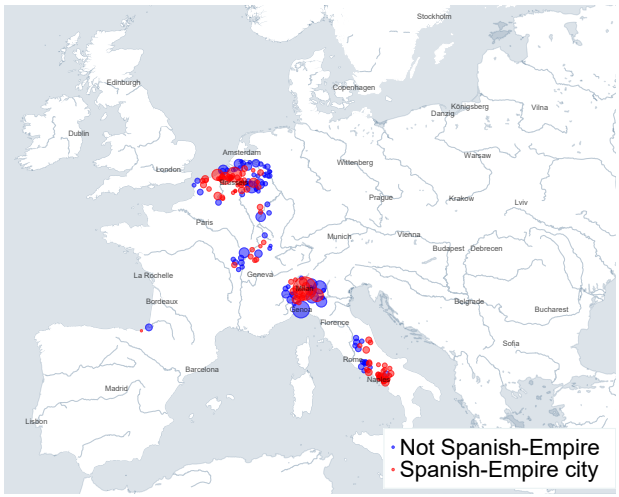
Notes: The figure corresponds to a map early modern cities coloured increasingly reddish the larger the share of Catholics born in the city between 1450 and 1750. A darker (less transparent) color indicates more people with known religion used to compute the share. Cities are those in Bairoch, Batou, and Chevre, 1988 and the share of Catholics is computed using queries from wikidata. (See query religion3)

Map E4: Border cities in table 1

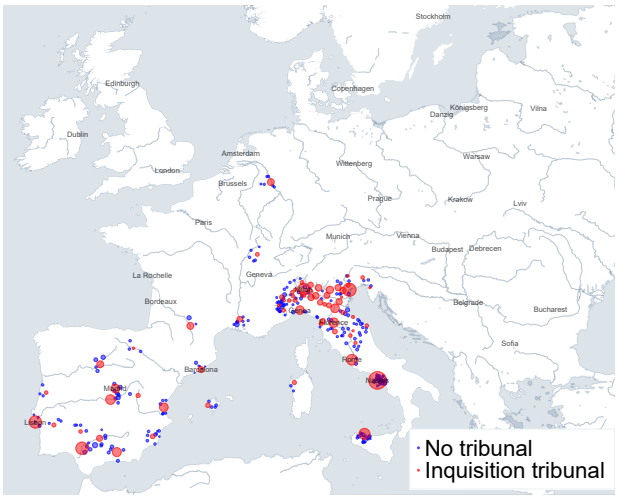
(a) Confessional border (column 2)



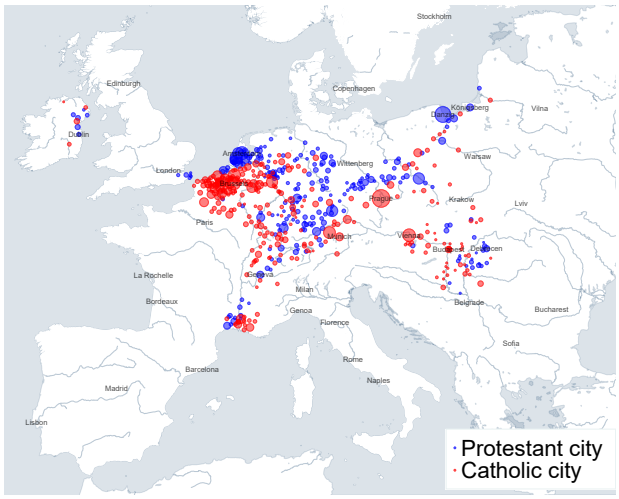
(b) Imperial border (column 4)



(c) Inquisition border (column 6)

