Sympathy for the Devil*

José-Antonio Espín-Sánchez†

Abstract

Saint Thomas Aquinas argued in the 13^{th} century that the devil operates in the physical world through natural laws, not supernatural powers. Telling true miracles from demonic imitation therefore required knowing those laws, and investigating nature became a Christian duty. I trace the consequences of this doctrine through the institutions that enforced it: the exorcism record of the Cathedral of Murcia (1406–1941), the diabolism charges of European witch trials, the evidentiary reforms of the Spanish Inquisition, and the medicalization of Vatican miracle certification. The Dominican order taught the new curriculum, and its medieval network of houses predicts where Europe produced scientists between 1450 and 1800. Holding region, medieval population, and the co-located Franciscan network fixed, only Dominican density predicts scientist production, and the medieval stock predicts post-1550 science equally well in Protestant territories that had dissolved every house by 1580. The knowledge accumulated under this doctrine eventually displaced religion from the physical world.

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†Department of Economics, Yale University.

1 Introduction

Sustained economic growth comes from technological change: the Industrial Revolution, electricity, antibiotics, computing. The other sources of growth, capital accumulation and specialization and trade, eventually run into diminishing returns. Technology is knowledge of nature turned into power over nature (Mokyr, 2016). The origins of the relationship between humans and nature lie in magic and religion. Disasters were read as signs of what a god intended, and the answer was a ceremony. Before the 13^{th} century every major world religion discouraged the investigation of natural disasters by framing them as expressions of divine will or harmony. The rational response to a plague of locusts was prayer, not research.

If the history of technology is one invention after another, from Watt's engine to Bessemer's converter to Edison's bulb, then the history of the science behind it is one scholar after another proving Aristotle wrong: Galileo on motion, Harvey on the circulation of the blood, Newton on the heavens. That raises a question the inventions do not answer. Why did Europeans have an Aristotle to disprove when the Chinese did not (Needham, 1956)? Aristotle was nearly lost in the Latin West, and he came back in the 12^{th} and 13^{th} centuries through Arabic translation. What turned him into the common property of every educated European was a work of theology. Saint Thomas Aquinas argued in his *Summa Theologica* (1274) that the devil operates in the physical world through natural laws, not supernatural powers. True miracles can only come from God. The devil, a fallen angel with complete knowledge of physical laws, produces events that *look* like miracles. People therefore have a *duty* to learn those laws, so that they can tell true miracles from false ones and not be fooled.

This paper argues that turning the devil into a natural agent created institutional incentives for empirical research, and that those incentives shaped the long-run path of European economic development. The argument has three phases. In the first phase, before Aquinas, the harmonious consensus held everywhere. In the second phase, from the 13^{th} century to the early 20^{th} in Europe, Aquinas's theological framework created a duty to investigate nature, and the

replacement of Peter Lombard's Platonic *Sentences* by the Aristotelian *Summa* as the standard university textbook trained every educated European in observation, categorization, and causal reasoning. The experimentation that followed produced cumulative technological change: the Age of Discovery, the Renaissance, the Enlightenment, and the Industrial Revolution. In the third phase, the science that Thomistic theology encouraged displaced religion from the physical world. The Church built the tools that made itself partially redundant.

I present five bodies of empirical evidence for this transformation. First, using archival records from the Cathedral of Murcia (c. 1300–2000), I trace how exorcisms (*conjuros*) changed over centuries. Conjuros are absent from early medieval records. They appear in the 15^{th} century and are aimed almost entirely at pest plagues (locusts, insects, birds), which are exactly the events the new doctrine had reassigned to the devil. The pest share then falls from near 100 percent in the 15^{th}–17^{th} centuries to roughly one-sixth in the 19^{th} and zero in the 20^{th}. Conjuros peak in volume in the 19^{th} century. By the late 19^{th} century the ceremony was performed routinely each May, directed at no particular disaster (Espín-Sánchez and Gil-Guirado, 2026).

Second, I examine European witch trials in two complementary datasets. In Kieckhefer (1976)'s compilation of 476 confirmed trials before 1500, the share of trials carrying explicit charges of diabolism (pacts with the devil, attendance at sabbats) rises from near zero before 1400 to roughly 30 percent by the late 15^{th} century. Trials cluster geographically around Dominican houses, where the Thomistic curriculum was taught. In the larger Leeson and Russ (2018) dataset of 43,240 persons tried (1300–1850), 7.3 percent of all persons tried were prosecuted before the Reformation existed, and 28.1 percent after the Peace of Westphalia ended the wars of religion. Competition between confessions cannot on its own produce that pattern. The prosecution machinery first appears where Thomistic demonology had the firmest hold, and it persists long after religious conflict subsides.

Third, the Spanish Inquisition was a centralized institution working inside the Thomistic tradition. It applied something close to empirical method to supernatural claims. Between 1611 and 1612, the inquisitor Alonso de Salazar Frías interviewed 1,802 individuals accused of

witchcraft, cross-examined witnesses, physically tested alleged magical substances, and concluded that none of the accusations could be substantiated. He set out the findings in his first memorial to *La Suprema* in March 1612. The 1614 instructions that followed kept Spanish witch executions to 300–500, against an estimated 40,000–60,000 in Northern Europe.

Fourth, I study the miracles submitted in Catholic canonization proceedings, using data from Duffin (2009) and Parigi (2012). The share of healing miracles (as against exorcisms, levitations, and other wonders with no medical content) rises from 92 percent in the 16^{th} century to over 97 percent in the 20^{th}. Claims involving demons all but vanish after 1700. The number of physicians required to testify rises from one to three in the early modern period to nearly five by the 20^{th} century. Cases surged once the new procedural rules of the Counter-Reformation came into effect. Process openings peak at 46 to 54 candidates per quarter-century between 1600 and 1650. The number of new saints did not increase: the rate at which open processes converted into saints fell from 43 percent for the cohort opened in 1600–1649 to 15 percent for the cohort opened in 1650–1699. Canonization turns on the characteristics of the saint and their following rather than on the miracle: indicators for the specific content of the miracle dossier are individually and jointly insignificant, while the existence and thickness of the dossier dominate. The Vatican designed its canonization procedure to certify holiness through supernatural signs of many kinds, then narrowed what it would accept as evidence to healing that a physician could verify. Over four centuries an empirical machine built in the service of the supernatural rejected the very category of explanation that had justified its creation.

Fifth, I trace how the new dogma itself spread. The *Summa* moved with the Dominicans, and their houses were in place long before any of the outcomes I measure existed: 885 geocoded foundations, two-thirds of them established within a century of the order's foundation. Grid cells and regions with denser Dominican networks produce more scientists between 1450 and 1800, measured both by the Science cluster of the RETE academic database (De la Croix, 2021) and by the notable scientists of the Laouenan et al. (2022) database. Three results sustain the causal claim. The Franciscans are the natural comparison group: a mendicant network of the

same vintage, in the same towns, with a different intellectual programme. Holding macro-region, medieval city population, and the Franciscan stock fixed, only Dominican density predicts scientist production. The channel also survives the destruction of the institution itself: in Protestant territories that dissolved every mendicant house by 1580, the medieval Dominican stock predicts post-1550 science just as strongly as in Catholic Europe. The channel is specific to the upper tail of human capital: the same network does not predict overall city population growth in any window between 1500 and 1800.

Mokyr (2016) traces the cultural and institutional changes of the 16^{th} and 17^{th} centuries that supported knowledge production, and makes Francis Bacon the "cultural entrepreneur" who articulated the value of experimental knowledge. I cast Thomas Aquinas as an earlier cultural entrepreneur, whose theological innovations created the foundations for the experimental approaches Bacon would later formalize. The point is not simply that Mokyr's timeline should be pushed back. Across the continent, replacing the Platonic *Sentences* with the Aristotelian *Summa* as the standard teaching text changed the *content* of what educated Europeans learned, and European learned men after Aquinas had an "Aristotle" to engage with, to test, and to disprove through experiment. The rest of the world had only a "Platonic" reference point. Mokyr (1990) emphasizes technological innovation as the primary driver of growth, and Mokyr (2002) argues that the acceleration of living standards after 1750 depended on a community committed to producing and sharing propositional knowledge about the natural world. The Thomistic curriculum helped build the human capital base from which that community was recruited.

The existing literature on religion and growth has not identified this specific mechanism. Becker et al. (2024) survey the channels through which religion affects economic performance (physical capital, human capital, labor supply, and productivity). Bénabou et al. (2022) formalize a model in which scientific discoveries raise productivity but may erode religious beliefs, and their causal arrow runs from science to doctrinal response. The model admits several long-run regimes: a secular path with unimpeded science, a theocratic path in which religious authorities block

discovery, and an intermediate path in which religion and science coexist because doctrine adapts. I propose a historical mechanism that selects among the regimes: a 13^{th}-century theological reform, undertaken for purely internal reasons with no scientific challenge to accommodate, unintentionally created the conditions that made sustained empirical research possible. The Averroist controversy of the 13^{th} century was the moment Europe moved from the theocratic equilibrium to the coexisting one. The coexisting equilibrium need not be stable: as scientific discoveries crowd out religious explanations of the natural world, the long-run equilibrium is the secular path. Europe's settlement on the middle regime was not inevitable. The same Aristotelian corpus reached the Islamic world two centuries earlier, and there the parallel debate between theology and natural philosophy settled on the opposite equilibrium (Subsection 2.4).

Rubin (2017) shows how religious legitimacy affected political and economic development in Western Europe compared with the Middle East. The rise of the madrasa system in the 11^{th} and 12^{th} centuries shifted Islamic learning *toward* religious sciences and *away* from rational sciences (Chaney, 2023). Schulz et al. (2019) show how the medieval Church's marriage regulations weakened extended kinship networks and encouraged an individualist and impersonally prosocial psychology. Arruñada and López-Manuel (2026) document opposing long-run effects of Dominican and Franciscan exposure on individualism, impersonal prosociality, and the regional density of notable scientists, and trace the difference to the orders' distinct doctrinal specializations.

This paper makes three contributions. First, it identifies a theological innovation (the redefinition of the devil as an agent who works through nature) as a source of incentives for empirical research with long-run economic consequences. Second, it assembles five independent bodies of evidence, spanning centuries. Third, it offers a new account of why the Scientific Revolution happened in Europe rather than elsewhere: not because Europeans were more rational, but because a 13^{th}-century theological dispute about the limits of demonic power gave European intellectuals both the duty and the training to investigate the natural world.

Section 2 describes the pre-Thomistic worldwide consensus of acceptance of natural disasters and the evolution of the devil. Section 3 presents the Thomistic revolution. Section 4 presents

the empirical results. Section 5 discusses how Thomistic theology eventually displaced religion from the physical world. Section 6 concludes.

2 Living on a Prayer

Every major world religion before the 13^{th} century met natural disasters with acceptance. Paganism, Christianity, Judaism, Islam, Hinduism, Buddhism, and Taoism differed deeply on theology, but all of them read environmental catastrophe as an expression of divine will, cosmic order, or karmic consequence. Under any of these frameworks the economically rational response was prayer rather than investigation.

2.1 Harmony

Abrahamic religions treated natural disasters as divine punishment for human sin. The biblical plagues of Egypt (locusts, hail, and disease) are sent explicitly as punishment (Exodus 7–11). Faced with drought, pestilence, or storms, the rational response under this framework was penance and prayer rather than investment in understanding natural causes. Communities put resources into ceremonies during environmental crises, which was rational given prevailing beliefs about causation (Iannaccone, 1998). Medieval and early modern Christian responses to natural disasters ran to prayer, fasting, and heavier religious observance rather than to systematic study of natural causes (Bartlett, 2008; Espín-Sánchez et al., 2026). Giuliano and Nunn (2021) show that the value of inherited practices depends on the stability of the environment: traditions persist where the world changes slowly, because what worked for one generation still works for the next. Belief systems that discourage material investigation may limit innovation for preventing or mitigating disasters, even as they offer coping benefits during crises (Bentzen, 2019). Harrison (2007) argues that St. Augustine's emphasis on the corruption of human reason by the Fall offered limited grounds for sustained natural investigation. The Thomistic synthesis would later relax that constraint.

Classical Greco-Roman philosophy pushed in the same direction. Stoic philosophy, and Marcus Aurelius's *Meditations* above all, treated natural events as aspects of a rational cosmic order. Stoic acceptance was a cultural technology for managing uncertainty (Hadot, 1995). Chinese religious and philosophical traditions, Taoism in particular, asked people to harmonize with the natural order rather than intervene in it (Needham, 1956, vol. 2). Rosenthal and Wong (2011) describe a Chinese state that met natural disasters with administration and relief. Hindu and Buddhist traditions made *karma* the causal frame linking moral action to worldly outcome, which put the explanatory work on the moral side rather than the material one (Lal, 1998). The pattern across all these traditions was the same: little justification for systematic investigation of natural causes, resources directed toward propitiation rather than prevention, and a culture that valued acceptance over intervention. Huff (2003) argues that scientific knowledge alone did not decide which civilization crossed the threshold to modern science. Differences in legal institutions and in the organizational culture of inquiry did.[1]

2.2 *Monoponirism*

As Christianity spread across the Roman Empire and into Europe, it ran into a large and varied body of popular belief. Local populations held convictions about fairies, forest spirits, water nymphs, household goblins, and other preternatural beings, each one grounded in regional folklore and resistant to theological correction. Church councils condemned these beliefs for centuries. The Council of Braga (572), the Indiculus Superstitionum (c. 743), and dozens of penitentials and episcopal capitularies all targeted belief in spirits, yet the beliefs persisted (Flint, 1991; Bailey, 2013).

The problem was one of evidence: the Church could not prove a negative. Even if a priest could show that a particular event (a blighted crop, a sick child, a strange light in the forest)

[1] Kuran (2011) shows that legal institutions rooted in religious tradition, among them Islamic inheritance rules and restrictions on corporate forms, put long-run economic development on a path that diverged sharply from Western Europe's. McCleary and Barro (2006) discuss the trade-off: frameworks that emphasize acceptance of misfortune can reduce welfare losses from disasters but may limit innovation for preventing or mitigating them.

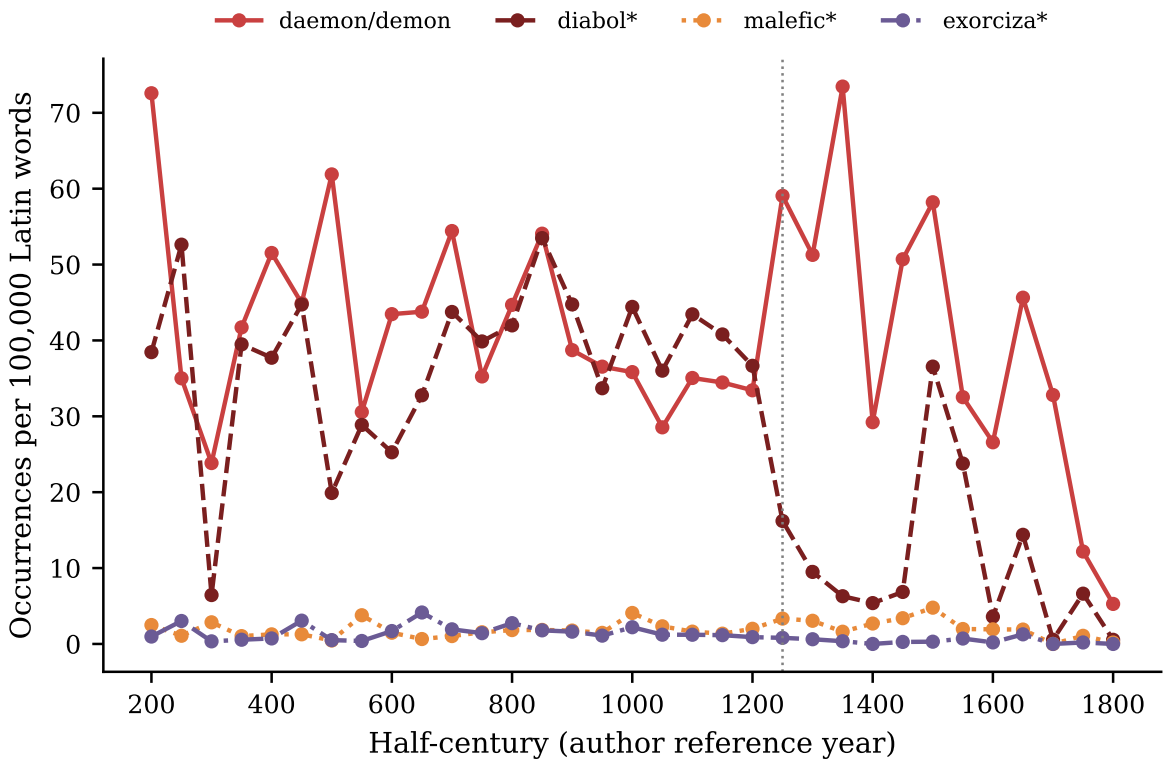
was not caused by a fairy, he had not shown that fairies do not exist. The sheer variety of folk belief made the task impossible. Each local tradition posited different beings with different powers, and refuting one left all the others standing. The theological solution was not to deny the reality of these experiences but to consolidate them under a single cause already present in Christian dogma: the devil. What I call *monoponirism* (from the Greek *ponēros*, "the evil one") is the structural feature of late Christianity that posits a single personified source of evil able to produce every kind of illusion and mischief. Under *monoponirism* the Church did not need to prove that fairies, elves, or forest spirits were unreal. It needed only to assert that all such appearances were the work of the devil, who could assume any form and produce any illusion.

This consolidation had institutional advantages. Pre-Christian "pantheons" of major gods tended to disappear almost immediately at conversion (see Brückner, 1918, for the Slavic case). Minor beings (fairies, nymphs, household spirits) survived precisely by being recast in diabolical form. Local spirits were not suppressed but consolidated and standardized into a unified diabolical category, and that is how Christian "demons" came into being (Frankfurter, 2006). The Latin vocabulary kept the two-level structure throughout: *diabolus* for the singular cosmic adversary, *daemones* for the plural lower-order spirits that absorbed the local folk inventory. The Fourth Lateran Council of 1215 wrote the distinction into canon law ("*Diabolus enim et alii daemones*", Russell, 1984; Kelly, 2006). I trace the divergence of the two terms across more than two hundred million words of Latin (see Appendix C.3).[2] Figure 1 shows the *diabol** and *daemon** registers separating precisely in the 1250–1300 window that the theological account predicts.

The strategy acknowledged popular belief and neutralized it at the same time. By attributing

[2]This is the first of four text corpora the paper draws on, each covering a language and period the others do not. The Latin reference corpus gives full text: 8,063 dated documents and 203 million words from the 2^{nd} century to the 19^{th} (Appendix A.9). The Incunabula Short Title Catalogue gives the titles of 30,680 editions from the first half-century of print (Appendix A.10). The EarlyPrint corpus gives full text for roughly 60,000 English books printed 1473–1700 (Appendix A.11). The Google Books corpora give word frequencies in five languages from 1500 to 2019 (Appendix A.8). Almelhem et al. (2026) work with a fifth corpus of the same family, the HathiTrust bag-of-words representations of 264,443 English volumes printed 1500–1900, and find the languages of science and religion separating from the mid-18^{th} century.

Figure 1: Diabolical vocabulary in the Latin corpus, second through nineteenth centuries.