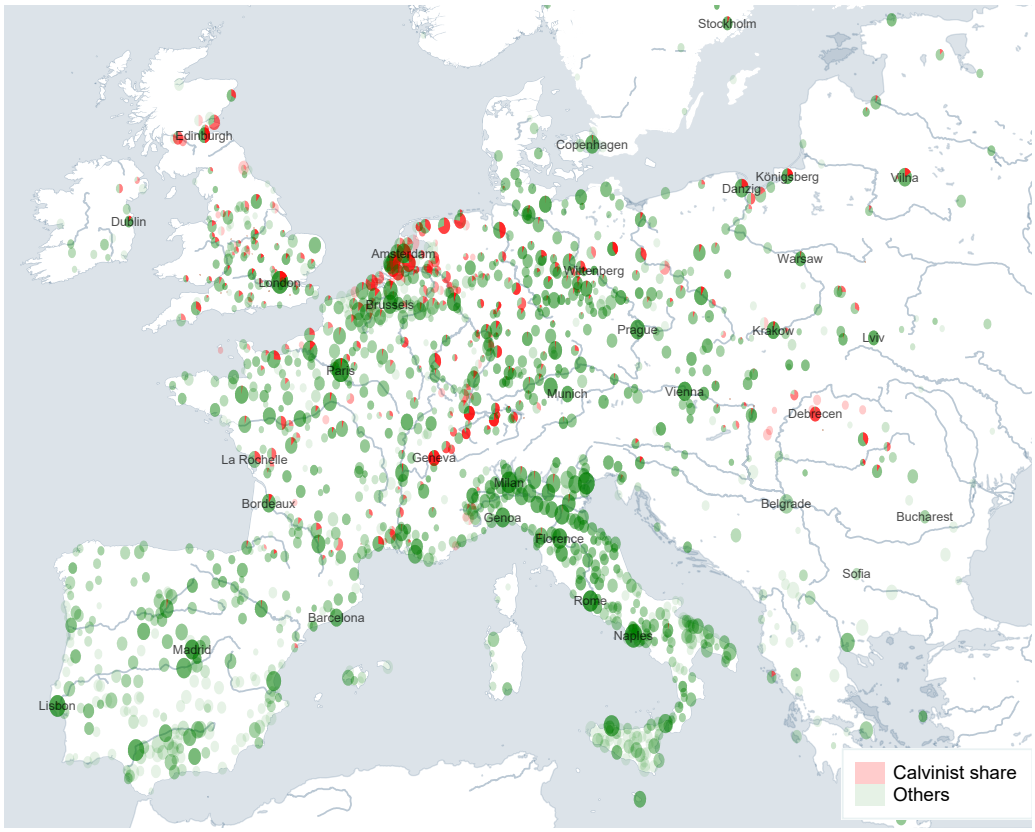


(d) Extensive border (column 10)



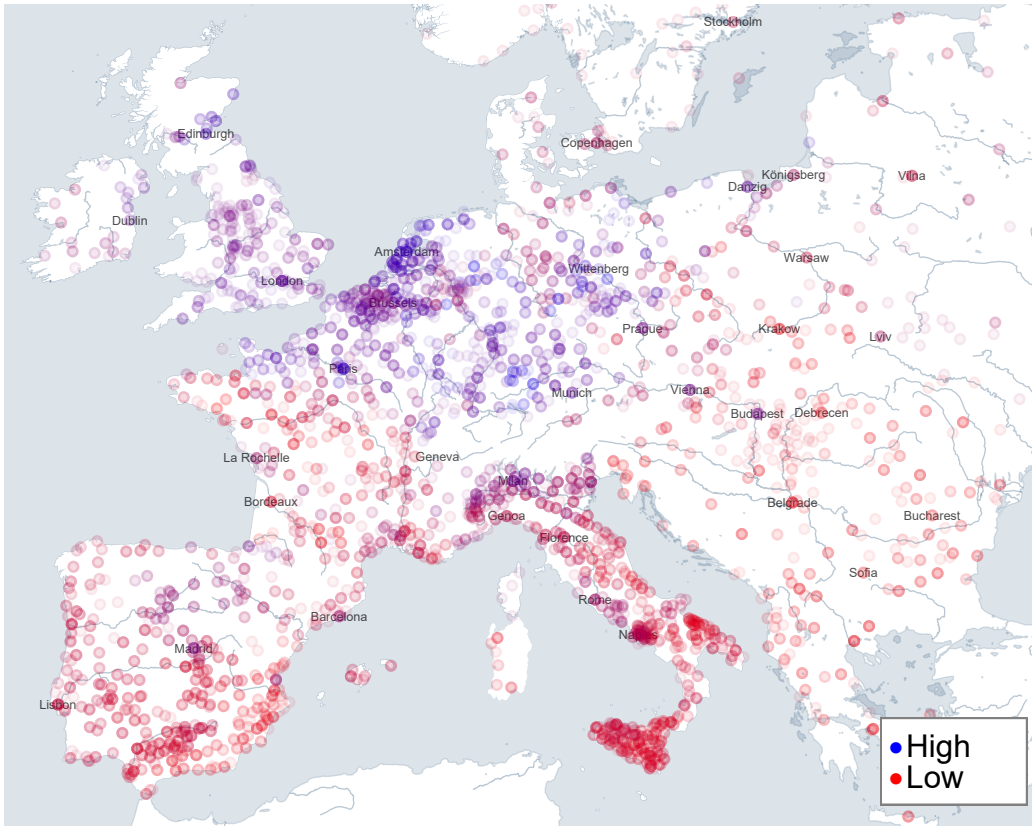
Notes: Samples used for the estimates in table 1.

Map E5: Empirical share of Early Modern Calvinists per city



Notes: The figure corresponds to a map early modern cities coloured increasingly reddish the larger the share of Calvinists born in the city between 1450 and 1750. A more intense (less transparent) color indicates more people with known religion used to compute the share. Cities are those in Bairoch, Batou, and Chevre, 1988 and the share of Calvinists is computed using queries from Wikidata.

Map E6: Estimated literacy rates by cities around 1800



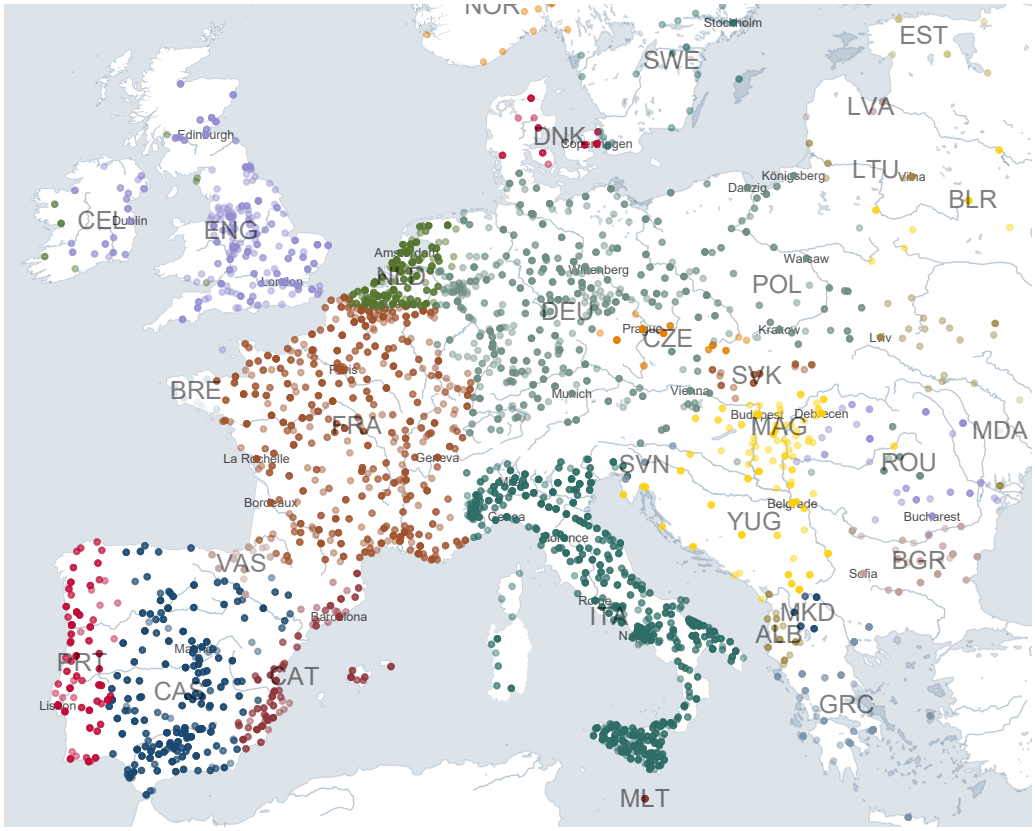
Notes: The population weighted averages at the country level are AL: 0.07; AT: 0.41; BE: 0.55; BG: 0.07; CH: 0.6; CZ: 0.35; DE: 0.55; DK: 0.3; EE: 0.23; EL: 0.07; ES: 0.2; FI: 0.23; FR: 0.4; HR: 0.06; HU: 0.15; IE: 0.49; IT: 0.25; LT: 0.32; LU: 0.6; LV: 0.22; ME: 0.07; MK: 0.07; NL: 0.67; NO: 0.21; PL: 0.26; PT: 0.2; RO: 0.06; RS: 0.06; SE: 0.23; SI: 0.06; SK: 0.12; UK: 0.55.

Map E7: States by 1820



Sources: See data appendix

Map E8: Languages 1500–1938



Sources: See data appendix

G Appendix References

Acemoglu, **Daron**, **Giuseppe De Feo**, **Giacomo De Luca, and Gianluca Russo** (2022). "War, Socialism, and the Rise of Fascism: an Empirical Exploration." *The Quarterly Journal of Economics* qjac001.

Akçomak, **İ. Semih**, **Dinand Webbink, and Bas ter Weel** (2016). "Why Did the Netherlands Develop So Early? The Legacy of the Brethren of the Common Life." *The Economic Journal* 126 (593): 821–860.

Alexander, **Amir** (2015). *Infinitesimal: How a Dangerous Mathematical Theory Shaped the Modern World*. New York: Farrar, Straus and Giroux.

Alfani, **Guido** (2013). "Plague in seventeenth-century Europe and the decline of Italy: an epidemiological hypothesis." *European Review of Economic History* 17 (4): 408–430.

Allen, **Robert C.** (2003). "Progress and poverty in early modern Europe." *The Economic History Review* 56 (3): 403–443.

Bachleitner, **Norbert** (2022). *Censorship of Literature in Austria, 1751-1848*. Leiden: Brill.

Bairoch, **Paul**, **Jean Batou, and Pierre Chevre** (1988). *La population des villes européenes: banque de données et analyse sommaire des résultats: 800-1850*. Geneva: Droz.

Becker, **Sascha O., and Francesco Cinnirella** (2020). "Prussia disaggregated: the demography of its universe of localities in 1871." *Journal of Demographic Economics* 86 (3): 259–290.

Becker, **Sascha O.**, **Francisco J. Pino, and Jordi Vidal-Robert** (2021). "Freedom of the Press? Catholic Censorship during the Counter-Reformation." Working Paper SDT 516. Universidad de Chile.

Becker, **Sascha O., and Ludger Woessmann** (2009). "Was Weber wrong? A human capital theory of Protestant economic history." *The Quarterly Journal of Economics* 124 (2): 531–596.