Notes: Each series gives the frequency of the labelled Latin stem per hundred thousand words, aggregated over 8,063 documents in the Patrologia Latina and twenty-five adjacent Corpus Corporum sub-corpora. The vertical dotted line marks 1250 (the half-century of the *Summa Theologica*). Appendix C.3 gives the theological account and Appendix B.4.2 the corpus construction.

all preternatural experiences to the devil, the Church did not need to persuade a peasant that the spirits in his forest were imaginary, a claim the peasant would find absurd given the evidence of his own senses. The Church could instead affirm that something real had occurred while insisting that its true cause was diabolical. The rituals attached to local spirits could now be classified as dealings with the devil, which put them under ecclesiastical jurisdiction and made them punishable as superstition or, in extreme cases, heresy.

Flint (1991) shows that the Church absorbed some non-Christian magical practices and demonized the rest: practices that could be Christianized were kept, and those that could not were condemned as diabolical. *Monoponirism* and the folk beliefs it displaced are not symmetric. A peasant tradition that posits dozens of independent spirits, each with its own personality, habitat, and mode of interaction with humans, cannot be refuted one spirit at a time. *Monoponirism*

reduces the problem to a single claim: the devil exists and can produce illusions. That claim was already settled dogma and required no new evidence. The institutional machinery built to run this explanation (the penitentials, the episcopal courts, and eventually the inquisitorial apparatus) later proved decisive in shaping how European societies responded to other unexplained events, from natural disasters to epidemic disease. A similar framework was used to assess true miracles (see Subsection 3.3).

Consolidation under a single evil cause was not the only option available to a monotheism absorbing a populated spirit world, and the comparison with Islam shows it. The jinn of the Quran are not devils. They are a third class of created beings alongside angels and humans, made from smokeless fire (Quran 55:15), who eat, marry, die, and choose: "And among us are the righteous, and among us are [others] not so: we were [of] divided ways" (Quran 72:11). Whole communities of jinn hear the Quran and convert (Quran 46:29–32 and 72:1–2). El-Zein (2009) shows that Islamic theology and law took the moral mixture of the jinn seriously. Jurists discussed the legal status of marriages between humans and jinn, the property rights of jinn, and the religious obligations of Muslim jinn. The jinn are morally mixed beings who share the world with humans, which puts them far closer to the elves, fairies, and household spirits of the European folk inventory than to the consolidated Christian demon. Latin Christendom inherited a comparable folk inventory and made the opposite choice. Green (2016) documents how clerical writers between the 12^{th} and 15^{th} centuries systematically reclassified the fairies of vernacular belief as demons, collapsing a varied spirit world into the single diabolical category that the Fourth Lateran Council's canon *Firmiter* (1215) had made dogma.

Among world religions this codification stands out. Judaism kept Satan an accuser operating inside the divine court and left the *shedim* of folk belief morally ambiguous, with no machinery to rule on them (Pagels, 1995). In the Hebrew Bible *satan* is ordinarily a common noun, an adversary or an accuser, and not the name of one being. The single personified adversary is a later construction, built up in the sectarian writing of the Second Temple period and taken over by early Christians to name their opponents Pagels (1995). Islam retained the morally mixed

jinn alongside Iblīs and his *shayāṭīn* (El-Zein, 2009). The karmic traditions spread misfortune impersonally and fill the cosmos with asuras, yakshas, and rakshasas that are dangerous but not agents of a unified evil (Lal, 1998). Zoroastrianism comes closest with Angra Mainyu, but its dualism posits two rival primordial principles, while *Firmiter* insists on the opposite: "*Diabolus enim et alii daemones a Deo quidem natura creati sunt boni*". The devil and the other demons were created good by God and fell by their own act (Boyce, 1979; Russell, 1984; Kelly, 2006). Medieval Latin Christianity is the one major tradition that consolidated its entire preternatural inventory under a single created adversary and wrote the consolidation into canon law. That codification gave the Church uniform jurisdiction over every preternatural claim. Once Aquinas made the demons work through natural causes, it supplied a uniform reason to investigate them as well.

2.3 Aristotle Reloaded

The Thomistic revolution required Aristotle, and Aristotle had to travel a long way to reach 13^{th}-century Paris. When the Roman Empire collapsed in the West during the 5^{th} century, much of the Greek intellectual heritage (Aristotle, Galen, Euclid, Ptolemy) was at risk of being lost. A central role in preserving these texts fell to the Nestorian Christians, who followed Nestorius, Patriarch of Constantinople. After the Council of Ephesus condemned his theological views in 431 AD, their communities moved east, taking extensive libraries of Greek philosophical and scientific manuscripts with them. They settled mainly in the Sassanid Persian Empire and built major centers of learning at the School of Nisibis (modern-day Turkey) and the Academy of Jundishapur (modern-day Iran, see Figure 2). At these centers Nestorian scholars translated the works of Aristotle, Hippocrates, Galen, and other Greek thinkers into Syriac, the lingua franca of Eastern Christianity.

When the Islamic conquests reached Persia in the 7^{th} century, a new phase of translation began. Under the patronage of the Abbasid caliphs, the great translation movement centered at the House of Wisdom (*Bayt al-Hikma*) in Baghdad produced Arabic versions of the Greek texts

Figure 2: The transmission of Aristotle's works (4^{th} c. BC–13^{th} c. AD.)



Notes: Each city is labeled with the name "Aristotle" in the script used by local scholars: [Greek] (Greek, Athens and Constantinople), [Syriac] (Syriac Esṭrangelā, Jundishapur), [Arabic] (Arabic, Baghdad and Córdoba), *Aristóteles* (Castilian/Latin, Toledo), and *Aristote* (French, Paris). Arrows indicate the direction of textual transmission. The southern arc from Baghdad to Córdoba shows the westward spread of Arabic scholarship across North Africa and into al-Andalus. The northern arc from Constantinople to Jundishapur follows the overland route through Anatolia and the Sasanian Empire along which Syriac Christians took Greek philosophical texts eastward.

the Nestorians had preserved in Syriac (see Figure 2). Scholars such as Hunayn ibn Ishaq (809–873), himself a Nestorian Christian, translated Greek medical and philosophical texts into Arabic, often working from the Syriac versions his coreligionists had made centuries earlier.[3] While Western Europe in the early Middle Ages had only fragments of Aristotle's logical works (and those through Boethius's Latin translations), the Islamic world had the full corpus of Aristotelian philosophy, together with extensive commentaries and original contributions by Islamic scholars (see Table C.2).

The gap between the Islamic world and Christian Europe in the 10^{th} century is visible in the size of their libraries. Under the caliph al-Ḥakam II (r. 961–976), the royal library of Córdoba

[3]On the translation movement as a whole, see Gutas (1998). Saliba (2007) sets out the Islamic scientific tradition that grew out of these translations.

reportedly held over 400,000 volumes (see al Maqqarī, 1861; Lévi-Provençal, 1953; Walker, 2003). Even the Sorbonne held only 1,017 codices when it was first cataloged in 1290.

When Christian kingdoms reconquered parts of the Iberian Peninsula during the 11^{th} and 12^{th} centuries, Western European scholars came into direct contact with the Arabic-language intellectual tradition (see Appendix C.5). Toledo fell to Christian forces in 1085, and its libraries survived the fall. The Toledo School of Translators then organized the systematic translation of Arabic philosophical and scientific texts into Latin. Translation ran in two stages: a Jewish or Muslim scholar turned the Arabic text into the vernacular, and a Christian scholar then rendered it into Latin. Aristotle thus came back to Western Europe in Latin during the 12^{th} and 13^{th} centuries, filtered through Arabic translations of Syriac translations of the Greek originals (see Table C.2).

Moses Maimonides (1138–1204), born in Cordoba, reconciled Aristotelian natural philosophy with Jewish theology in his *Guide for the Perplexed* (c. 1190) (Stroumsa, 2009). Apparent conflicts between reason and scripture could be resolved by careful interpretation, he insisted, and understanding the natural world was itself a form of worship. On divine action he held that God usually works through natural causes rather than by direct miraculous intervention, a position that would shape Aquinas deeply.

Ibn Rushd, known in the Latin West as Averroes (1126–1198) and also from Cordoba, wrote the most influential commentaries on Aristotle in the medieval world. His insistence that philosophical reasoning answers to itself earned him the title "The Commentator" in medieval European universities. Aquinas engaged Averroist readings directly in working out his own positions on the soul and the intellect (Taylor, 2012).[4] The Thomistic revolution could not have happened without this three-way encounter between Maimonidean Jewish rationalism, Averroist Islamic philosophy, and the Christian scholastic tradition. Arguing with Maimonides and Averroes is how Aquinas arrived at his distinctive positions on natural causality, demonic power, and human

[4] Burrell (1986) compares how Aquinas, Maimonides, and Averroes handled the problem of speaking about God.

knowledge, and those positions transformed European intellectual culture. The *Summa Theologica* came out of cross-cultural exchange that the recovery of Aristotelian philosophy made possible.

Aquinas was not the only scholar reading Aristotle in 13^{th}-century Paris. Roger Bacon, a Franciscan who arrived at Paris in the 1240s, caught Aristotle's errors by his own observation, called for a curriculum built on mathematics and experimental science rather than scholastic logic, and was eventually imprisoned by his order (see Appendix C.2). Aquinas went the other way. Instead of correcting Aristotle by observation, he set out to reconcile Aristotelian philosophy with Christian theology by argument. His synthesis eventually became the official philosophy of the Catholic Church, not because it was radical, but because it was the softest reform the Church would accept.

2.4 On Earth as it is in Heaven

"Your kingdom come, your will be done, on earth as it is in heaven."

Matthew 6:10

Everywhere the recovered Aristotle arrived, he posed the same institutional question: when natural philosophy and theology conflict, which one is supreme? Three answers were available. Theology could rule, with philosophy subordinated to it. Philosophy could claim autonomy inside its own domain, or the two could be placed on the same level, on the principle that truth cannot contradict truth. The answer determined whether the systematic study of nature would be protected, tolerated, or subordinated.

The Islamic world faced the question first, and its debate ran for two centuries before Europe's began. Al-Farabi, Avicenna, and Averroes built the *falsafa* tradition on the full Aristotelian corpus and treated demonstrative reason, which proceeds by proof, as a path to truth in its own right. The theologian al-Ghazali (1058–1111) attacked that tradition in his *Tahafut al-Falasifa* (*The Incoherence of the Philosophers*, c. 1095), charging the philosophers with incoherence on

twenty counts and with unbelief on three. His most consequential charge concerned causation itself. In the seventeenth discussion al-Ghazali denied that natural causes necessitate their effects: "The connection between what is habitually believed to be a cause and what is habitually believed to be an effect is not necessary, according to us" (al Ghazali, 2000, p. 170). Fire does not burn cotton. God creates the burning on the occasion of their contact, and could withhold it at will.

This occasionalism is the precise inverse of the framework Aquinas would build. Thomism insists that even the devil must work through fixed natural laws, which makes those laws worth learning. Ash'arite occasionalism dissolves natural law into the moment-by-moment will of God and leaves nothing for empirical research to test. Averroes answered al-Ghazali point by point in the *Tahafut al-Tahafut*, but the institutional contest went the other way: the madrasa system that spread from the 11^{th} century taught the religious sciences and left natural philosophy at the margins (Chaney, 2023). Because Muslim rulers drew legitimacy from religious authorities, those authorities held a permanent seat at the bargaining table and could defend theology's supremacy over rival sources of knowledge for centuries (Rubin, 2017). The equilibrium, once reached, was self-reinforcing (Bénabou et al., 2022).

Latin Christendom replayed the same debate in the 13^{th} century. The "radicals" were the Latin Averroists of the Paris arts faculty (Siger of Brabant and Boethius of Dacia), who followed Averroes in treating philosophy as autonomous and supreme within its domain, even where its conclusions strained against dogma (Van Steenberghen, 1970). The Franciscan school (Bonaventure, then Pecham and the authors of the *Correctoria*) held that theology was supreme and that the new philosophy needed correction wherever it touched doctrine. The Dominicans (Albertus Magnus and Aquinas) took the middle position: theology and philosophy are distinct sciences, each sovereign over its own objects, and a genuine conflict between them is impossible because both descend from the same author (Grant, 1996). In 1270 and 1277 the condemnations tried to impose the Franciscan answer by decree: Bishop Tempier's 219 articles attacked the Averroists and Thomistic theses on nature's regularity (Wippel, 1995; Bianchi, 1998).

For fifty years the European outcome was undecided, and each of the three settlements had a

live constituency. Had Tempier's condemnation held, Latin Europe would have institutionalized the same answer as the Islamic world (theology supreme) a generation after al-Ghazali's answer had hardened into the madrasa curriculum. Had the Averroists prevailed, philosophy would have been autonomous but institutionally homeless, confined to an arts faculty with no network of houses to spread it across the continent. Aquinas was canonized in 1323, the Paris condemnation was revoked in 1325, and the *Summa* spread through the Dominican network (Subsection 4.5). That outcome locked in the only one of the three settlements under which investigating nature was a religious duty rather than a tolerated or suspect activity. In the language of Bénabou et al. (2022), the 13^{th}-century contest is the moment Europe selected the regime in which religious institutions adapt doctrine to absorb discovery rather than block it. Nothing about that selection was unavoidable: the two civilizations read the same Aristotle, debated the same question, and reached different equilibria.

3 Raising Hell

The theological changes described in this section span the 13^{th}–18^{th} centuries and work through a single mechanism: once demonic activity had to obey natural law, investigating natural law became an obligation of faith.

3.1 *Inferno*

> *Il maestro di color che sanno*
>
> Dante Alighieri (1321), *Inferno*, IV.131

The problem Aquinas faced with Aristotelian philosophy mirrors the one Dante faced with Aristotle in the *Inferno*. Dante could not put the greatest minds of antiquity in the flames next to murderers and heretics. He could not put them in Paradise either, because they had died without baptism. His solution was Limbo, the first circle of Hell, where Aristotle sits honored but permanently cut off from God: *il maestro di color che sanno*, "the master of those who

know" (Alighieri, 1321, IV.131). Classical wisdom sits inside a Christian frame it cannot escape. Aquinas's treatment of demonic causation has the same shape.

Aquinas's largest innovation was to redefine how people should relate to the natural world. Where earlier frameworks emphasized acceptance, he made humans stewards, responsible for understanding and managing natural processes. In his *Summa Theologica* (I, q.96) he argued that humanity's dominion over nature is a *divine mandate* that requires active engagement rather than passive acceptance. This created new incentives to invest in natural knowledge, because such investment now counted as fulfilling divine purpose rather than as impious interference. The same idea reappears in what Mokyr (2016) identifies as the "Baconian program" for the conquest of nature.[5] Francis Bacon wanted knowledge that would serve human beings, and technology that would improve the conditions of life. Aquinas wanted knowledge that would tell demonic causation from natural causation, or knowledge for its own sake. In modern terms, and stretching both definitions, Bacon argued for applied science and Aquinas for basic science.

Early Christian texts made the devil chiefly a spiritual adversary, a tempter and an accuser more than a cause of physical events (Russell, 1981; Kelly, 2006). Satan worked in moral and spiritual domains rather than as an independent actor with power over the physical world. That began to change as Christian theology met folk beliefs about nature across Europe. Early medieval demonology gave demons more and more physical effects, but it usually treated those effects as directly supernatural (see Subsection 2.2). The devil could cause storms, disease, and crop failures through powers that broke natural law outright. That conception of demonic power made natural events uncertain in a way that discouraged systematic investigation of them.

The change came in the 12^{th}–13^{th} centuries and culminated in Aquinas's reformulation, which did not deny that demons exist but redefined how their power works. In the *Summa Theologica* (I, q.114, a.4) he wrote that demons "[cannot work] a miracle [which] is something done outside the order of the entire created nature." What demons have instead is superior *knowledge* of

[5] Mokyr (2016) argues that Bacon did not reject religious frameworks outright but reinterpreted them so that empirical research became a way of fulfilling divine purposes. In that sense Aquinas is an earlier cultural entrepreneur with a similar message.

natural processes. Aquinas (1920) (I, q.114, a.4): "[I]f we take a miracle in the strict sense, the demons cannot work miracles, nor can any creature, but God alone[...] But sometimes miracle may be taken in a wide sense, for whatever exceeds the human power and experience. And thus demons can work miracles[...] by reason of their being beyond [man's] power and outside his sphere of *knowledge*" (emphasis added). Anyone who wants to avoid being fooled by the devil's *false miracles* has to acquire that knowledge. This is the naturalization of demonic causation: Aquinas put demonic influence *within* the natural order rather than *beyond* it, which made it something empirical research could reach (Boureau, 2006).

Parigi (2012) studies the institutional side of this shift through the procedures the Church used to make saints. In those trials the *promotor fidei* (the *advocatus diaboli*, or devil's advocate) argued against canonization on two grounds: the presumed miracle had a natural explanation, or the event was a demonic counterfeit rather than a true miracle by God. If demons worked through natural means rather than supernatural ones, then telling a natural cause from a demonic one required systematic empirical research (see Subsection 3.3).

Paracelsus states the logic best: "If we can learn from the devil his entire art, we should do so, thereby making use of the [magical] art and leaving the devil alone," *De causis morborum invisibilium* (c. 1531–32) (Paracelsus, 2008, 907). A physician who could tell divine from diabolical causation could take useful knowledge from either. Once the devil worked through natural means, studying his methods was studying nature. The tradition that followed placed demonology inside Aristotelian natural philosophy (Clark, 1997), and identifying a demonic cause meant first establishing what nature could do on its own. Newman (2004) shows that medieval alchemy became a central arena for the art-nature debate (Can demons make gold?). Scholastic thinkers had to say what natural processes could and could not achieve, and the same line fixed the limits of demonic power. Once the Thomistic reclassification made demonic activity natural rather than supernatural, telling natural marvels, demonic operations, and genuine miracles apart became a central intellectual problem of medieval Scholasticism (Bartlett, 2008).

By insisting that demons worked through natural means rather than supernatural ones,

Aquinas turned uncertainty that could not be measured into risk that could, in the sense of Knight (1921). An unusual natural event was no longer a wholly unpredictable display of supernatural power, but something natural investigation might explain. In the Greek myth the titan Prometheus gave humanity fire, a proxy for *technology*. On this paper's reading, Lucifer's gift is worth far more: *science*. Saint Thomas's devil operates in the physical world rather than the metaphysical one, and he operates with complete knowledge. That new reading of the devil is a prerequisite for empiricism, the scientific method, and the Scientific Revolution.

Return to Figure 1, which plots how often four diabolical word stems appear, per word, in more than two hundred million words of Latin writing from the 2^{nd} through the 19^{th} centuries (See Appendix B.4.2).[6] A visible inflection falls between 1250 and 1300, the period in which Aquinas drafted the *Summa* and in which the Averroist controversy at Paris ended in the 1270 and 1277 condemnations. The singular *diabol** names Satan, the metaphysical cosmic adversary, and the plural *daemon** names the lower-order spirits that operate on matter.[7] The two series diverge: *diabol** steps down to a lower medieval plateau, while *daemon** stays high. This is what the Thomistic specialization looks like in the texts. The discussion narrows away from Satan, whose investigation is not a research program, and onto the demons that empirical work can reach. Investigating those demons is Aquinas's framework.

3.2 *Summa Cum Laude*

A century separates the writing of the *Summa Theologica* (1265–1274) from the first evidence that Thomistic demonology was running inside institutions. The gap measures how slow and contested the reception was. Aquinas died in 1274, leaving the *Summa* unfinished and unpublished, though Dominican friars already knew it. Within three years the Paris and Oxford

[6] Tertullian (*c.* 160–220) and Cyprian (*c.* 210–258), the two North African authors who founded the Latin Christian theological vocabulary of the Devil, drive the third-century peak in the *diabol** series. Their short polemical and pastoral treatises carry *diabolus* at rates of two hundred to four hundred per hundred thousand words, and the seven highest-rate *diabol** documents in the entire pre-1000 record are all theirs.

[7] The other two stems, *malefic** (the language of *maleficium*, the harmful magical act) and *exorciza** (the vocabulary of exorcism), are an order of magnitude less common across the whole period, and both mark the boundary of the demonological discussion rather than doing its main work.

condemnations of 1277 put some Thomistic theses under formal Church censure. The *Correctoria* controversy between Franciscans and Dominicans grew through the 1280s until the Franciscan order banned study of the *Summa* without critical annotations in 1282. Even inside the Dominican order, repeated General Chapter legislation in 1278, 1279, 1286, 1309, and 1313 was needed to enforce adherence to Aquinas's positions, which suggests compliance was far from universal. Full rehabilitation came only with Aquinas's canonization in 1323 and the formal revocation of the Paris condemnation in 1325 (see Appendix C.6).[8]

After rehabilitation, diffusion was fast, and the Dominican order did most of the work. By the 14^{th} century Dominican monasteries and priories numbered in the hundreds across Europe (see Figure 13), and they built their teaching on Thomistic theology. Thomistic teaching went from Paris to Bologna, Oxford, Salamanca, and Cologne, and by the 16^{th} century the *Summa* had displaced Peter Lombard's *Sentences* as the standard theological text. The *Sentences* rested on a broadly Platonic frame that emphasized abstract theological reasoning, while the *Summa* was built instead on Aristotelian methods of systematic observation, categorization, and causal inquiry. Every student who read the *Summa* took in its method along with its theology. This is not about an increase in learned people, it is about the content, i.e., the quality, not the quantity, of human capital.[9]

Mokyr (2016) has shown how European scientists spent centuries "disproving" Aristotle, but the point is that they *had* an Aristotle to disprove. Elsewhere in the world, learned traditions rested on broadly Platonic or analogous frameworks that prized abstract ideals, harmony, and acceptance, while European learned men after Aquinas thought in Aristotelian terms (Greif et al., 2025). Aristotle's method is empirical at bottom: it starts from observation of the natural world, sorts what it observes into categories, and looks for causes in material processes. When

[8] On how the medieval universities and early modern intellectual culture absorbed Aristotelian natural philosophy, see Grant (1996) and Gaukroger (2006). Appendix C.7 surveys the literature on monasteries and economic growth.

[9] Cantoni et al. (2018) show a later instance of the same mechanism in the Reformation, which shifted university curricula from theology to law. Squicciarini (2020) show that what Catholic schools in 19^{th}-century France taught, and in particular how much weight they gave religious rather than secular subjects, had lasting effects on economic development.

later Europeans attacked Aristotelian positions (Galileo on motion, Harvey on blood circulation, Newton on celestial mechanics), they did it with the empirical methods that Aristotelian training had given them. No other civilization produced this combination at comparable scale.[10]

The monastic network moved Thomistic ideas across Europe. In regions far from a major university, monasteries were where people learned, copied manuscripts, and taught. They were the main source of both supply and demand for books in the Middle Ages (Buringh and van Zanden, 2009). Once the *Summa Theologica* became the standard reference in theological education, this network took it to even the most remote parts of Europe.

The spread of Thomistic theology through educational institutions had measurable effects on how communities handled accusations of sorcery. Kieckhefer (1976) documents that university-trained judges brought learned demonological categories (the devil's pact, the sabbat, and systematic diabolism) into trials that had turned on folk concerns like maleficium. Judges schooled in the scholastic curriculum tied scattered folk accusations to a coherent theory of demonic agency built on Aquinas's natural philosophy. The same training that taught them to think about demons in an orderly way also taught them to ask for evidence and to tell categories of causation apart.[11]

3.3 Devil's Advocate

In the 17^{th} century, largely in response to the Protestant Reformation, the Catholic Church codified how it formally ratified miracles worked by candidates for sainthood. The *Promotore Fidei*, known colloquially as the devil's advocate, was central to that process. He did not deny that the supernatural exists. His job was to establish the *source* of a supernatural event: was it the work of God, acting through the candidate, or was it the work of the devil? As Parigi

[10] The Islamic world had access to Aristotelian ideas and discussed them, and this era coincided with the Golden Age of Islam. The causes of its end are hotly debated and beyond the scope of this article (Rubin, 2017). But the point remains: reading the *Summa* is what made Europeans intellectually different from what they had been before.

[11] On how clerical education shaped the way demonic influence was identified, see Clark (1990); Cohn (1993); Bailey (2001).

(2012, p. 14) writes, "defining the boundaries of the supernatural was precisely the task of the *Promotore Fidei*." The name follows from the job: the attorney argued that the devil, not the candidate, had performed the alleged miracle. "The task of the devil's advocate was not to deny the existence of miracles but to create a space for false miracles, that is, for the occurrence of events or facts that, although inexplicable by science or medicine, were nevertheless not true miracles" (Parigi, 2012, p. 110).

This institutional arrangement was impossible under the theology of the early Middle Ages. Before the late medieval period the devil's powers were understood to stop at the mind: he could whisper temptations, plant visions, and corrupt a conscience, but he could not act physically in the natural world. If only God could break the laws of nature, every genuine supernatural event would be an act of God by definition. The Church would have had to build a tribunal that could establish whether a supernatural event had happened at all. That is a far harder thing to settle, and much harder for Rome to control. The late-medieval innovation that gave the devil physical powers solved the problem. Once the devil was understood as a competing supernatural agent working in the physical world, the Church had only to tell divine causation from diabolical causation. That task was far more open to institutional control.

If the miracle was credited to the candidate, sainthood followed, and the candidate's followers won the right to found a new religious order. If it was credited to the devil, sainthood was denied, and the acolytes had to bring new evidence or put forward someone else. The system gave the Church a powerful lever over which movements got official recognition and institutional resources. Leeson (2013) shows that vermin trials (the formal Church proceedings brought against locusts, rats, and other pests) put supernatural adjudication to an institutional use of its own, and that they raised belief in the Church's supernatural sanctions and with it tithe compliance. The sainthood process, the vermin trials, and the ordeal system studied by Leeson (2012) share one logic: the Church ran structured proceedings with a theological veneer and got outcomes that strengthened its authority over how uncertain events were read.

3.4 The Devil We Know

> *"Fas est et ab hoste doceri."*
>
> Ovid, *Metamorphoses*, IV.428

> *"If we can learn from the devil his entire art, we should do so, thereby making use of the [magical] art and leaving the devil alone."*
>
> Paracelsus, *De causis morborum invisibilium* (c. 1531–32)

Ovid's line, that one should learn even from one's enemies, captures the disposition that the Thomistic framework institutionalized. Mokyr (1990) argues that Europeans, unlike other civilizations, were eager to learn from other cultures whenever the knowledge was useful to them. The naturalized demonology of the *Summa* extended that eagerness to the most dangerous teacher of all: if the devil works through natural law, then what he does teaches how nature works. By the 16^{th} century the empirical research that Thomistic theology had encouraged was producing natural philosophers whose engagement with the devil was central to their scientific work. Renaissance natural philosophers increasingly built experimental methods while keeping the theological frames that justified their research (Eamon, 1994). Francis Bacon put method into formal shape and kept a theological justification for empirical research (Harrison, 2007). Mokyr (2016) stresses the "Republic of Letters," the cross-border network in which natural philosophers shared and checked each other's claims. Across the whole period the devil was one of the most fiercely contested problems in early modern science.[12]

Paracelsus made learning from the devil a principle of method. Newton wrote thousands of words about Satan and settled, in private, on the view that demons were nothing but metaphors for human sin, merely "distempers of ye mind" (Snobelen, 2004, 169). Hobbes gave a whole chapter of *Leviathan* to demolishing demonology. Kepler used a daemon as a literary device to convey Copernican astronomy. Boyle, Glanvill, and Henry More ran a campaign at the Royal

[12] Appendix C.4 catalogues the principal works of the debate, demonologist and skeptic alike, from Nider's *Formicarius* to Mather's *Wonders of the Invisible World*.

Society to prove the existence of evil spirits empirically, and read the denial of them as the first step toward atheism. Cotton Mather, a Fellow of the Royal Society and part of that campaign, wrote that "an Army of Devils is horribly broke in upon" Massachusetts. Descartes turned the devil into a tool for testing what a person can know. Appendix C.1 documents each case. The founders of modern science held positions on the devil that ranged from aggressive belief to dangerous heresy. The scientific works of the 16^{th} and 17^{th} centuries are often read as though they came from a world of pure secular reason. In fact, whether the devil was real was a live scientific and theological question: the nature of spirits, the limits of the physical world, and the foundations of the Christian faith. The debate ran into the early 18^{th} century and ended with the devil gradually dropping out of serious scientific explanation. The empirical evidence that follows measures how that happened.

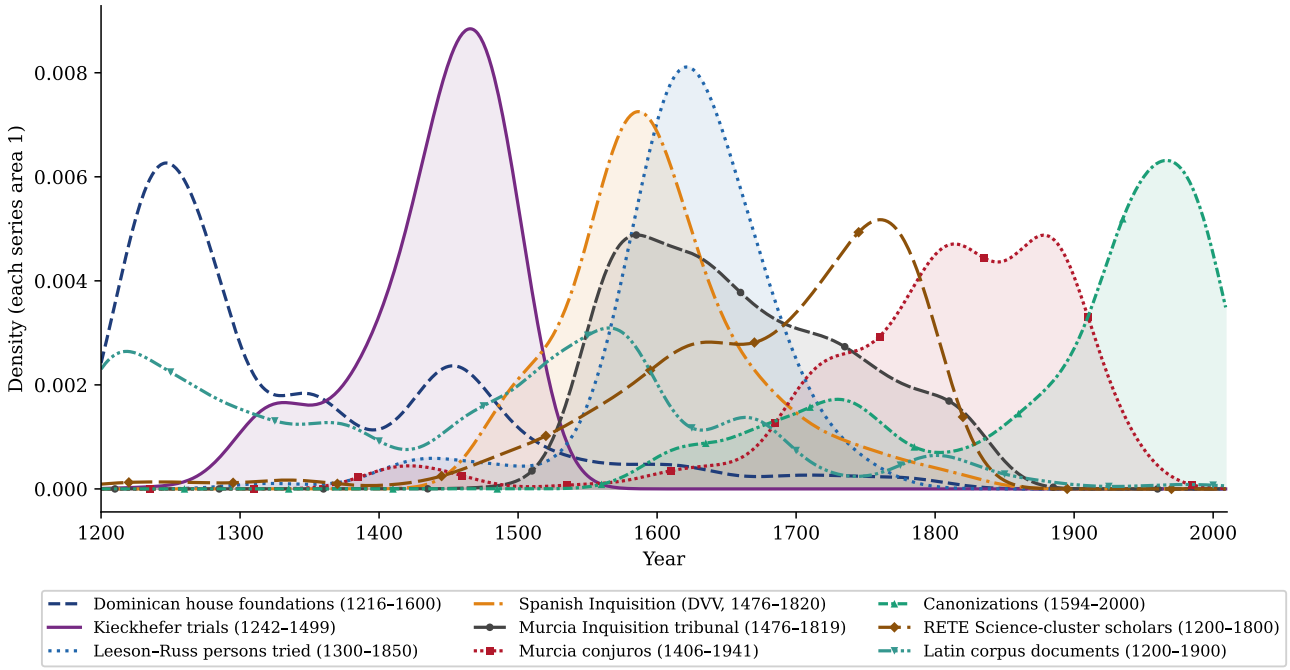
4 Empirical Evidence

Five bodies of evidence trace the transformation in the framework above. Each looks at a different part of it: the institutional response to environmental disasters in Murcia, the rise and fall of witch trials across Europe, the Spanish Inquisition, the rationalization of miracle claims in canonization procedures, and the spread of the Dominican network and its effect on the production of scientists. They play different evidentiary roles. The Dominican-network analysis provides identification an explicit counterfactual (the co-located Franciscan network) and falsification tests (the dissolution of the houses in Protestant Europe, the placebo origins, and the placement-timing event study).

Figure 3 shows the temporal coverage of all nine data sources. Six series record institutions ruling on claims about the supernatural: the Murcia *conjuros*, the two witch-trial compilations, the Spanish Inquisition at the national level and at the Murcia tribunal, and the canonizations. Three series, drawn with dashed lines, record the production side of the argument: the foundation of Dominican houses, the Science-cluster scholars of the RETE database, and the dated

documents of the Latin corpus. Read together, the series tell the story as cause and consequence: the Dominican network is built in the 13^{th} and 14^{th} centuries, the adjudication series peak between 1450 and 1700, and scholar production accumulates through the 18^{th} century as the supernatural caseload fades.

Figure 3: Density of recorded events across all data sources, 1200–2000



Notes: Gaussian kernel density estimates with bandwidth 25 years, restricted to 1200–2010. Each series is normalized to area one, so the comparison is of shape rather than level. Solid lines are the adjudication series. Murcia: 218 *conjuros*, 1406–1941. Kieckhefer: 476 confirmed witch trials, 1242–1499. Leeson–Russ: 43,240 persons tried, 1300–1850 (records dated only to the decade are placed at the decade midpoint). Spanish Inquisition: 61,599 trials across sixteen tribunals from the DVV/EMID individual-trial data, 1476–1820, of which the 107 without a year do not enter the density. Murcia Inquisition tribunal: 4,457 dated trials from the Blázquez Miguel (1987) catalogue, 1476–1819. Canonizations: 225 individual canonizations from the Hagiography Circle, 1594–2000. Dashed lines are the production-side series. These are 885 dated Dominican foundations from the refined inventory (Appendix A.7), 765 RETE Science-cluster scholars by year of activity (De la Croix, 2021), and 1,293 dated Latin corpus documents from 1200 onward (Appendix A.9).

The adjudication datasets of Figure 3 are complementary in three ways. First, in time. The Kieckhefer compilation runs to 1499 and concentrates in the 14^{th} and 15^{th} centuries. Leeson–Russ extends witch-trial coverage through 1850 and concentrates between 1550 and 1700. The Inquisition series concentrate in the 16^{th} and 17^{th} centuries. The Murcia conjuros begin in 1406 and run to 1941, with most of their mass in the 18^{th} and 19^{th} centuries. The canonization series

is post-Tridentine and runs from 1594 to 2000. Together the series span the full 1200–2000 arc. Second, in geography and in institutional setting. The witch-trial datasets concentrate in central and northern Europe. The Spanish Inquisition, treated separately in Subsection 4.3, is a single centralized institution, and Spain has very few witch trials in those datasets but tens of thousands of Inquisition trials. Murcia is also in Spain, but the conjuro evidence comes from a cathedral chapter rather than from a court. Third, in the use of more than one source for both the witch trials and the Inquisition. For witch trials I use Kieckhefer's 14^{th}- and 15^{th}-century compilation alongside the larger Leeson–Russ panel, because Kieckhefer records charge category, court type, and a demon-mention flag that the Leeson–Russ public release does not. For the Inquisition I use three sources: the Drelichman–Vidal-Robert–Voth (DVV) extract from EMID for time, place, and tribunal, the Contreras–Henningsen (1986) classification for offense composition at the national level, and the Blázquez Miguel (1987) catalogue for offense composition over time at one tribunal. The smaller datasets hold detail the larger ones omit, and the larger ones hold coverage the smaller ones lack.[13]

4.1 The Exorcist

The Thomistic framework gave the devil physical powers, and in doing so it gave people both the opportunity and the obligation to investigate the physical world. If a natural disaster could come from the devil rather than from God, then people had a duty to find out which it was. Where the cause was diabolical, that duty extended to fighting back. The archival records of the Cathedral of Murcia show this logic at work (Espín-Sánchez et al., 2026; Espín-Sánchez and Gil-Guirado, 2026). From the late 14^{th} century, priests at the cathedral changed the way they treated environmental disasters, and locust plagues in particular. Locust plagues are the

[13]The Murcia *conjuros* data comes from primary archival work, and the universe of records is complete: the city council and the cathedral chapter both met at least twice a week from the middle of the 13^{th} century onward, and the full minutes of both bodies survive without gap from that point through the modern period (Espín-Sánchez and Gil-Guirado, 2026). The others are secondary sources that I take as published. Where coverage is partial in those secondary sources (the geographic gaps in the Leeson–Russ public release, the partial reconstruction of physician counts in Duffin's transcripts), I note the limitation in the relevant subsection.

canonical divine punishment in the Bible, and the canonical response is submission and prayer for mercy. Priests in 14^{th}-century Murcia began to ask something else: was this plague sent by God, or by the devil?

The shift worked on two levels. The first was diagnostic: priests treated the question of whether the cause was divine or diabolical as one they could in principle settle. Their working rule was that human effort that overcame the plague was itself evidence that the plague had not come from God, since no human effort could overcome a divine punishment. The second was technical: if the cause was diabolical, what would work against it? The initial tool was exorcism. Over time the archival record shows priests trying other things as well, among them fire, smoke, sulfur, and various chemical substances, always inside the ritual frame of the exorcism. None of this was the scientific method as Francis Bacon later codified it, and the priests of Murcia were not testing hypotheses in the modern sense. The practical effect was still to encourage systematic observation, trial and error, and the accumulation of practical knowledge about what worked. The theological requirement to tell a divine cause from a diabolical one made institutional room for empirical research, even when the investigators understood their work in purely theological terms.

I use a unique dataset of documented events tied to environmental disasters in Murcia, Spain, together with the ceremonial and municipal responses to them. The *conjuros* runs from 1406 to 1941, when the last *conjuro* was invoked. The primary sources are the historical archives of the Cathedral of Murcia (see Appendix A.1). Each entry records the year (with the precise date where the record gives one), the nature of the environmental disaster, and the ceremony performed in response. I group disasters into four categories (locust plagues, disease, weather, other) and ceremonies into three groups: *rogativa* (a prayer procession), *conjuro* (a conjuration or exorcism), and other (mass, bell-ringing, charity, blessing, practical action, unknown). The *conjuro* is a direct institutional expression of the naturalized demonology developed by Aquinas.

Figure 4 plots the count of recorded *conjuros* in each century and the share aimed at pests. The framework makes three predictions about this object: *conjuros* should be absent before

Aquinas, should fall on the disasters that naturalized demonology reinterprets as diabolical (chiefly locust plagues), and should then fade as natural science crowds out the diabolical attribution. The data line up with all three. The records begin in the 1240s with the Christian conquest of the city, but the first *conjuro* on record appears in 1406, well after the *Summa* had spread. In the 15^{th}, 16^{th}, and 17^{th} centuries, almost every recorded *conjuro* answers a pest plague of locusts, birds, or insects. The pest share then falls to about one-half in the 18^{th} century, to roughly one-sixth in the 19^{th}, and to zero in the 20^{th} (see Appendix B.1.6 and Table B.7 for tests of structural break).