Beltrán Tapia, **Francisco, and Julio Martínez-Galarraga** (2015). "Land access inequality and education in pre-industrial Spain." Oxford Economic and Social History Working Papers 137. University of Oxford, Department of Economics.

Bernstein, **Samuel** (1945). "English Reactions to the French Revolution." *Science & Society*: 147–171.

Bethencourt, **Francisco** (2009). *The Inquisition: A Global History 1478-1834*. Trans. by Jean Birrell. Cambridge: Cambridge University Press.

Biraben, **Jean-Noël** (1975). *La peste dans l'histoire*. Reprint 2019. Berlin: De Gruyter Mouton.

Biraben, **Jean-Noël, and Didier Blanchet** (1999). "Essay on the Population of Paris and its Vicinity Since the Sixteenth Century." *Population* 11 (1): 155–188.

Bolt, **Jutta**, **Robert Inklaar**, **Herman de Jong, and Jan Luiten Van Zanden** (2018). "Maddison project database, version 2018 (Rebasing 'Maddison': new income comparisons and the shape of long-run economic development)." Maddison Project Working paper 10. Groningen Growth and Development Centre.

Bolt, **Jutta, and Jan Luiten Van Zanden** (2020). "Maddison style estimates of the evolution of the world economy. A new 2020 update." Maddison-Project Working Paper WP-15. University of Groningen.

Bosker, **Maarten**, **Eltjo Buringh, and Jan Luiten van Zanden** (2013). "From Baghdad to London: Unraveling Urban Development in Europe, the Middle East, and North Africa, 800–1800." *Review of Economics and Statistics* 95 (4): 1418–1437.

Britannica (2023). "Europe, 1815." URL: https://www.britannica.com/event/Congress-of-Vienna#/media/1/628086/214576 (visited on 07/22/2023).

Buringh, **Eltjo** (2021). "The Population of European Cities from 700 to 2000: Social and Economic History." *Research Data Journal for the Humanities and Social Sciences* 6 (1): 1–18.

Calvo Maturana, **Antonio** (2014). ""Is it useful to deceive the people?" The Debate on Public Information in Spain at the End of the Ancien Régime (1780–1808)." *The Journal of Modern History* 86 (1): 1–46.

Canales, **Antonio Francisco** (2020). "The Reactionary Utopia: the CSIC and Spanish Imperial Science." In: *Science Policies and Twentieth-Century Dictatorships: Spain, Italy and Argentina*. London: Routledge, 79–102.

Cañizares-Esguerra, **Jorge** (2004). "Iberian Science in the Renaissance: Ignored How Much Longer?" *Perspectives on Science* 12 (1): 86–124.

Cañizares-Esguerra, **Jorge** (2008). "Introduction." In: *Science in the Spanish and Portuguese Empires, 1500–1800*. Ed. by Daniela Bleichmar, Paula De Vos, Kristin Huffine, and Kevin Sheehan. Stanford, CA: Stanford University Press, 1–6.

Cantoni, **Davide** (2012). "Adopting a New Religion: The Case of Protestantism in 16th Century Germany." *The Economic Journal* 122 (560): 502–531.

Ciccarelli, **Carlo, and Jacob Weisdorf** (2019). "Pioneering into the past: Regional literacy developments in Italy before Italy." *European Review of Economic History* 23 (3): 329–364.
Clark, **Gregory, and Rowena Gray** (2014). "Geography is not destiny: geography, institutions and literacy in England, 1837–63." *Oxford Economic Papers* 66 (4): 1042–1069.
Colella, **Fabrizio**, **Rafael Lalive**, **Seyhun O. Sakalli, and Mathias Thoenig** (2019). "Inference with Arbitrary Clustering." IZA Discussion Paper Series No. 12584.
Crofts, **Richard A.** (1985). "Printing, Reform, and the Catholic Reformation in Germany (1521-1545)." *The Sixteenth Century Journal* 16 (3): 369–381.
De la Croix, **David, and Pauline Morault** (2020). "Winners and Losers from the Protestant Reformation: An Analysis of the Network of European Universities." IRES Discussion Papers 2020/29. Université Catholique de Louvain.
De Rocca, **A. J. Michel** (1815). *Memoirs of the war of the French in Spain*. Trans. by Maria Graham. London: John Murray.
De Vries, **Jan** (1984). *European Urbanization 1500-1800*. London: Methuen.
Dittmar, **Jeremiah E., and Ralf R. Meisenzahl** (2020). "Public Goods Institutions, Human Capital, and Growth: Evidence from German History." *The Review of Economic Studies* 87 (2): 959–996.
Dowley, **Tim** (2015). *Atlas of the European Reformations*. Minneapolis: Fortress Press.
Drelichman, **Mauricio**, **Jordi Vidal-Robert, and Hans-Joachim Voth** (2021). "The long-run effects of religious persecution: Evidence from the Spanish Inquisition." *Proceedings of the National Academy of Sciences* 118 (33): e2022881118.
Dupré, **Sven**, **Bert De Munck**, **Werner Thomas, and G. Vanpaemel**, eds. (2015). *Embattled territory: the circulation of knowledge in the Spanish Netherlands*. Gent: Academia Press.
Eisenstein, **Elizabeth L.** (1980). *The Printing Press as an Agent of Change*. Cambridge: Cambridge University Press.
Eisenstein, **Elizabeth L.** (1988). "Print culture and enlightenment thought." *Réseaux. Communication - Technologie - Société* 6 (31). Ed. by the University of North Carolina at Chapel Hill University library: 7–38.
Epstein, **Klaus** (2015). *The Genesis of German Conservatism*. Princeton, NJ: Princeton University Press.
Ericksen, **Robert P.** (1985). *Theologians Under Hitler*. New Haven, CT: Yale University Press.
Espinosa, **Aurelio** (2008). *The Empire of the Cities: Emperor Charles V, the Comunero Revolt, and the Transformation of the Spanish System*. Leiden: Brill.
Feingold, **Mordechai** (2003a). *Jesuit Science and the Republic of Letters*. Cambridge, MA: MIT Press.
Feingold, **Mordechai** (2003b). "Jesuits: Savants." In: *Jesuit Science and the Republic of Letters*. Cambridge, MA: MIT Press, 1–45.
Feldman, **Matthew**, **Marius Turda, and Tudor Georgescu**, eds. (2013). *Clerical Fascism in Interwar Europe*. London: Routledge.
Fernihough, **Alan, and Kevin Hjortshøj O'Rourke** (2021). "Coal and the European Industrial Revolution." *The Economic Journal* 131 (635): 1135–1149.
Freytag, **G** (1910). "G. Freytags Völker- und Sprachenkarte von Österreich-Ungarn." URL: https://ark.digitalcommonwealth.org/ark:/50959/4m90fp41x (visited on 04/04/2023).
Frijhoff, **Willem** (1996). "Patterns." In: *A History of the University in Europe: Volume 2: 1500-1800*. Ed. by Hilde de Ridder-Symoens. Vol. 2. A History of the University in Europe. Cambridge: Cambridge University Press, 43–106.
García Tapia, **Nicolás** (2003). *Técnica y poder en Castilla durante los siglos XVI y XVII*. Salamanca: Junta de Castilla y León, Consejería de Educación y Cultura.
Gawthrop, **Richard, and Gerald Strauss** (1984). "Protestantism and literacy in early modern Germany." *Past & present* (104): 31–55.
Gielis, **Gert, and Violet Soen** (2015). "The Inquisitorial Office in the Sixteenth-Century Habsburg Low Countries: A Dynamic Perspective." *The Journal of Ecclesiastical History* 66 (1): 47–66.
Gómez, **Amparo**, **Antonio F. Canales, and Brian Balmer**, eds. (2020). *Science Policies and Twentieth-Century Dictatorships: Spain, Italy and Argentina*. London: Routledge.
González Redondo, **Francisco A.** (2020). "Spanish Science: from the Convergence with Europe to Purge and Exile." In: *Science Policies and Twentieth-Century Dictatorships: Spain, Italy and Argentina*. London: Routledge, 59–78.