Any account resting on simple secularization has to explain one feature of the data: the *conjuro* does not disappear in the 19^{th} century. It peaks in volume there. What disappears is its earlier function as a pest-fighting tool (Espín-Sánchez and Gil-Guirado, 2026). The *conjuro* arrives once the Thomistic framework allows demonic causation of physical events, concentrates on locusts because locusts are the canonical target of demonic reinterpretation, and loses its target as natural alternatives for pest control accumulate. By the late 19^{th} century the *conjuro* had become purely ceremonial: performed each May on a fixed date, directed at no particular disaster, and understood by no one involved as a serious response to demonic agency. The ritual had passed from theology into folklore.

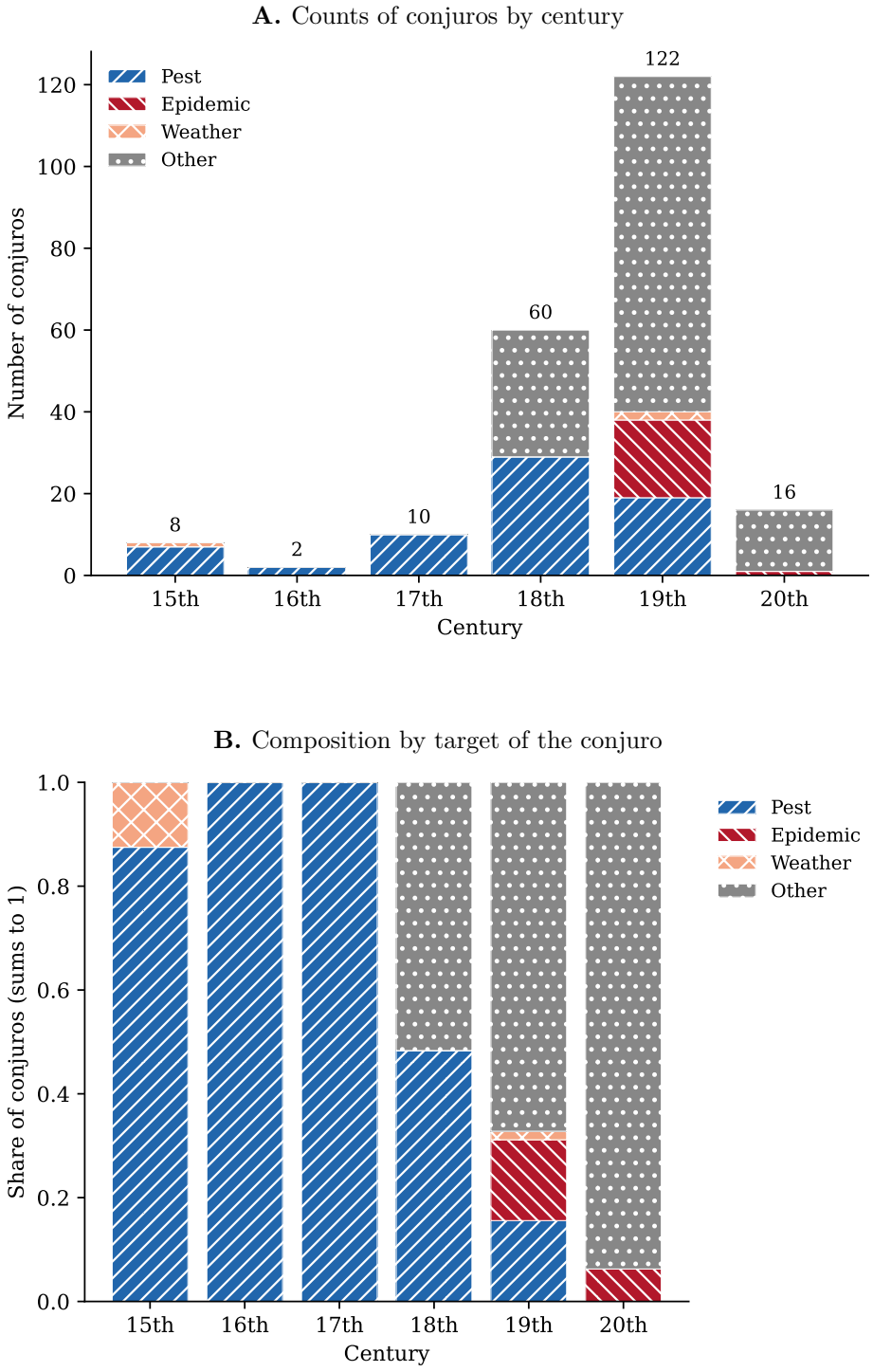
4.2 Witch Trials

I trace European witch trials with two datasets. The first comes from Kieckhefer's *Calendar of Witch Trials* (Kieckhefer, 1976) and contains 558 trial entries spanning 1242–1499, of which 476 are confirmed (See Appendix A.2). The second, from Leeson and Russ (2018), covers 43,240 persons tried across 21 countries between 1300 and 1850, with an average death rate of 37.8 percent (Table B.2 and Figure B.2 in Appendix B.1.2).[14]

Figure B.1 plots trial counts in the Kieckhefer data by decade. The 14^{th} century is quiet,

[14]The Leeson–Russ count of 21 countries separates England, Scotland, and Northern Ireland, and the public release codes these to the present-day United Kingdom (GADM), which gives the 19 countries reported in Table B.2.

Figure 4: Murcia *conjuros* by century: counts and composition



Notes: A *period* here is one century. Panel A plots the count of conjuros performed by the cathedral chapter of Murcia in each century. Panel B plots the composition of conjuros by their target (pest plague, weather, illness, other). The share aimed at pests falls over the 19^{th} and 20^{th} centuries. Source: Cathedral of Murcia archives and municipal records (Espín-Sánchez and Gil-Guirado, 2026).

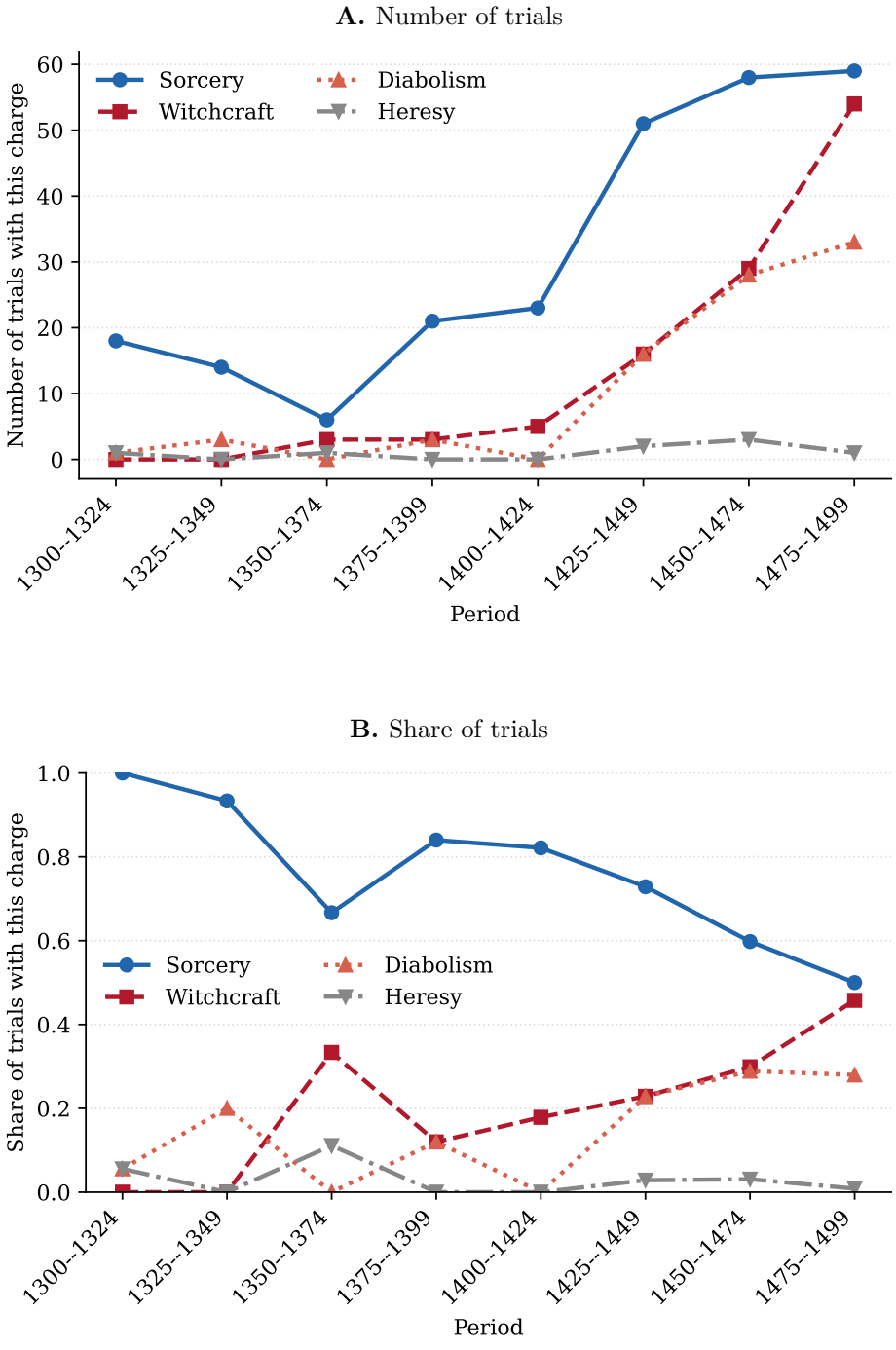
with fewer than ten confirmed trials per decade before the 1390s. Counts climb from around 1400, rise through the middle of the 15^{th} century, and reach 62 confirmed trials in the 1480s. The timing coincides with the spread of the *Summa Theologica* across Europe and with the first *conjuro* record at Murcia in 1406. Murcia is a different setting, with no direct institutional link to the Northern European trials. The framework predicts more than an increase in volume: the *kind* of charge should shift toward distinctively Thomistic categories as the new curriculum spreads through universities and monastic networks. Figure 5 reports, for each 25-year period, both the count and the share of confirmed trials carrying each broad charge type (a single trial may carry more than one). Sorcery covers folk magic, divination, weather magic, image magic, and killing by occult means, and it remains the most common charge throughout. Heresy concentrates in the early period. The two categories that are direct products of the Thomistic framework are witchcraft as an organized offense and explicit diabolism (pacts with the devil, attendance at sabbats, worship of demons), and both are near-absent before 1400.[15] Witchcraft as an organized offense rises from a share indistinguishable from zero before 1400 to a point estimate of 0.46 in 1475–1499. Diabolism climbs to a point estimate of 0.28 over the same final period. The early-period and late-period intervals do not overlap for witchcraft as an organized offense. For diabolism the early interval is wide, because the early periods hold few trials. [16]

Figure 6 shows the same shift in two further ways. Figure 6.A plots the share of trials in which the surviving record explicitly mentions the devil or a demon. That share rises from roughly twenty percent in the mid-14^{th} century to around thirty percent in the second half of

[15] The early 14^{th} century contains a cluster of high-profile political prosecutions that carry diabolism, invocation, or image-magic language in the original records but that use demonology as a political weapon rather than as ordinary judicial practice. They include the trial of Walter Langton, bishop of Coventry (1301–3), the charges brought against Pope Boniface VIII by officials of Philip IV (1303–11), the prosecution of the Templars (1306–14), the papal commission against clerics and laymen at Avignon under John XXII (1318), and the trial of Bernard Délicieux at Carcassonne (1319). They also include the charges of image magic to kill John XXII brought against Matteo and Galeazzo Visconti (1320), the prosecution of Federico of Montefeltro's allies by John XXII (1320–26), the trial of clerics for image magic against Charles IV (1327), and the 1337 Béziers case in which two clerics were tried for falsely accusing a bishop of image magic during John XXII's pontificate. I do not count these nine trials as diabolism in Figures 5 and 6 or in the figures that track the demon share in Appendices B.1 and B.1.3, though they remain in the total counts.

[16] Table B.1 in Appendix B.1.1 reports the bootstrap evidence.

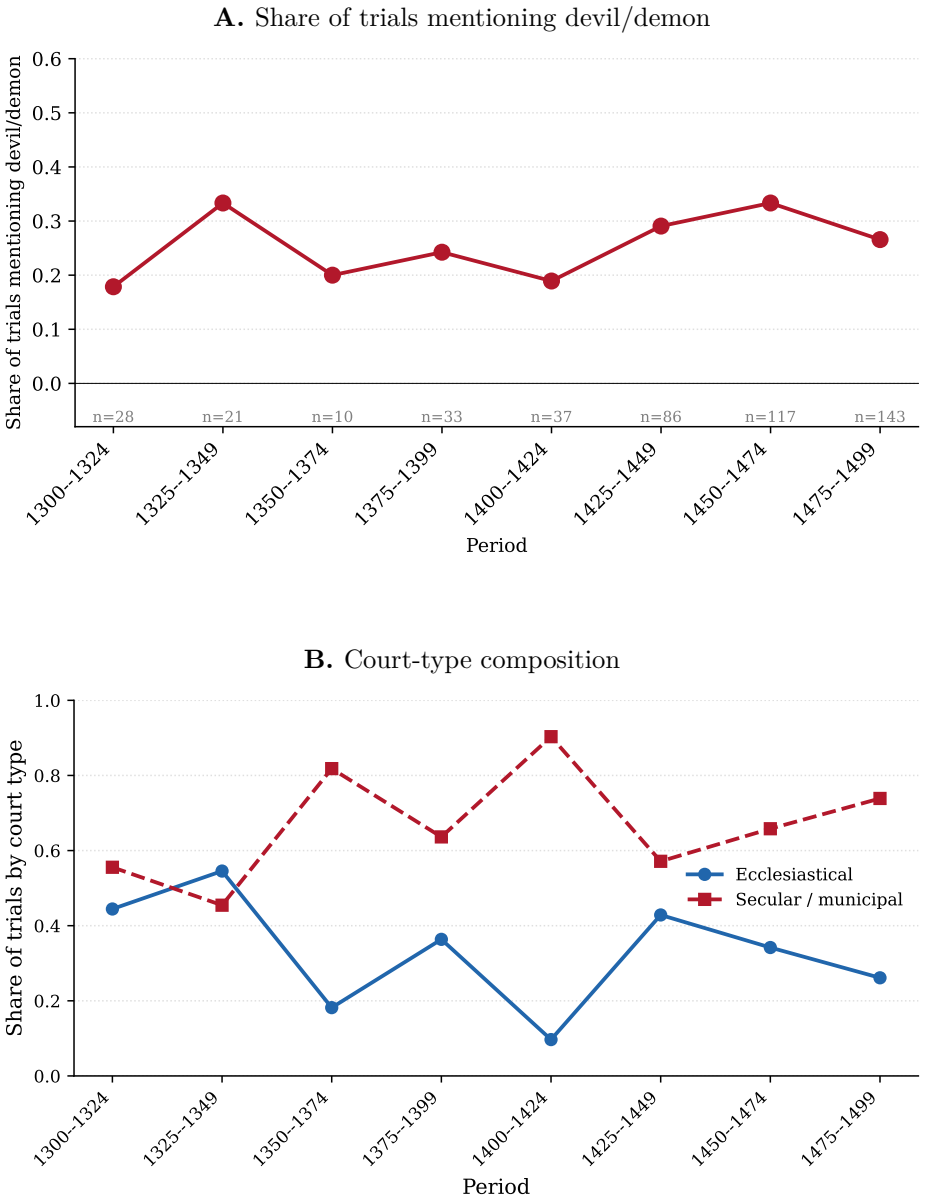
Figure 5: Witch trials by broad charge category and 25-year period



Notes: A *period* here is a 25-year window. Each line gives the number (Panel A) or the share (Panel B) of confirmed trials in which a given category appears in the corresponding 25-year period. A trial may fall in more than one category, so the lines need not sum to one. Confirmed trials only. Source: Kieckhefer Calendar of Witch Trials.

the 15^{th}. Figure 6.B shows the parallel shift in court type: secular and municipal courts overtake ecclesiastical and inquisitorial ones after 1400 and try two-thirds of cases by the late 15^{th} century.

Figure 6: Diffusion of demonic categories and shift to secular courts



Notes: Panel A gives the share of confirmed trials in which the record mentions the devil or a demon, by 25-year period. Sample sizes appear below the axis. Panel B gives the share of confirmed trials in each court-type bucket among trials with court-type information. Source: Kieckhefer Calendar of Witch Trials.

Kieckhefer (1976) reads this evidence as a new demonology imposed from above: ordinary

people held a patchwork of pagan beliefs and rites that had nothing to do with the devil. University-trained scholars reinterpreted those rites as demonic and pressed the new categories on the accused, typically through torture, and judges with formal university training were more likely to extract a confession of dealings with the devil. The human capital channel of this paper would predict the same pattern. The Thomistic curriculum taught judges to read the world in demonic terms. The case records are consistent with the rise in diabolism charges coming from that training rather than from a change in what ordinary people believed. On Kieckhefer's reading, the difference between a judge who charged sorcery and one who charged diabolism was largely a difference in education. The mechanism is the one Cantoni et al. (2018) document for the post-Reformation move from theology to law in Protestant universities: a change in what universities teach reallocates who works in which profession and how they do the work.

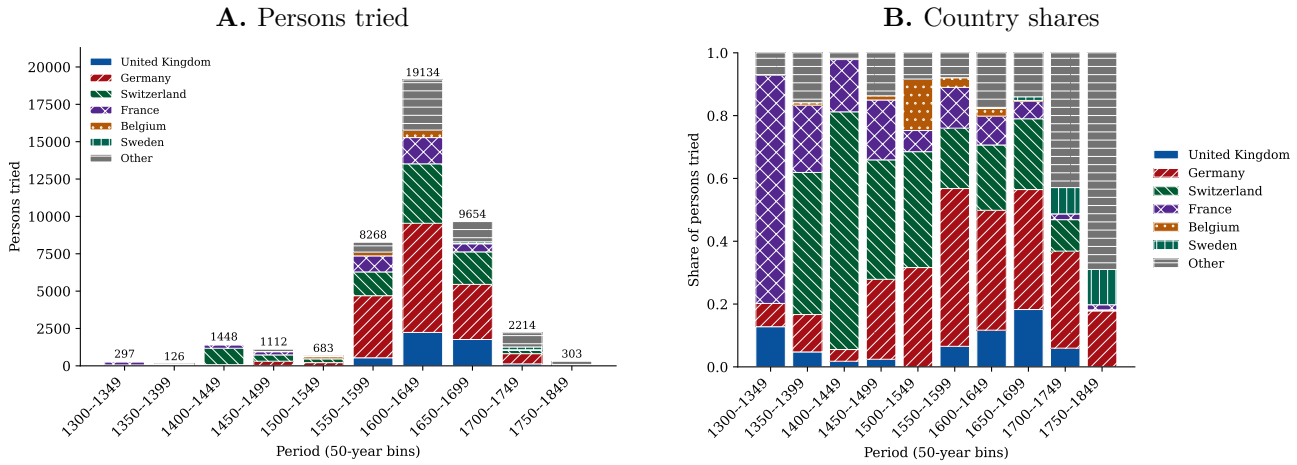
Leeson and Russ (2018) compile the fullest quantitative record of European witch trials, covering 43,240 persons tried across 21 countries. Their central argument is that confessional competition between Catholics and Protestants drove the rise and fall of witch trials. The mechanism I propose complements theirs rather than replacing it. Their account explains the intensification during the 16^{th} and 17^{th} centuries, while the Thomistic framework supplies the legal and intellectual categories that made organized witch trials thinkable at all, as the 14^{th}- and 15^{th}-century Kieckhefer data show. On this reading, confessional competition amplified a phenomenon whose intellectual foundations were laid more than two centuries before the Reformation.