Goodman, **David** (1983). "Philip II's Patronage of Science and Engineering." *The British Journal for the History of Science* 16 (1): 49–66.
Goodman, **David** (2002). *Power and Penury: Government, Technology and Science in Philip II's Spain*. Cambridge: Cambridge University Press.
Goodman, **David** (2005). "Intellectual Life under the Spanish Inquisition: A Continuing Historical Controversy." *History* 90 (3 (299)): 375–386.
Griffin, **Roger** (2008). "The 'Holy Storm': 'Clerical Fascism' through the Lens of Modernism Roger Griffin." In: *Clerical Fascism in Interwar Europe*. Ed. by Matthew Feldman, Marius Turda, and Tudor Georgescu. New York: Routledge, 1–16.
Hakluyt, **Richard** (1599). *The Principal Nauigations, Voyages, Traffiques and Discoueries of the English Nation*. Ed. by Edmund Goldsmid. Vol. VIII. London: George Bishop.
Hays, **Jo N.** (2005). *Epidemics and Pandemics: Their Impacts on Human History*. Santa Barbara, CA: ABC-CLIO.
Henriques, **António, and Nuno Palma** (2023). "Comparative European Institutions and the Little Divergence, 1385–1800." *Journal of Economic Growth* 28 (2): 259–294.
Hobsbawm, **Eric J.** (1954). "The General Crisis of the European Economy in the 17th Century." *Past & Present* 5 (1): 33–53.
Houston, **Robert A.** (2002). *Literacy in Early Modern Europe: Culture and Education 1500-1800*. 2nd ed. Harlow: Routledge.
Israel, **Jonathan I.** (2019). *The Enlightenment that Failed: Ideas, Revolution, and Democratic Defeat, 1748-1830*. Oxford and New York: Oxford University Press.
ISTC (1998). "Incunabula Short Title Catalogue." London: British Library. URL: https://data.cerl.org/istc/_search (visited on 01/14/2021).
Jacob, **Margaret C., and Larry Stewart** (2004). *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687-1851*. Cambridge, MA: Harvard University Press.
Kamen, **Henry** (1997). *Philip of Spain*. New Haven, CT: Yale University Press.
Kamen, **Henry** (2014). *The Spanish Inquisition: A Historical Revision*. New Haven, CT: Yale University Press.
Kertzer, **David I.** (2015). *The Pope and Mussolini: The Secret History of Pius XI and the Rise of Fascism in Europe*. Illustrated Edition. New York: Random House Trade Paperbacks.
Kiepert, **Heinrich** (1869). "Völker- und Sprachen-Karte von Österreich und den Unter-Donau-Ländern." URL: https://collections.library.yale.edu/catalog/15497810 (visited on 04/04/2023).
Landes, **David S.** (1998). *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*. New York: W. W. Norton & Company.
Langhans, **Paul**, ed. (1904). *Deutsche Erde : Zeitschrift für Deutschkunde : Beiträge zur Kenntnis deutschen Volkstums allerorten und allerzeiten*. Gotha: Justus Perthes.
Laouenan, **Morgane**, **Palaash Bhargava**, **Jean-Benoît Eyméoud**, **Olivier Gergaud**, **Guillaume Plique, and Etienne Wasmer** (2022). "A cross-verified database of notable people, 3500BC-2018AD." *Scientific Data* 9 (1): 290.
Lea, **Henry Charles** (1890). *Chapters from the religious history of Spain connected with the Inquisition*. Philadelphia: Lea Brothers.
Lea, **Henry Charles** (2010). *The Inquisition in the Spanish Dependencies: Sicily, Naples, Sardinia, Milan, the Canaries, Mexico, Peru, New Granada*. Cambridge: Cambridge University Press.
Lees, **Lynn Hollen, and Paul M. Hohenberg** (1989). "Urban Decline and Regional Economies: Brabant, Castile, and Lombardy, 1550–1750." *Comparative Studies in Society and History* 31 (3): 439–461.
Linder, **Robert Dean** (2008). *The Reformation Era*. Westport, Connecticut: Greenwood Publishing Group.
López Piñero, **José María** (1979). *Ciencia y técnica en la sociedad española de los siglos XVI y XVII*. Barcelona: Labor universitaria.
López Piñero, **José María**, **Thomas F. Glick**, **Victor Navarro Brotóns, and Eugenio Portela Marcos**, eds. (1983). *Diccionario histórico de la ciencia moderna en España*. Barcelona: Ediciones Península.
Luttikhuizen, **Frances** (2017). *Underground protestantism in sixteenth century Spain: a much ignored side of Spanish history*. Göttingen: Vandenhoeck & Ruprecht.
Ma, **Chicheng** (2021). "Knowledge Diffusion and Intellectual Change: When Chinese Literati Met European Jesuits." *The Journal of Economic History* 81 (4): 1052–1097.
MacKenney, **Richard** (1993). *Sixteenth Century Europe: Expansion and Conflict*. London: Macmillan.
Magocsi, **Paul R.** (2018). *Historical Atlas of Central Europe*. 3rd. University of Toronto Press.

Malanima, **Paolo** (2011). "The long decline of a leading economy: GDP in central and northern Italy, 1300-1913." *European Review of Economic History* 15 (2): 169–219.
Malinowski, **Mikołaj, and Jan Luiten van Zanden** (2017). "Income and its distribution in preindustrial Poland." *Cliometrica* 11 (3): 375–404.
Maltby, **William S.** (2009). *The Rise and Fall of the Spanish Empire*. New York: Palgrave.
Merton, **Robert K.** (1936). "Puritanism, Pietism, and Science." *The Sociological Review* a28 (1): 1–30.
Merton, **Robert K.** (1938). "Science, Technology and Society in Seventeenth Century England." *Osiris* 4: 360–632.
Merton, **Robert K.** (1968). *Social Theory and Social Structure*. New York: Macmillan.
Mira Caballos, **Esteban** (2002). "El padrón de vecinos de sevilla y su tierra de 1571." Unpublished manuscript. Universidad de Sevilla.
Mokyr, **Joel** (1990). *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford University Press.
Mokyr, **Joel** (2005). "Long-Term Economic Growth and the History of Technology." In: *Handbook of economic growth*. Ed. by Philippe Aghion and Steven N. Durlauf. Vol. 1. Amsterdam: Elsevier, 1113–1180.
Mokyr, **Joel** (2017). "Religion, Culture and the Great Enrichment." Tech. rep. Northwestern University.
Morgan, **Philip** (2002). *Fascism in Europe, 1919-1945*. London: Routledge.
Murdock, **Graeme** (2000). *Calvinism on the Frontier 1600-1660: International Calvinism and the Reformed Church in Hungary and Transylvania*. 1st edition. Oxford : Oxford ; New York: Clarendon Press.
Nalle, **Sara T.** (1989). "Literacy and Culture in early modern Castile." *Past & Present* (125): 65–96.
Nexon, **Daniel H.** (2009). *The Struggle for Power in Early Modern Europe: Religious Conflict, Dynastic Empires, and International Change*. Princeton, NJ: Princeton University Press.
Nolte, **Ernst** (1966). *Three Faces of Fascism: Action Francaise, Italian Fascism, National Socialism*. New York: Henry Holt & Company.
Nuessli, **Cristos** (2011). "Geographical Maps." URL: http://www.euratlas.com/about.htm.
O'Connell, **Marvin R.** (1974). *Counter-reformation, 1550-1610*. The Rise of Modern Europe. New York: Joanna Cotler Books.
O'Malley, **John W.** (2013). *Trent: What Happened at the Council*. Cambridge, MA: Harvard University Press.
Oftestad, **Bernt Torvild** (2019). *The Catholic Church and Liberal Democracy*. New York: Routledge.
Ogilvie, **Sheilagh, and Markus Küpker** (2015). "Human Capital Investment in a Late-Developing Economy: Evidence from Württemberg, c. 1600 – c. 1900." Working Paper 1528, p. 81.
Palma, **Nuno, and Jaime Reis** (2019). "From Convergence to Divergence: Portuguese Economic Growth, 1527–1850." *The Journal of Economic History* 79 (2): 477–506.
Pardo Tomás, **José** (1991). *Ciencia y censura: la inquisición española y los libros científicos en los siglos XVI y XVII*. Madrid: Editorial CSIC.
Parker, **Geoffrey** (1977). *The Dutch Revolt*. London: Penguin Books.
Parker, **Geoffrey** (1997). *The Thirty Years' War*. 2nd ed. New York: Routledge.
Parker, **Geoffrey** (2004). *The Army of Flanders and the Spanish Road, 1567-1659: The Logistics of Spanish Victory and Defeat in the Low Countries' Wars*. Cambridge: Cambridge University Press.
Parker, **Geoffrey** (2013). *Global Crisis: War, Climate Change and Catastrophe in the Seventeenth Century*. New Haven, CT: Yale University Press.
Parker, **Geoffrey** (2014). *Imprudent King: A New Life of Philip II*. New Haven, CT: Yale University Press.
Pérez, **Joseph** (2005). *The Spanish Inquisition: A History*. New Haven, CT: Yale University Press.
Pettegree, **Andrew** (2010). *The book in the Renaissance*. New Haven, CT: Yale University Press.
Philpott, **Daniel** (2004). "The Catholic Wave." *Journal of Democracy* 15 (2): 32–46.
Pius IX, **Pope** (1865). "Syllabus Errorum (Syllabus of Errors, 1864)." In: *Pastoral Letter Promulgating the Jubilee*. Trans. by Martin John Spalding. Baltimore: Kelly & Piet.
Pollard, **John** (2007). "'Clerical Fascism': Context, Overview and Conclusion." *Totalitarian Movements and Political Religions* 8 (2): 433–446.
Portuondo, **María M.** (2009). *Secret Science: Spanish Cosmography and the New World*. Chicago: University of Chicago Press.
Posselt, **Alfred** (1956). "Das Schicksal Des Ostprotestantismus." *Osteuropa* 6 (1): 45–55.
Prados de la Escosura, **Leandro**, **Carlos Álvarez-Nogal, and Carlos Santiago-Caballero** (2021). "Growth recurring in preindustrial Spain?" *Cliometrica*.

Quételet, **L. Adolphe J.** (1864). *Histoire des Sciences Mathématiques et Physiques chez les Belges*. Bruxelles: Hayez.

Reclus, **Élisée** (1881). *The Earth and its inhabitants ...* Ed. by A. H. Keane and Ernest George Ravenstein. Vol. 4. New York: D. Appleton and company.

Reis, **Jaime** (2005). "Economic Growth, Human Capital Formation and Consumption in Western Europe Before 1800." In: *Living standards in the past: new perspectives on well-being in Asia and Europe*. Ed. by Robert C. Allen, Tommy Bengtsson, and Martin Dribe. Oxford and New York: Oxford University Press.

Reusch, **Franz H.** (1883). *Der Index der verbotenen Bücher: Ein Beitrag zur Kirchen- und Literaturgeschichte*. Bonn: Cohen.

Rodrígues, **Graça Almeida** (1980). *Breve História da Censura Literária em Portugal*. Ministério da Educação e Ciência, Instituto de Cultura e Língua Portuguesa.

Roehner, **Bertrand M.** (1997). "Jesuits and the State: A Comparative Study of their Expulsions (1590–1990)." *Religion* 27 (2): 165–182.

Rubin, **Jared** (2017). *Rulers, Religion, and Riches: Why the West Got Rich and the Middle East Did Not*. Cambridge Studies in Economics, Choice, and Society. New York: Cambridge University Press.

Santarelli, **Daniele**, **Luca Al Sabbagh**, **Herman H. Schwedt, and Domizia Weber** (2017). *I giudici della fede: L'Inquisizione romana e i suoi tribunali in età moderna*. Firenze: Edizioni CLORI.

Schilling, **Heinz** (2007). "Konfessionalisierung und Staatsinteressen." In: *Handbuch der Geschichte der Internationalen Beziehungen*. 2007th ed. 9 2. Paderborn: Verlag Ferdinand Schöningh, 675.

Schön, **Lennart, and Olle Krantz** (2015). "New Swedish Historical National Accounts since the 16th Century in Constant and Current Prices." Tech. rep. 140. Lund University, Department of Economic History.