The timing of the trials is hard to square with an account that rests primarily on Catholic–Protestant competition. The pre-Reformation period (1300–1517) accounts for 3,167 persons tried, or 7.3 percent of the total: a substantial wave of witch-trial activity was already under way before Protestantism existed. The *Malleus Maleficarum* was published in 1487, thirty years before Luther's break with Rome. Widely regarded as the handbook of witch persecution, it was itself a product of Thomistic demonology. At the other end of the period, 12,172 persons, or 28.1 percent of the total, were tried after the Peace of Westphalia in 1648. If confessional competition were the main driver, trial activity should drop sharply once the wars of religion

ended. Instead, nearly a third of all trials in the dataset take place in the post-war period (Figure B.2 in Appendix B.1.2).[17]

Figure 7 shows the share of persons tried in each of the six most-represented countries, in 50-year periods. Of the 297 persons tried in 1300–1349, France accounts for 73 percent: that is the period and the place of Aquinas's teaching at Paris, and the prosecution evidence concentrates there before it spreads anywhere else. Switzerland and southern Germany take over in the 15^{th} century, consistent with the early alpine tribunals staffed by Dominicans. Germany alone accounts for half or more of every 50-year period from 1550 to 1700. The United Kingdom barely appears before 1625, and then rises sharply in the mid-17^{th} century. Sweden becomes a substantial share only in the 18^{th} century. The prosecution machinery first appears where Thomistic demonology was most deeply built into institutions, then spreads outward, and persists where confessional competition can no longer plausibly be the driver.

Figure 7: Composition of Leeson–Russ persons tried by country, 1300–1849



Notes: Consistent 50-year bins from 1300 to 1849. Panel A gives persons tried per period, with totals shown above the bars. Panel B gives each country's share of persons tried in the period. Source: Leeson and Russ (2018) replication dataset.

If the spread of the new curriculum is part of what raises the diabolism share, the geography

[17]The pre-1500 evidence in Kieckhefer and Leeson–Russ is not independent: of the 1,803 persons tried in Leeson–Russ before 1500, 1,323 (73 percent) come from records attributed to Kieckhefer (1976). Leeson and Russ (2018) note that the count of 10,805 separate trials is "a very conservative estimate," so persons tried (43,240) is the more reliable summary statistic.

of trials should follow the geography of training. Figure 8.A plots the geocoded Kieckhefer trials on a map of western and central Europe, over the Dominican houses founded by 1500.[18] Trials cluster where Dominican houses were densest: around Paris, the western Alps, the Rhineland, and northern Italy. There are essentially no trials in eastern Europe along the regions of Catholic–Orthodox confessional competition, and none in the parts of eastern Europe served only by Orthodox monastic networks rather than Dominican houses. Thomistic demonology belonged to the Catholic intellectual world, and within it to the Dominicans. The geography of witch prosecution tracks the geography of the curriculum, not the geography of Christianity.

Figure 8.B maps every geocoded Leeson–Russ record on the same base map, keeping the Dominican houses underneath.[19] The densest clusters sit in the western Alps and the Rhine corridor, the German lands, eastern France, and the Low Countries, while Britain enters the record in the second half of the 17^{th} century and Sweden in the 18^{th}. Italy and Iberia contribute very little despite a substantial Dominican network. As I show in the next subsection, these offenses were centralized in Spain in the hands of the Inquisition. Accusations about the devil did not typically take the form of a witch trial.

4.3 The Spanish Inquisition

The Spanish Inquisition was one bureaucracy under a single central authority, and it ran without a break from 1478 to 1834. Unlike the scattered local courts behind the witch trials examined above, the Inquisition left records that let me follow how one Church institution responded to claims of supernatural activity over nearly four centuries, and how the empirical methods that Thomistic theology encouraged shaped that response.

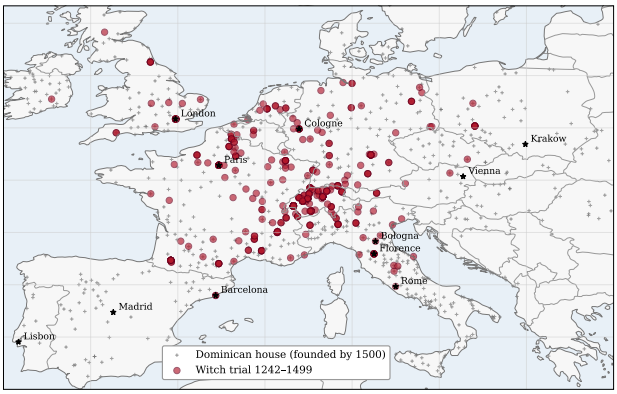
I use three sources. The first is trial-by-trial data from the Early Modern Inquisition Database

[18] Of the 476 confirmed trials, 446 match to coordinates. The rest name a country rather than a town, or a village with no unique geographic match. The dataset reflects the state of research as of the 1970s, and geographic coverage is uneven (Switzerland and France loom large partly because of the availability of sources). The compositional patterns reported here are robust to plausible alternative codings.

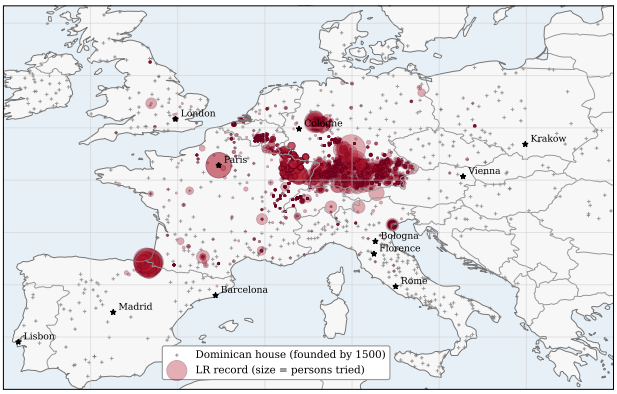
[19] The Leeson–Russ public release contains 10,940 records, of which 5,137 carry latitude and longitude. Coverage is densest in central Europe and lightest in southern Italy and Iberia.

Figure 8: Witch trials and Dominican houses in Europe

A. Kieckhefer trials, 1242–1499



B. Leeson–Russ records, 1300–1850



Notes: In both panels, grey crosses are the 782 Dominican houses with a foundation year of 1500 or earlier in the refined inventory (Appendix A.7), and black stars mark major reference cities. Country borders and coastlines come from Natural Earth (50m). In Panel A, red circles are the 446 of 476 confirmed Kieckhefer witch trials that geocode to a specific place. In Panel B, red circles are the 5,137 geocoded Leeson–Russ records, with area proportional to persons tried (capped). Sources: Kieckhefer Calendar of Witch Trials, Leeson and Russ (2018) replication dataset, and the refined Dominican inventory built on DARMC Layer 48.

(EMID), compiled by Drelichman et al. (2021): 61,599 trials across sixteen tribunals, spanning 1476–1820 (Table B.10 in Appendix B.3). The second is the count of cases by offense in Contreras and Henningsen (1986), who sorted 44,674 cases from the *relaciones de causas* covering 1540–1700 into ten offense categories (Table B.11 in Appendix B.3). The third is the case-by-case catalogue of the Murcia tribunal compiled by Blázquez Miguel (1987): 4,512 trials, 1476–1819, recording offense category, sentence, and gender (Appendix A.3 gives details on all three sources).

What the Inquisition prosecuted is the first thing that sets it apart from the witch courts of Northern Europe (Table B.11). In Spain the Inquisition policed identity (conversos and moriscos) and policed what people said about religion (heretical propositions, offenses against the Holy Office), while witch-hunting accounted for under eight percent of cases. Where Northern European courts prosecuted tens of thousands of witches and almost nothing else, the Spanish Inquisition prosecuted tens of thousands of cases of which only a small fraction concerned witches.[20]

[20]Figure B.9 in Appendix B.3 tells the same story tribunal by tribunal: the Castilian core dominates the early period, Andalusia and the Aragonese morisco belt together account for half or more of all trials from 1525 to the 1609–1614 expulsion, and the *Corte* tribunal in Madrid rises steeply after 1675. That rise tracks the change in

The second pattern the framework points to is the Salazar break of 1614, the clearest case in the record of a Thomistic institution applying empirical methods to demonic claims and revising its own rules of evidence in response. Henningsen (1980) documents the episode in detail. In 1610 the Logroño tribunal convicted and executed several individuals accused of witchcraft in the Basque region. *La Suprema* then assigned Alonso de Salazar Frías, one of the three inquisitors at Logroño, a systematic review of the evidence. Over eighteen months Salazar interviewed 1,802 individuals and applied what would today be called proto-empirical methods: he cross-examined witnesses, physically tested the alleged magical substances, and checked claimed events against independent records. None of the accusations, he concluded, could be substantiated. His 1612 memorial argued that the witch panic had been produced by the process of investigation and prosecution, not by actual demonic activity. In 1614 *La Suprema* issued new instructions requiring rigorous standards of evidence in witchcraft cases.

The change shows up sharply in the national trial series, which I fit with a constant and a linear trend and then test in two ways. Both tests agree. The Chow test splits the sample at a date fixed in advance. At the 1614 policy date it gives $F = 216.3$ ($p < 0.0001$), with mean annual trials falling from 299 before 1614 to 98 afterward, a decline of 67 percent. The Quandt–Andrews sup-F test (Andrews, 1993) searches over every candidate break year instead of fixing one beforehand, and it locates the strongest break at 1611, the year Salazar was conducting his investigation (Figure 9.A, sup-$F = 221.1$). A single-break Bai–Perron specification gives the same date, and allowing more breaks splits the periods on either side of it into finer segments. Appendix B.3 (Table B.13) reports the full sweep over $m \in \{0, \ldots, 5\}$ together with placebo sup-F tests that confirm the 1611 break is not a generic feature of the late period.

The institutional consequence is the contrast with Northern Europe at the height of the witch hunts. Spain produced an estimated 300–500 witch executions over the whole period, against an estimated 40,000–60,000 in Northern Europe (Kamen, 2014; Henningsen, 1980). The difference does not come from a lesser Spanish concern with demonic activity (the offense mix

what was prosecuted, as the institution moved from policing identity to policing thought.

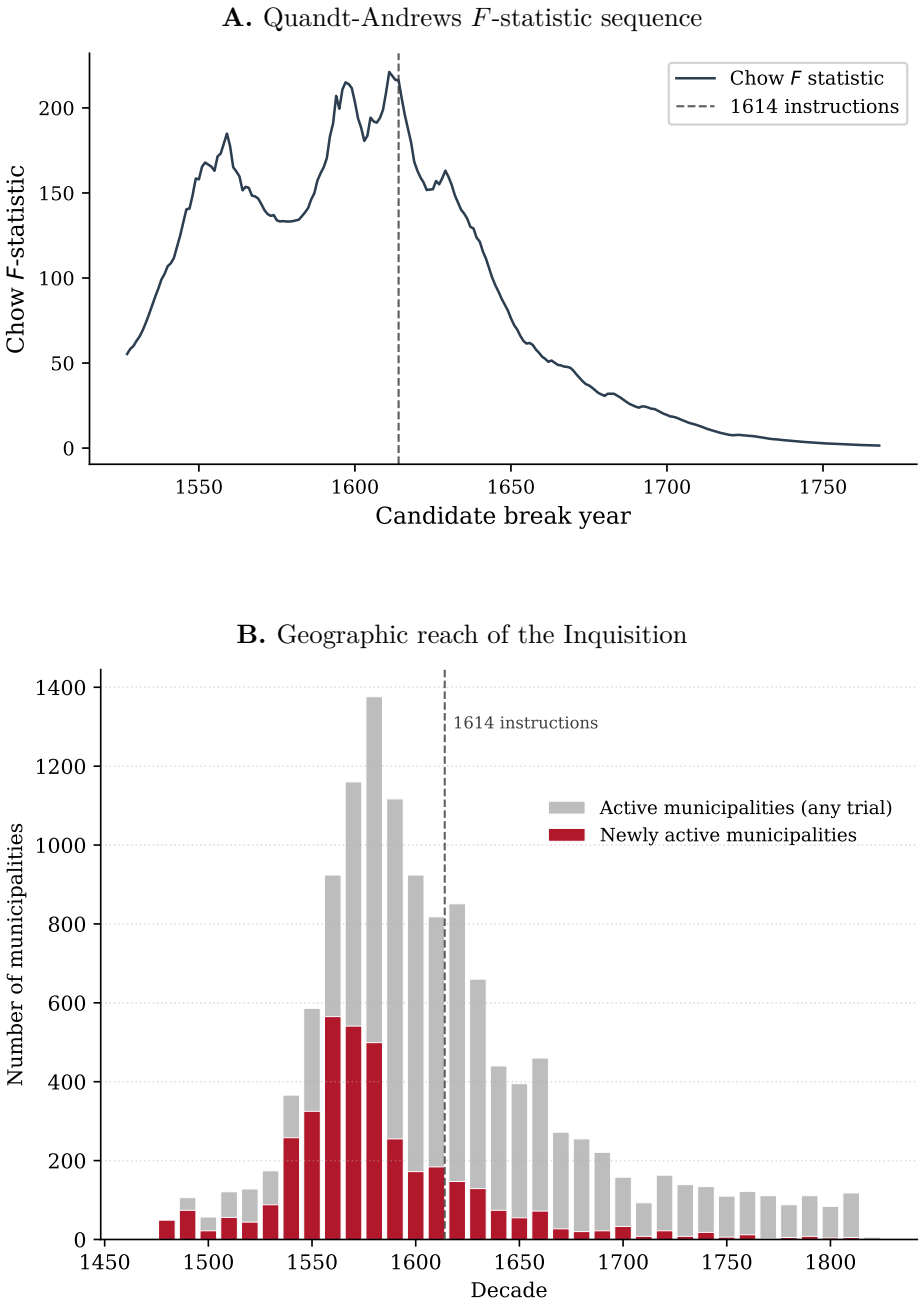
in Table B.11 and the trial volumes reported above show the opposite) but from a centralized Inquisition that revised its standards of proof instead of suppressing what it found inconvenient, and that afterwards kept witchcraft convictions to a small share of its caseload.

State capacity offers a second account of the Spain–Northern Europe gap. Johnson and Koyama (2019) show that a state has to be centralized before it can enforce legal rules impersonally, and that pre-modern persecutions were usually the work of weak or fragmented authorities rather than strong ones. On that reading, the Spanish Inquisition had the centralized power to hear and decide cases that Northern European secular courts lacked: it could absorb one inquisitor's eighteen-month investigation, rewrite its rules of evidence in 1614, and then enforce the new rules across sixteen tribunals. The two accounts are not in tension, because the Thomistic framework gave Salazar the categories in which an empirical investigation of demonic claims made sense, and the centralized institution gave his conclusions a route to becoming binding policy.

The third pattern is the shrinking of the Inquisition's geographic reach. Figure 9.B plots, for each decade, the number of municipalities with at least one trial and the number entering the record for the first time. The set of active places rises through the 16^{th} century, peaks in the 1560s–1580s, and shrinks steadily after that. Most municipalities first appear in the record before 1600, and from then on the institution prosecutes a smaller and increasingly familiar set of places.

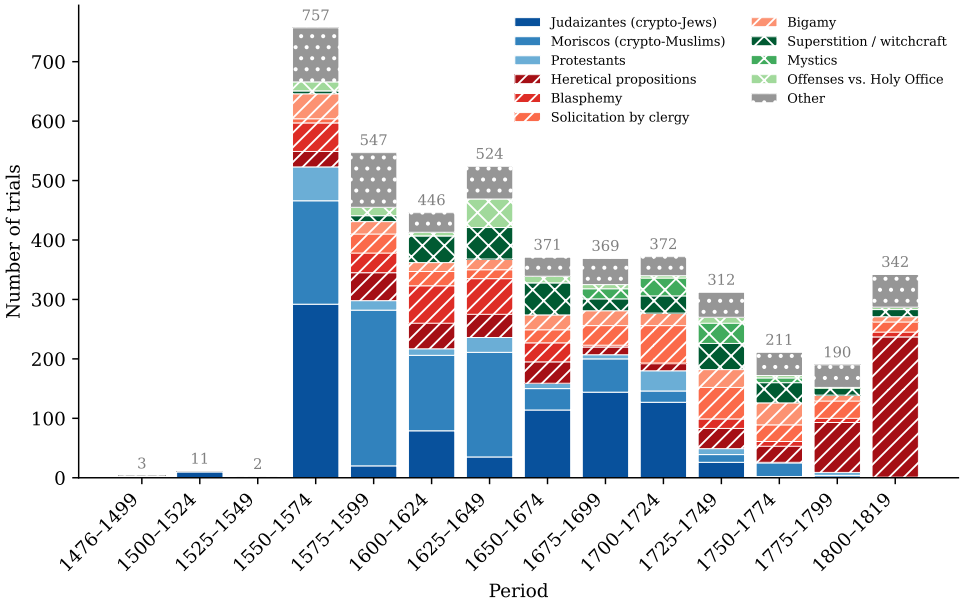
The catalogue from Blázquez Miguel (1987) records 4,512 trials at the Tribunal of Murcia, 1476–1819. It lets me check the national shift in the mix of offenses at the one tribunal for which I have trial-by-trial data. Figure 10 reports the count of trials in each 25-year period. Murcia reproduces the national pattern at the level of individual trials. Judaizantes account for almost all of the earliest periods (1476–1524). Morisco prosecution rises in the second half of the 16^{th} century, peaks just before the expulsion, and then drops away. From the mid-17^{th} century the offense mix turns to heretical propositions, blasphemy, solicitation by clergy, bigamy, and superstition. Superstition and witchcraft peak around the 1610s and never recover. The

Figure 9: The Salazar break and the geographic reach of the Spanish Inquisition



Notes: Panel A plots the Chow F-statistic computed at each candidate break year (15% trimming), testing for a structural break in total annual Inquisition trials. The Quandt-Andrews data-driven sup-F break is at 1611, the year Salazar conducted his investigation. Salazar's report appeared in 1612 and *La Suprema*'s formal instructions in 1614. In Panel B, grey bars give the number of municipalities with at least one trial in the decade and red bars the number of municipalities for which the decade is the first trial on record. A *period* here is one decade. Source: DVV/EMID data.

Figure 10: Offense composition of trials at the Inquisition Tribunal of Murcia, 1476–1819



Notes: Each bar gives the count of trials at the Murcia tribunal in the indicated 25-year period. A *period* here is a 25-year window. Categories follow Blázquez Miguel (1987) and are mapped to the Contreras–Henningsen classification of offenses. Source: Blázquez Miguel (1987), $N = 4{,}457$ trials with a usable year, of 4,512 in the catalogue.

path matches the broader picture of an institution that began by policing identity and ended by policing thought, with witchcraft a minor and short-lived part of its work.

The Inquisition evidence adds to the other findings in two ways. First, a centralized institution working inside the Thomistic tradition built and used empirical methods to test supernatural claims, and those methods produced institutional restraint rather than persecution. Drelichman et al. (2021) show that municipalities with a stronger Inquisitorial presence have lower economic performance and lower trust today, and the evidence here suggests that the same institution also had an offsetting effect through what it contributed to empirical method. The contrast with Northern Europe is sharp: there, scattered secular courts produced tens of thousands of executions. Cox and Figueroa (2025) find the opposite sign for science itself: increases in inquisitorial activity reduced the output of books in science, technology, engineering, and mathematics across early modern Europe, and after the censorship shock of 1559 fewer Spanish authors worked closely with another scholar or attended a foreign university, while the previously rising rate of entry

into scientific occupations turned down. Censorship and the rewriting of the rules of evidence pulled in opposite directions inside one institution, and their estimates measure the first while the Salazar episode measures the second. Second, engagement with supernatural claims rises through the 16^{th} century and is then followed by institutional reform and decline. That path follows the broader trajectory across the other three datasets. Salazar's investigation and the 1614 instructions are a clear case of doctrinal adaptation in the sense of Bénabou et al. (2022): faced with evidence that contradicted established beliefs about demonic activity, the institution changed its rules of evidence rather than suppressing what it had found.

4.4 *Te Deum*

The Protestant Reformation exposed how fragile the Catholic Church was as a supra-national organization. In the Middle Ages, heretical movements had been contained relatively easily. In the 16^{th} century, movements such as Lutheranism and Calvinism won independence from Rome, helped by the printing press (Rubin, 2017). The Church answered with two instruments: the *carrot* was sainthood and the founding of new religious orders, and the *stick* was the Inquisition. A reformist movement whose theology was mild, and whose leaders wanted to stay inside the Catholic fold, usually ended in a canonization and a new order. One that went further met the Inquisition or an army.

The reformed sainthood system worked like a federal arrangement inside the Catholic structure. Religious orders became the main device through which Rome accommodated local preferences that differed from place to place while holding doctrine fixed. Each order could develop its own rituals, devotional practices, and internal organization, but all of them operated under Catholic dogma. Because the parallel system was more flexible than the standard hierarchy of cardinals, bishops, and priests, it let the Church absorb the regional demands for reform and the local preferences over dogma and ritual that might otherwise have fueled separatist movements. Ignatius of Loyola founded the Jesuits in 1534, Gaetano da Tiene the Teatini in 1524, Teresa of Ávila the Discalced Carmelites in 1562, and Angela Merici the Ursulines in 1535. All four follow

the same pattern.[21]

The kinds of miracle the Church recognized changed over time, and the changes followed the advance of science, above all in medicine. In the early modern period miracles covered a broad range of physical phenomena, from weather events to resurrections. As natural science accounted for more of the physical world, the miraculous retreated to the places where explanation was still missing. Parigi (2012, p. 128), citing Delooz (1979), reports that "healing people from cancer became the most common approved miracle in the century after the year 1642." Cancer is still imperfectly understood and incompletely curable, and the line between what can and cannot be explained there remains contested (Duffin, 2009). This progressive narrowing is the doctrinal adaptation that Bénabou et al. (2022) model. The Church did not give up miracles. It moved the evidentiary line, and concentrated supernatural claims where science had not yet given a complete account.

The canonization timeline runs roughly opposite to the witch-trial pattern. Trials rose sharply from the mid-15^{th} century, peaked around 1600, and collapsed by the early 18^{th} century. Canonizations were rare at the height of the witch craze, rose slowly as trials fell away, and accelerated sharply in the 20^{th} century (Figure B.8, Panel A, in Appendix B.2). John Paul II alone accounts for more canonizations through 2000 than every pope before the 19^{th} century combined (Panel B of the same figure). In the 16^{th} and 17^{th} centuries, secular and church courts both acted on witchcraft accusations without demanding much proof. At the same time, Rome had only just created the Congregation of Sacred Rites (1588) and was still working out how a canonization should proceed. The early Counter-Reformation popes canonized sparingly: only eleven people between 1594 and 1634, when Urban VIII's *Caelestis Hierusalem Cives* tightened the rules further.

Witch trials declined over the late 17^{th} and 18^{th} centuries, in part because centralizing states

[21] Bossy (1985) argues that Counter-Reformation policy weakened the role of families and clans in religious life and strengthened parish-centered organizations. Schulz et al. (2019) show that regions where the Catholic Church was present during the Middle Ages later developed more impersonal social traits. The reformed sainthood system is one channel through which that broader pattern worked.

grew strong enough to impose stricter standards of proof on local courts (Johnson and Koyama, 2014). Over the same decades Rome was putting canonization on a regular footing. Prospero Lambertini's *De Servorum Dei Beatificatione et Beatorum Canonizatione* (1734) set out the rules for judging a miracle: medical testimony, several witnesses drawn from different social ranks, and proof that the healing was "complete, durable, and instantaneous" (Parigi, 2012). By the time the trials ended in Western Europe, the machinery for producing saints was firmly in place, and it began to speed up. Only 39 of the 225 canonizations in the dataset occurred before Lambertini's codification. The other 186 (over 80 percent) came after the standards for judging a miracle had settled. Appendix A.4 describes the dataset.

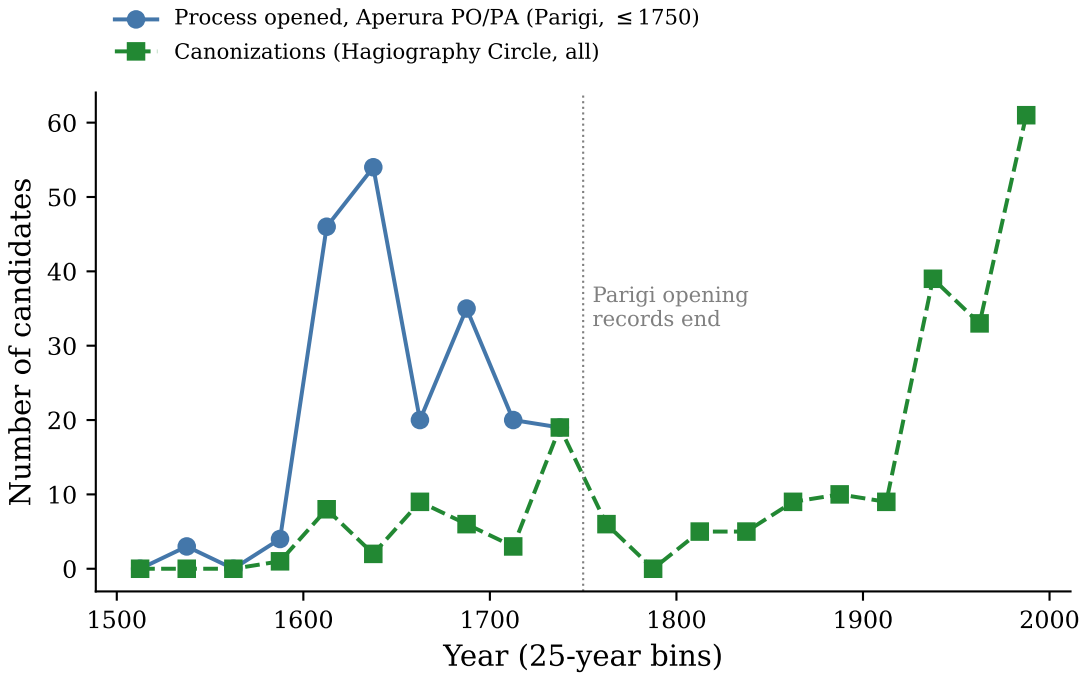
Tightening evidentiary standards should show up in the timing of canonizations and in how often an open process produced a saint.[22] Of the 100 candidates whose processes opened in 1600–1649, 43 percent became saints. Of the 55 opened in 1650–1699, only 15 percent did, and the eighteenth-century cohort (39 candidates, 1700–1749) holds at the same 15 percent. The share of open cases that ended in sainthood collapses between the first and second halves of the 17^{th} century, well before Lambertini's 1734 codification.

Figure 11 shows both ends of the pipeline: process openings (blue line) peak between 1600 and 1650 at 46 to 54 candidates in each quarter-century, while canonizations in the full Hagiography Circle record (green dashed line) reach their early-modern peak a century later, with 19 in the 1725–1749 window. Cases surged once the new procedure came into effect, but the number of new saints did not. Openings rise from four in 1575–1599 to 46 in 1600–1624 and 54 in 1625–1649, while those same two windows produced eight canonizations and then two. The Counter-Reformation Church built up a long backlog of unresolved causes and took a century to clear it. In the 20^{th} century the green line climbs again to 61 canonizations in 1975–2000 under John Paul II. This second wave draws on the machinery of the early-modern pipeline rather than

[22] I thank Paolo Parigi for sharing the underlying records compiled for his 2012 volume. The file lists 228 candidates, with the dates on which the apostolic and ordinary processes were opened, the highest rank each candidate reached (Venerable, Causa Coronata, Blessed, or Saint), and the canonization year for those who got there. Appendix A.5 describes the dataset.

on its backlog.

Figure 11: Canonization process openings and final canonizations



Notes: 25-year bins. The blue line plots process openings, taken as the earlier of *Aperura PO* and *Aperura PA* in the records compiled by Parigi (2012) (228 candidates, Appendix A.5). That series stops at 1750 because Parigi's recording of new openings ends there. The green dashed line plots all 225 individual canonizations in the Hagiography Circle list, 1594–2000 (Appendix A.4).

A linear probability model for whether a candidate was ever canonized tells the same story. Table B.8 in Appendix A.5 reports three specifications, each adding more explanatory variables to the same outcome. Canonization turns on the characteristics of the saint and their following, not on the content of the miracle. Having a structured miracle dossier at all raises the probability of canonization by 52 percentage points (Table B.8, column 2), and each additional miracle claim adds 2.9 points, both at $p < 0.01$. Indicators for whether the dossier held a cancer, tuberculosis, resurrection, plague, or neurological miracle (column 3) are all individually insignificant, and together they raise the R^2 by only 0.002 (from 0.563 to 0.565). The existence of an evidentiary file, and its thickness, decided the case: once cohort and order are held fixed, the content of the file does not separate saints from venerables.

The evidence that filled those dossiers was medical, and medicine was redrawing the Church's

other supernatural category at the same time. Reading demonic possession as illness has a long intellectual history. Johann Weyer's *De Praestigiis Daemonum* (1563) argued that the people accused of witchcraft were mentally ill rather than parties to a pact with the devil (Weyer, 1991). Weyer did not deny that demons existed, but he insisted that natural law limited what they could do, and that careful observation could tell a natural cause from a supernatural one. Conrad and Schneider (1980) and Conrad (2007) trace how Western societies moved deviance out of religious and criminal categories and into medical ones, a process called "medicalization." Caciola (2003) shows that between 1200 and 1500, the practice of "discerning spirits" (judging whether an inspiration came from God or from the devil) forced observers to rely increasingly on bodily evidence rather than on purely spiritual criteria. That shift anticipated the later medical rereading.[23]

The Vatican's canonization archive records how the rules of evidence changed over four centuries. Jacalyn Duffin, a hematologist and historian of medicine, compiled the largest existing dataset of miracle claims from Vatican canonization proceedings (Duffin, 2009), complementing Paolo Parigi's dataset (Parigi, 2012). The data Duffin shared cover 1,345 healing miracles, 100 non-medical miracles, and 47 records of physician testimony, spanning canonization years from 1588 to 2025 and involving more than 400 distinct saints (Appendix A.6 describes the data). Table 1 reports the main patterns by century.[24]

Three patterns in these data stand out. The first concerns the kind of miracle the Vatican was prepared to certify. Healing accounts for roughly 92 percent of approved miracles in the 16^{th} century, and by the 20^{th} century medically verifiable healing accounts for over 97 percent of what the Vatican certified. The rise coincides with the decades in which the devil's advocate was settling into his role as the tribunal's official skeptic. As the bar for evidence rose, non-

[23] Almond (2004) documents the English cases in detail.

[24] Parigi (2012) reports a parallel tabulation for 1588–1642, covering 511 miracles. Recoding his categories into Duffin's gives a healing share of about 85 percent, with neurological-type conditions at about 31 percent of all miracles and organic and contagious disease at about 24 percent. Matching Duffin's miracle records to the Hagiography Circle list by canonization year attaches a canonising pope to 1,075 of the 1,345 healing miracles (80 percent), with similar match rates for the cancer (87 percent) and tuberculosis (88 percent) records.

Table 1: Miracle claims in Vatican canonization files, by century

	Century						
Category	16th	17th	18th	19th	20th	21st	Total
Healing miracles	99	316	238	184	481	27	1345
Non-medical miracles	9	47	19	12	13	0	100
Total miracles	108	363	257	196	494	27	1445
% Healing	91.7	87.1	92.6	93.9	97.4	100.0	93.1
Disease categories, as % of healing miracles, categories overlap							
Neurological	98%	105%	97%	98%	88%	78%	96%
Orthopedic	11%	12%	11%	20%	12%	0%	13%
Cancer	0.0%	2.2%	4.6%	11.4%	8.7%	11.1%	6.2%
Tuberculosis	3.0%	1.6%	3.4%	9.2%	16.4%	0.0%	8.3%
Demon-related miracles	4	7	1	1	1	0	14
Avg. doctors per case	1.0	1.8	2.4	2.7	4.8	8.0	
(cases with data)	(1)	(5)	(11)	(7)	(22)	(1)	(47)

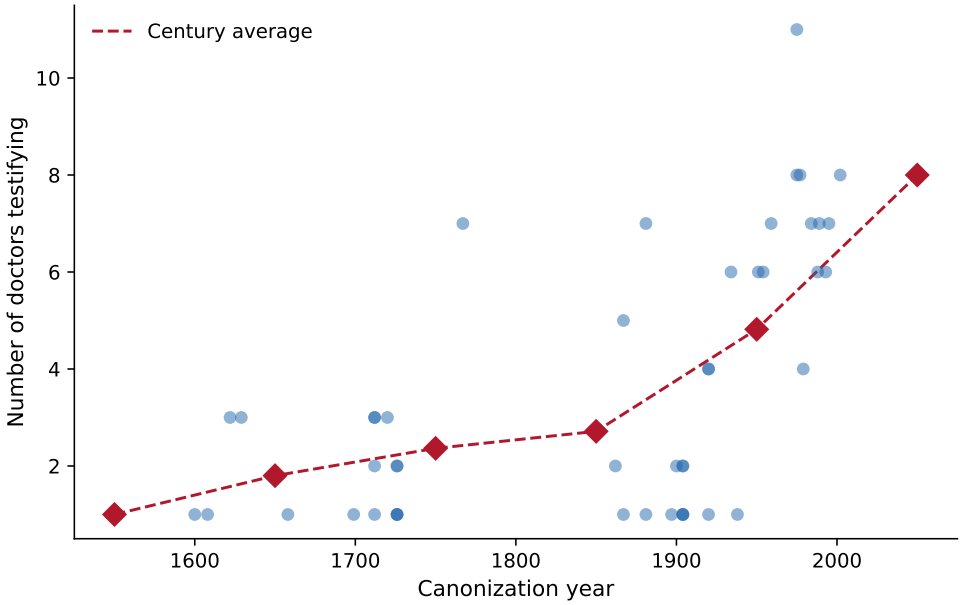
Notes: Data from Duffin (2009) and original files shared by the author. Each row is one miracle claim, and one canonization can carry many of them. The 1,345 healing miracles come from 438 distinct saint and canonization-year pairs, and the largest of those, Didacus of Alcalá in 1588, carries 80. The table covers canonizations from 1588 onward. Three healing records in Duffin's file carry much earlier canonization years (St Peter at 100, Trophimena at 890, and Domenico glorioso patriarci at 1234) and fall outside it. Disease categories are Duffin's own retrospective classifications, and a single miracle may fall in more than one category. "Doctors per case" is the number of physicians recorded as testifying, and is available for 47 records.

medical miracles became harder to defend before a tribunal increasingly staffed by physicians, and almost the only claims that survived scrutiny were those with a medically documented illness and recovery.

The second is about who did the judging. The number of physicians required to testify rises over the same period. In the 16^{th}- and 17^{th} century, one to three doctors was typical. By the 20^{th} century the average was close to five, and some cases ran to eleven (Figure 12). Each round of skeptical cross-examination called for better documentation, and better documentation called for more expert witnesses. By the end of the period a canonization tribunal looked much like a modern clinical case review.

The third is the devil's disappearance from the certified miracle record. Demon-related miracles almost vanish from canonization files after the 17^{th} century: of the 14 demon-related

Figure 12: Number of physicians testifying in canonization cases, by canonization year



Notes: Each point is one canonization case with physician testimony data. Red diamonds mark the century average. Source: Duffin (2009) and original data.

claims in the dataset, 11 occur before 1700 and only 3 after. The last recorded case involves Alexander Sauli, canonized in 1904, and even there the testimony dates to the 17^{th} century. Table B.9 in Appendix B.2 lists every demon-related claim. The timing matches the Murcia *conjuro* record and the witch-trial data: demonic causation is gradually squeezed out as standards of evidence tighten. The Vatican has never formally abolished the idea of a miracle worked by fighting the devil. The category simply could not hold up before a tribunal that demanded physician testimony and medical documentation.

The mix of diseases behind healing miracles also shifts. Cancer miracles are absent from the 16^{th}-century record, appear at about 2 percent in the 17^{th} century, and climb to 11 percent by the 19^{th}. Tuberculosis moves the same way, from 3 percent in the 16^{th} century to over 16 percent in the 20^{th}. Both are diseases that took increasingly sophisticated medicine to diagnose, and their rise reflects the Church's growing insistence that physicians first certify the illness as real and terminal. As medicine improved at naming what was wrong, the Church asked for proof that something genuinely serious had been cured, and the bar for what counted as miraculous

ratcheted up (Table 1). Tuberculosis fell to 0 percent in the 21^{st} century.

Read together, the three patterns describe a single process. The canonization machinery was built to certify holiness through supernatural signs of many kinds, demonic encounters among them, and it narrowed over time until almost everything it certified was healing that a physician could verify. By making skepticism a permanent office, the devil's advocate crowded out claims that could not survive cross-examination. Demons left the certified record not because theology changed (the Church never denied that they existed) but because the institutional demand for evidence made demonic claims impossible to sustain. The Church built an empirical machine in the service of the supernatural, and over four centuries that machine increasingly turned away the kind of explanation that had helped justify building it. Section 5 makes this argument more general. The knowledge produced under Thomistic theology pushed religious explanation out of the physical world.