Schwetschke, **Gustav** (1850). *Codex nundinarius germaniae literatae bisecularis. Meß-Jahrbücher des Deutschen Buchhandels von dem Erscheinen des ersten Meß-Kataloges im Jahre 1564 bis zu der Gründung des ersten Buchhändler-Vereins im Jahre 1765*. Halle: Schwetschke.

Schwetschke, **Gustav** (1877). *Codex nvndinarivs Germaniae literatae continvatvs. Der Meß-Jahrbücher des Deutschen Buchhandels Fortsetzung die Jahre 1766 bis einschließlich 1846 umfassend*. Halle: Schwetschke.

Scibner, **Robert William** (1976). "Why was there no Reformation in Cologne?" *Bulletin of the Institute of Historical Research* 49 (120): 217–241.

Serafinelli, **Michel, and Guido Tabellini** (2022). "Creativity over time and space." *Journal of Economic Growth* 27 (1): 1–43.

Shore, **Paul** (2020). "The Years of Jesuit Suppression, 1773–1814: Survival, Setbacks, and Transformation." *Brill Research Perspectives in Jesuit Studies* 2 (1): 1–117.

Sigmund, **Paul E.** (1987). "The Catholic Tradition and Modern Democracy." *The Review of Politics* 49 (4): 530–548.

Sigmund, **Paul E.** (1994). "Catholicism and liberal democracy." In: *Catholicism and Liberalism: Contributions to American Public Policy*. Ed. by David Hollenbach and R. Bruce Douglass. Cambridge Studies in Religion and American Public Life. Cambridge: Cambridge University Press, 217–241.

Sorokin, **Pitirim A.** (1937). *Fluctuation of systems of truth, ethics, and law*. Social and Cultural Dynamics, Vol. II. New York: American Book Company.

Squicciarini, **Mara P.** (2020). "Devotion and Development: Religiosity, Education, and Economic Progress in Nineteenth-Century France." *American Economic Review* 110 (11): 3454–3491.

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

Stephan, **Michael** (2012). "Zensur (Altbayern und Bayern)." Historisches Lexikon Bayerns. URL: https://www.historisches-lexikon-bayerns.de/Lexikon/Zensur_(Altbayern_und_Bayern) (visited on 09/21/2020).

Stephens, **W. B.** (1990). "Literacy in England, Scotland, and Wales, 1500-1900." *History of Education Quarterly* 30 (4): 545–571.

Stollberg-Rilinger, **Barbara** (2017). *Maria Theresia: Die Kaiserin in ihrer Zeit*. Munich: C.H. Beck.

Van Horn Melton, **James** (1986). "From Image to Word: Cultural Reform and the Rise of Literate Culture in Eighteenth-Century Austria." *The Journal of Modern History* 58 (1): 95–124.

Van Horn Melton, **James** (1988). *Absolutism and the Eighteenth-Century Origins of Compulsory Schooling in Prussia and Austria*. Cambridge: Cambridge University Press.

Vanpaemel, **Geert** (2003). "Jesuit Science in the Spanish Netherlands." In: *Jesuit Science and the Republic of Letters*. Cambridge, MA: MIT Press, 389–432.

Van Zanden, **Jan Luiten**, **Eltjo Buringh, and Maarten Bosker** (2012). "The rise and decline of European parliaments, 1188–1789." *The Economic History Review* 65 (3): 835–861.

Vatican, **the, and the Congregation for the Doctrine of the faith** (1966). "Notification regarding the abolition of the Index of books." *Acta Apostolicae Sedis* 58: 445.

Verardi, **Donato** (2021). "Review of Al Sabbagh, Luca; Santarelli, Daniele; Schwedt, Herman H.; Weber, Domizia, I giudici della fede: L'Inquisizione romana e i suoi tribunali in età moderna." URL: https://www.h-net.org/reviews/showrev.php?id=56718 (visited on 11/01/2022).

Verger, **Jacques** (1991). "Patterns." In: *A History of the University in Europe: Volume 1: Universities in the Middle Ages*. Ed. by Hilde de Ridder-Symoens. Vol. 1. A History of the University in Europe. Cambridge: Cambridge University Press, 35–74.

Verhoeven, **Gerrit** (2014). "'Le pays où on ne sait pas lire': Literacy, Numeracy and Human Capital in the Commercial Hub of the Austrian Netherlands (1715–75)." *European History Quarterly* 44 (2): 223–243.

Vidal-Robert, **Jordi** (2013). "War and Inquisition: Repression in Early Modern Spain." CAGE Online Working Paper Series 119. Competitive Advantage in the Global Economy (CAGE).

Viñao, **Antonio** (1998). "Liberalismo, alfabetización y primeras letras (siglo XIX)." *Bulletin Hispanique* 100: 531–560.

Voigtländer, **Nico, and Hans-Joachim Voth** (2012). "The three horsemen of riches: Plague, war, and urbanization in early modern Europe." *Review of Economic Studies* 80 (2): 774–811.

Wilke, **Jürgen** (2013). "Censorship and Freedom of the Press." European History Online (EGO). Mainz: Leibniz Institute of European History (IEG).