4.5 Speak of the Devil

The four bodies of evidence so far show institutions trained in Thomistic demonology ruling on supernatural claims. This subsection turns to the institution that did the training. The Dominican order adopted the *Summa* as its standard curriculum, and its network of houses is the infrastructure through which the new dogma reached every corner of Catholic Europe (see Subsection 3.2). I show that exposure to that infrastructure is still measurable in the knowledge economy that grew up around it. Dominican density predicts scientist production across three centuries, the finding survives instrumenting the network with distance from Paris, and it belongs to the Dominicans alone: the Franciscan houses, built in the same decades and in the same towns, predict nothing once the Dominican count is held fixed. I begin with where and when the network was built, and with the correlation between Dominican presence and the production of scientists across places. The houses were standing long before the scientists I count. The outcomes are the universities active by 1500, the scholars in the Science cluster of the RETE academic database (De la Croix, 2021), and the books on the devil and on natural philosophy printed in the first

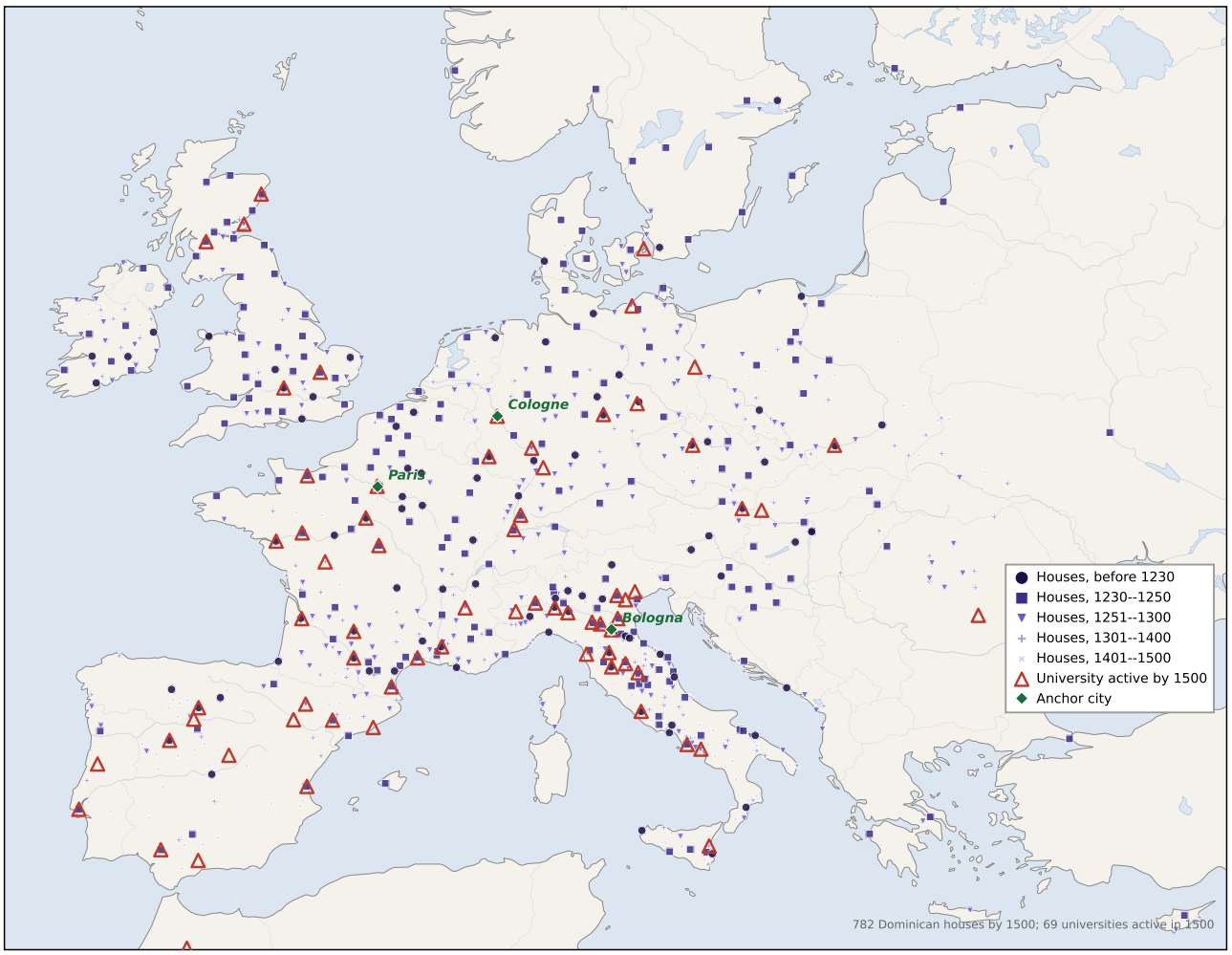
half-century of print, with the notable scientists of the Laouenan et al. (2022) database as a second, independent measure of the scholars. Appendix B.5.1 reports the detailed estimates.

Figure 13 maps the full network coloured by foundation period (see Appendix A.7 for details). Three features stand out. First, the early foundations (1216–1250) concentrate in a corridor running from Paris through the Rhineland to northern Italy, the corridor where the recovered works of Aristotle first entered Latin teaching. Second, the order grew explosively in the second half of the 13^{th} century, doubling in size by 1300 and reaching every major city in Catholic Europe. By c. 1300 roughly 488 of the 782 houses founded by 1500 (62 percent) had been established. Third, after 1400 the expansion is dominated by smaller priories in central Europe, coinciding with the consolidation of the Thomistic curriculum into the order's standard educational programme.

Both the timing and the geography of the network matter. The cumulative number of houses founded from 1200 to 1800 tells a consistent story for the Dominicans and for the two orders I use as comparisons below, the Franciscans and the Jesuits.[25] Among all 885 dated Dominican houses, 55 percent were founded by 1300, 69 percent by 1400, and 88 percent by 1500. The Franciscan network grew in two waves: 40 percent of its houses were founded by 1300, and after a quieter 14^{th} century the Observant reform added more than a thousand houses in the 15^{th}, bringing the share to 94 percent by 1500. The Jesuit curve is a separate wave that begins after the Society's foundation in 1540 and is largely complete by 1650. Both mendicant networks were therefore complete by 1500, when print had just arrived and the great witch-trial wave of 1560–1630 was still half a century away. The Dominican network was mostly built within a century of the order's foundation. This rules out the reverse story in which trials, or the print economy, pulled the orders toward particular places. The mendicant networks (both Dominican and Frasciscan) are medieval institutions that were already standing, not outcomes of the early modern scientific activity they predict. Figure A.2 in Appendix A.7 plots the three cumulative series.

[25] The Franciscan series is drawn from the foundation years in Moorman (1983), as digitized and amended by Boranbay and Guerriero (2019).

Figure 13: Dominican Houses and Universities in Europe, 1216–1500



Note: Each circle is one geocoded Dominican house, coloured by foundation cohort. Each open triangle is a university active by 1500, from the city panel of Bosker et al. (2013). Country borders and coastlines from Natural Earth (50m). The spatial layer for the houses is the Digital Atlas of Roman and Medieval Civilizations, Layer 48, Harvard University. Year-level dates are refined from country-specific Wikipedia, Mortier (1903–1920), Cottineau (1935–1939), Marchese (1854), Beltrán de Heredia (1939), the Reichert MOPH *Acta Capitulorum Generalium*, and Ripoll–Brémond's *Bullarium Ordinis Praedicatorum* (Appendix A.7).

Figure 13 also previews the correlation the regressions measure. The universities active by 1500 lie in the densest parts of the Dominican network, in the Paris–Rhineland–northern Italy corridor, the French Midi, and the Italian peninsula, and the scholars follow the same geography. Across grid cells, the OLS coefficient of Science-cluster scholars on Dominican houses is 0.71. That correlation is not a causal estimate, because the houses were not randomly located. An event study on the timing of placement shows what their placement looked like. Over the century and a half before a foundation, the cells about to receive a house produced fewer scholars than the cells the order never entered, by 0.098 log points, and that shortfall was closing as the foundation date approached.[26] Mendicant houses went up in towns, so the cross-section mixes the curriculum with urban vitality and with whatever else drew the order to a place. The co-located Franciscan network gives one counterfactual, and I take that up below. The many other robustness and placebo tests: the conditioned regressions, the count models on the full grid including its zeros, the placebo-origins analysis, and the dissolution test in Protestant Europe, are in Appendix B.5.4.

Identification rests on three elements. First, to estimate the size of the Thomistic-network channel, I use log distance from Paris as an instrument for the local density of Dominican infrastructure, in the spirit of the distance-to-Wittenberg and distance-to-Mainz designs in Becker and Woessmann (2009), Cantoni (2015), and Dittmar (2011). The outcome is the count of scholars in the Science cluster of the RETE academic database (De la Croix, 2021), aggregated to $2^\circ \times 2^\circ$ grid cells over the period 1450–1800. The first stage measures how strongly distance moves the local stock of houses, and it rests on the historical fact that Paris was the institutional and intellectual center of the Dominican order and of the Thomistic curriculum. Aquinas held the Dominican chair of theology there from 1252 to 1259 and again from 1269 to 1272, the 1270 and 1277 condemnations were issued by the bishop of Paris, the Order's General Chapter sat at Paris, and Dominican *studia generalia* radiated outward from Paris through Cologne, Bologna, and Padua. The exclusion restriction is that, once the controls are in, distance from Paris affects the local

[26] Appendix B.5.6 reports the event study.

production of Science-cluster scholars only through the Thomistic network. The most plausible threats to it are proximity to other early universities, to trade routes, and to printing centers. All three would, if anything, work *against* finding a positive Dominican effect, because they correlate with distance to Paris and with human capital production through channels other than the curriculum (a direct test of these alternatives appears in Appendix B.5.1). Zhao (2023) shows, for the distance-to-Wittenberg and distance-to-Mainz designs, that "distance from" instruments can return falsely significant estimates when the underlying diffusion did not in fact follow distance. Following her recommended placebo tests, I report the first stage throughout, rerun the design against every alternative origin in the city panel and under macro-region fixed effects and medieval population controls with weak-instrument-robust inference (Appendix B.5.6), and read the IV alongside the timing, diffusion, and event-study evidence rather than as a stand-alone identification (see also Appendix B.5.5).

Second, the Dominican IV on its own cannot separate the Thomistic curriculum from mendicant preaching in general, so I run the same 2SLS specification with the Franciscan order (Table B.23 in Appendix B.5.3 and Figure 15.B below). The Franciscans were founded in 1209, seven years before the Dominicans, and competed for the same audiences. Their school followed Bonaventure, Scotus, and Ockham rather than Aquinas (Subsection 2.4). The two orders were not interchangeable versions of one generic mendicant programme.[27]

Third, Figure 14 maps the two mendicant networks on the same European frame, together with the colleges of the Society of Jesus, who later re-adopted Thomism. That third network was created much later, and where its colleges went depended on the Reformation. The Society of Jesus formally adopted Thomism in the 1599 *Ratio Studiorum*.[28] Individual Jesuits were among

[27] Arruñada and López-Manuel (2026) document opposing long-run effects of exposure to the two orders on individualism, impersonal prosociality, and impartial enforcement: positive from the Dominicans, negative from the Franciscans, a difference they trace to the orders' distinct doctrinal specializations. They also find that Dominican exposure predicts the regional density of notable scientists (from the Laouenan et al., 2022 database) positively from 1500 onward, while Franciscan exposure predicts it negatively (see Appendix B.5.5).

[28] Rosenberger and Sunde (2026) document a direct curricular channel in France. From about 1600 the Jesuits established science chairs in the *collège* network, more often where a local Huguenot community sharpened religious competition, and towns whose college offered a science track by 1750 had more scientific societies and *Encyclopédie* subscriptions.

the finest scholars of early modern Europe.[29]

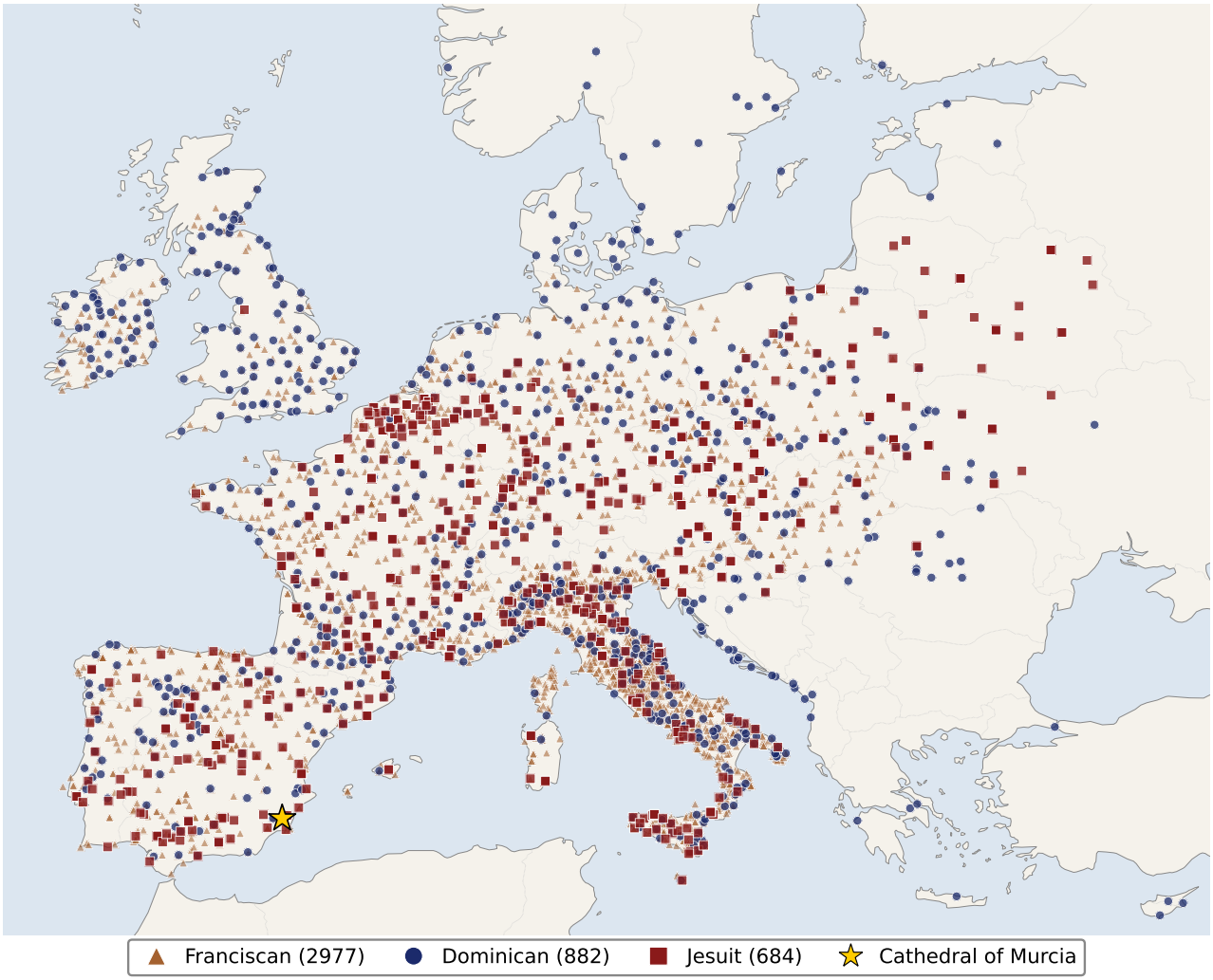
The Jesuit network is not a valid treatment in this design for two reasons. Its colleges were not already standing when the scientists I count began to appear: the Society was founded in 1540, and it placed its colleges in response to the Reformation, concentrating them in Italy, Iberia, and the contested Catholic borderlands. Nor does the distance-to-Paris instrument have any historical claim on an order founded by a Spaniard, governed from Rome, and repeatedly expelled from Paris. Taken on their own, the single-order Jesuit estimates come out positive, and they are a placebo: they show what the instrument returns when it is handed a dense post-1550 network that shares the geography of the Dominican corridor but lacks the historical first stage. Two results confirm that reading. In the joint specification, the Jesuit coefficient is statistically zero in every window once Dominican presence is controlled (Table B.24 in Appendix B.5.3). In the city-panel design of Table B.25 in the same appendix, which identifies from the timing of arrivals within a city rather than from cross-sectional geography, the Jesuit 2SLS coefficient turns sharply negative (-4.75, s.e. 0.98). For Dominican houses the coefficient is positive and significant in all three: under the cross-sectional instrument reported below, in the joint specification, and in the city panel.

The three orders share much of the same geographic presence, but the center of mass differs. The Dominican network is dense in Paris, the Rhineland, and northern Italy, the same corridor through which Aristotle's recovered works first entered Latin teaching. The Franciscan network is larger in raw count and tilts further south and west, with heavy presence in Italy, southern France, and the Iberian periphery. Jesuit colleges cluster in Iberia, southern Germany, and the Low Countries, and have only a small presence in the regions that turned Protestant.

Figure 15 traces the order effects across 50-year windows from 1300 to 1800. Figure 15.A reports the OLS coefficients and Figure 15.B the 2SLS coefficients, and Figure 15.C reports the horse race, a joint OLS in which the three order counts enter together, with log distance from

[29] Christopher Clavius led the mathematical reform behind the Gregorian calendar, Athanasius Kircher ran what amounted to a one-man research institute in Rome, and Ruggiero Boscovich anticipated parts of modern atomic theory.

Figure 14: Religious-order networks in Europe: Dominicans, Franciscans, and Jesuits.



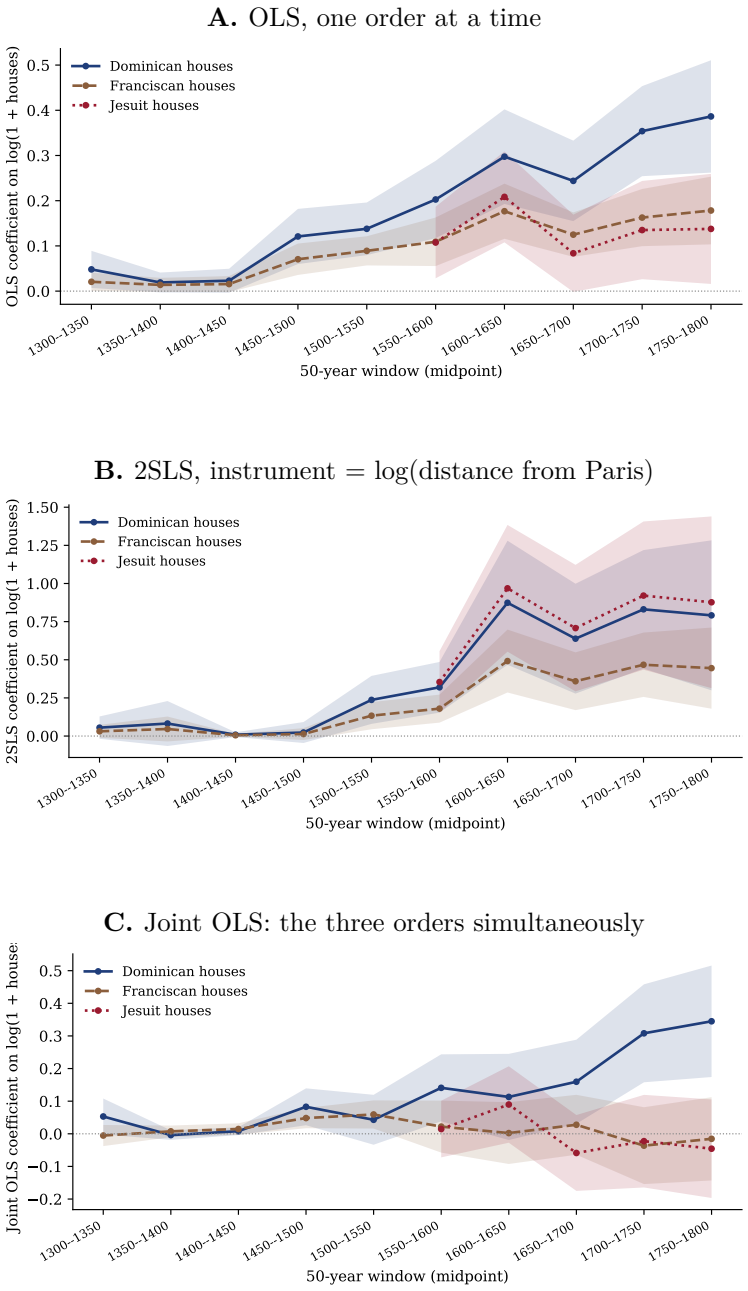
Note: Each marker is one geocoded house. The Dominicans (dark blue circles) come from the refined inventory built on DARMC Layer 48 (Appendix A.7). The Franciscans (brown triangles) come from Moorman (1983), as digitized and amended by Boranbay and Guerriero (2019). The Jesuits (dark red squares) come from the catalogue of Jesuit domiciles of Hamy (1892) and order records, restricted to European entries (Appendix A.7). Country borders and coastlines from Natural Earth (50m). Source-quality details in Appendix A.7.

Paris as a control. The windows before 1450 contain fewer than ten Science-cluster scholars each, so the early coefficients measure the absence of an outcome as much as the absence of an effect.

The three panels show the timing argument of the paper. In Figure 15.A, both mendicant lines are flat at zero through the 14^{th} and early 15^{th} centuries, when the networks were already built but Europe produced almost no scientists. The Dominican OLS coefficient then roughly triples across the early modern period, from 0.12 in 1450–1500 to 0.39 in 1750–1800, and sits above the Franciscan line in every window: the Franciscan coefficient is about half the Dominican one throughout. Figure 15.B sharpens the timing. The instrumented Dominican effect is still indistinguishable from zero in 1450–1500, when print had barely arrived and the witch-trial era had not begun, and it then climbs steadily to a peak of 0.87 in 1600–1650 (the half-century of Galileo, Kepler, and Descartes, and the crest of the witch-trial wave). It settles around 0.8 in the 18^{th} century. A medieval network whose last major additions predate 1500 predicts scholar production with growing force over the following three centuries: the stock of houses was fixed, and what grew was the return to the curriculum they taught. The timing suggests that the printing press, or its interaction with the curriculum, is what generated the large returns. The Jesuit line tracks the Dominican line closely after 1550, which is exactly what a placebo should do: the Paris instrument projects the same geography onto any dense post-1550 network, even one with no first stage behind it.

Figure 15.C is the horse race, and it is what separates the Thomistic-curriculum story from the more general mendicant-preaching alternative. Once the other two orders and distance from Paris are held fixed, only the Dominican line leaves zero: it separates from the other two after 1550 and climbs from 0.14 in 1550–1600 to 0.34 in 1750–1800. The Franciscan line never leaves zero (its largest conditional coefficient is 0.06, and from 1700 onward the point estimates are negative), and the Jesuit line enters at zero in 1550–1600 and stays there, drifting negative after 1650. The contrast with the single-order panels is the co-location problem. Taken alone, every order's houses predict scholars, because every order's houses sit in the same towns. Taken together, only the Dominican count carries information, and it does so in every window of

Figure 15: Order effects on Science-cluster scholars by 50-year window, 1300–1800



Notes: In Panels A and B, each point is the coefficient on log(1+order houses) from a separate regression, one per order per window, of log(1 + Science-cluster scholars active in the window) on the order's full house stock. In Panel C, each point comes from one joint OLS regression per window that includes the three order counts and log(1 + distance from Paris) together (the specification of Table B.24 in Appendix B.5.3). All panels use a fixed frame of 148 grid cells with at least five RETE scholars active 1450–1800. Shaded bands are 95 percent confidence intervals from heteroskedasticity-robust standard errors. The Jesuit series starts with the 1550–1600 window, since the Society was founded in 1540. The Paris instrument is not historically meaningful for the Jesuits, so their 2SLS line is a placebo for the design.

three centuries. The result is not about mendicant density, preaching, or Catholic teaching infrastructure in general. It is about the particular intellectual programme that the Dominican houses taught (Appendix B.5.3 reports the same comparisons as tables).

Used alone (Figures 15.A and 15.B), the Franciscan coefficient is positive but consistently about half the Dominican one, because the two mendicant networks overlap: the correlation between the two log house counts across the 148 cells is 0.79, so the Franciscan count on its own picks up the shared mendicant geography, whose predictive content is Dominican. Used together with the Dominican count (Figure 15.C), the Franciscan effect is close to zero in every window. Weighting by population turns the Franciscan effect negative throughout (Figure B.18 in Appendix B.5.5). Places with Franciscan but not Dominican presence are large, and they produce few scientists for their size. Franciscan presence predicts scientists only as a proxy for Dominican presence, so net of the Dominicans it predicts nothing in absolute terms, and less than nothing in per-capita terms.

With the three networks on the map, I return to the Dominican channel. Table B.21 in Appendix B.5.1 reports the first stage and the 2SLS estimate.[30] Doubling the count of Dominican houses in a cell is associated with roughly a $2^{1.45} \approx 2.7$-fold increase in the count of Science-cluster scholars in the same cell over 1450–1800. The OLS estimate of 0.71 is roughly half the IV estimate.[31] A second measure of scientists gives the same answer. On the regional frame of Arruñada and López-Manuel (2026), with the notable scientists of the Laouenan et al. (2022) database as the outcome and population-weighted Dominican exposure as the treatment, OLS puts the Dominican coefficient at 0.79 and 2SLS at 2.20, both significant at the one percent level, and the move from OLS to 2SLS is the same as in the grid design (Table B.30 in

[30] The first-stage F-statistic is 19.4 under heteroskedasticity-robust standard errors, above the Stock and Yogo (2005) critical value of 16.38 for one endogenous regressor and a single instrument at the 10 percent maximal-size level, and the reduced form is significant at $p < 0.001$. The same first stage gives 32.0 under classical standard errors, the value reported in Table B.19 and in the pooled column of Table B.23.

[31] Two robustness checks appear in Table B.20 in Appendix B.5.1. Under Conley (1999) standard errors with Bartlett-kernel cutoffs at 500, 1,000, and 1,500 km, which allow the errors of any two cells within those distances of each other to be correlated, the main coefficient stays significant at the one percent level. It also survives controls for proximity to other pre-1250 universities and to pre-1500 printing centres.

Appendix B.5.5).[32]

The same design applies to the other outcomes. Panel B of Table B.21 in Appendix B.5.1 reports the same specification, but for four outcomes: i) the count of universities active by 1500, ii) the count of Science-cluster scholars, iii) the count of devil-book editions, and iv) the count of natural-philosophy editions.[33] All four 2SLS coefficients are positive and significant. The university elasticity (0.33) is the smallest: universities were scarce and expensive institutions, and the Dominican network operated through its own *studia* as much as through chartered universities. The scholar elasticity (1.45) and the natural-philosophy print elasticity (1.68) are the largest: where the network was dense, the people and the books of the new learning accumulated together. And the devil-book elasticity (0.60) shows the distinctive signature of the Thomistic programme: the same network that produced natural philosophers also produced the demonological literature, and the two genres are joint outputs of the same curriculum. This is the central claim of the paper compressed into one table.[34]

[32]Those scientists come from Wikipedia rather than from university rosters, are placed by where they died rather than by where they worked, and are measured on administrative regions rather than grid cells. The sign, the magnitude, and the Dominican–Franciscan asymmetry still come out the same.

[33]The editions are Incunabula Short Title Catalogue imprints printed in the cell during the first half-century of print. Appendix A.10 gives the classification and construction details, and Appendix B.5.2 reports the complementary design that uses the editions as exposure measures rather than outcomes.

[34]Appendix B.5.4 reports four further tests. Adding macro-region fixed effects, medieval city population, and the distance gradient leaves the Dominican elasticity at 0.36 and the Franciscan one insignificant, and a regression that holds total mendicant density fixed and varies only the Dominican share of it still favors the houses that taught the *Summa*. Poisson models on the full European grid, which keep the cells that produced no scientists at all, put the elasticity between 0.81 and 3.4, a range that brackets the 2SLS estimate of 1.45. Rerunning the design from every origin the instrument might have had shows what the Paris gradient can and cannot pin down. And the dissolution test compares the Protestant territories that seized every mendicant house by 1580 with Catholic Europe: the pre-1500 Dominican stock predicts scholars active 1550–1800 with an elasticity of 0.55 in the first group and 0.46 in the second.

5 Losing My Religion

The third phase of the framework is the outcome we live with today: religious explanation has almost entirely left the physical world. No sudden revolution and no deliberate program of secularization produced this displacement. It was the cumulative and unintended consequence of the empirical research that Thomistic theology had encouraged. The process peaked in the Industrial Revolution (1750–1850), when theoretical knowledge and practical application began to feed each other systematically and transformed the economy (Mokyr, 2002).[35]

Investigating nature, a project first justified on theological grounds, slowly produced knowledge that left supernatural causes with less and less to explain. Brooke (1991) argues that science and religion have influenced each other in complicated ways rather than simply clashed.[36] The result is the division of labor we now take for granted: science claims authority over physical processes, and religion answers questions of meaning, purpose, and value. The division looks natural to modern minds, but it is historically contingent, set in motion by theological innovations that began by joining the two domains.[37]

The displacement is visible in how often European books use devil-related and natural-philosophy words. Figure 16 plots the combined frequency of devil, witchcraft, and exorcism terms against the combined frequency of natural-philosophy terms (experiment, observation, natural philosophy) in the Google Books English and Spanish corpora from 1500 to 2019. In both languages, diabolical vocabulary peaks in the 16^{th} and 17^{th} centuries and falls thereafter, while natural-philosophy vocabulary rises from the 18^{th} century onward.[38] The two lines cross around 1750–1800, the period Mokyr (2002) identifies as the onset of the Industrial Enlighten-

[35] Appendix C.8 places this argument inside the wider debate between economic and cultural explanations of the Industrial Revolution.

[36] Harrison (2015) shows that the modern categories of "science" and "religion" as separate domains emerged historically rather than representing natural divisions. Gregory (2012) argues that theological developments inadvertently contributed to the disenchantment of nature that made its technological exploitation possible.

[37] Taylor (2007) documents how this separation transformed human experience by creating distinct "immanent" and "transcendent" frames of reference.

[38] The scissors pattern holds across French, German, and Italian (Figure B.10 in Appendix B.4.1).

ment. Almelhem et al. (2026) date the same watershed with a different method and corpus: in a topic-model analysis of 264,443 English works printed between 1500 and 1900, the languages of science and religion separate from the mid-18^{th} century onward.

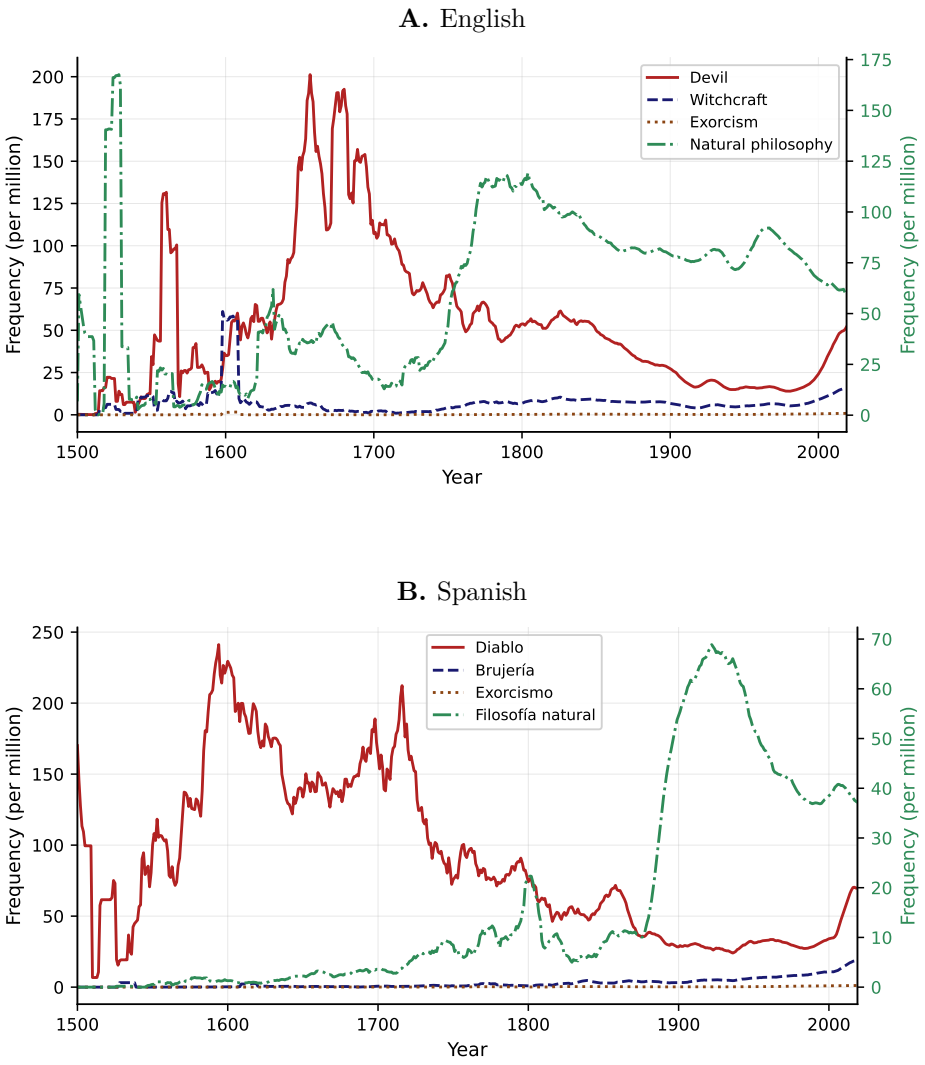
Otherwise the two corpora tell different stories. English devil terms spike around 1600–1700, at the height of the witch-trial era. Spanish devil vocabulary is higher in absolute terms and lasts longer, which fits the Inquisition's sustained institutional engagement with demonic categories. The same institution suppressed witch-trial activity, and witchcraft terms (*brujería, hechicería*) stay negligible in Spanish. Natural-philosophy vocabulary arrives later in Spain, reflecting the delayed adoption of empirical curricula that Squicciarini (2020) and Lecce et al. (2021) document for Catholic educational institutions in France.

Few events mark the turning point as cleanly as the Lisbon earthquake of November 1, 1755. It struck on All Saints' Day, with the churches of the Portuguese capital full of worshippers. The earthquake, the fires, and the tsunami that came after killed between 30,000 and 40,000 people (Shrady, 2008). Most of Lisbon's churches collapsed, while much of the city's brothel district, on higher ground, came through relatively intact. Providential interpreters, among them the Jesuit Gabriel Malagrida, argued that the disaster expressed divine wrath and that rebuilding before attending to moral reformation would invite further punishment (Kendrick, 1956). The Marquis of Pombal, who directed the reconstruction, treated the disaster as an engineering problem, expelled the Jesuits from Portugal in 1759, and rebuilt the city on a rational grid that took future earthquakes into account (França, 1983). Voltaire made the same point from Geneva in his *Poème sur le désastre de Lisbonne* (1756): if the earthquake was divine vengeance, what crime had the children committed, crushed on their mothers' breasts?[39] The contest between Malagrida and Pombal was not merely political. Two frameworks for explaining physical catastrophe were competing, and the naturalistic one won.

Malagrida's position was not idiosyncratic: by the 18^{th} century the Society of Jesus had

[39]The original: *"Direz-vous, en voyant cet amas de victimes: / 'Dieu s'est vengé, leur mort est le prix de leurs crimes'? / Quel crime, quelle faute ont commis ces enfants / Sur le sein maternel écrasés et sanglants?"* (Voltaire, 1756, ll. 17–20).

Figure 16: Devil, witchcraft, and natural-philosophy terms in published books, 1500–2019



Notes: The left axis gives the combined frequency per million words of devil, witchcraft, and exorcism terms. The right axis, in green, gives the combined frequency of natural-philosophy terms (experiment, observation, natural philosophy and their equivalents in each language). Both series are five-year moving averages. Source: Google Books Ngram Viewer, 2019 edition corpora. Appendix A.8 lists the terms and describes the method.

become the most conservative institutional defender of providential interpretation, and this was the order that had taken the Thomistic curriculum into its college network and produced scientists of the rank of Clavius and Boscovich. The expulsions that followed (Portugal in 1759, France in 1764, Spain in 1767, and the papal suppression of the Society in 1773) were in part the price of that conservatism. The same order that taught the new science in its own classrooms ended the period defending divine wrath against urban engineering.[40]

The Church built the ladder, and the Enlightenment climbed it beyond the Church's reach. Aquinas introduced systematic doubt about supernatural causation to protect religious institutions and put them on a rational footing, not to weaken them. The *Summa Theologica*'s treatment of demonic agency was a weapon aimed at popular credulity and heresy. By insisting that demons work through natural means and not supernatural ones, Aquinas denied the legitimacy of folk attributions that embarrassed the Church (Bailey, 2013; Boureau, 2006). He set a standard for what counts as an explanation: observed physical effects must be accounted for by natural secondary causes wherever possible. The standard was designed to serve theological ends, but once generations of Scholastic natural philosophers took it up, it proved far more generative than its author could have anticipated. Naturalistic investigation of the physical world was born inside the Church rather than against it, as a tool of theological refinement. The Scientific Revolution was an unintended consequence of medieval theological innovation.

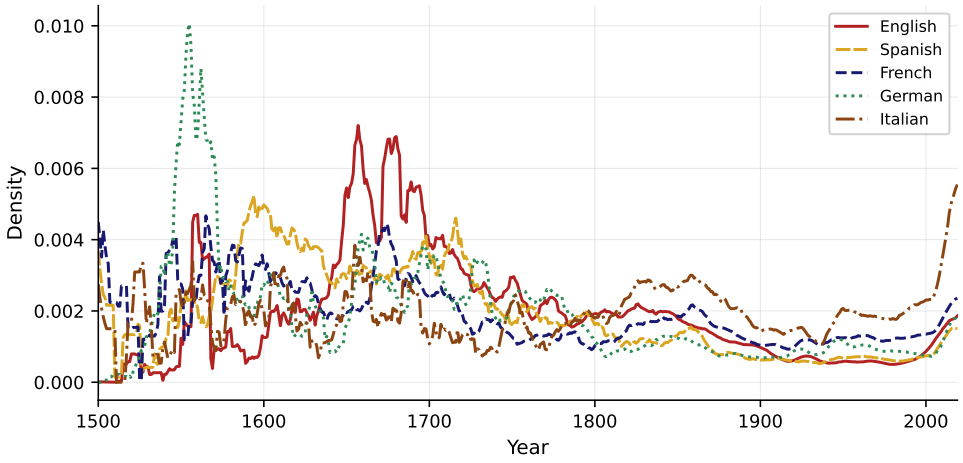
The Murcia archives record the process inside a single cathedral: conjuros against locust plagues fell away as agricultural knowledge accumulated and made a ceremonial response implausible. Theological reform did not end the ceremony. Naturalistic alternatives that worked better did. The chain from Aristotelian doctrine to practical invention is visible in particular cases: the overthrow of *horror vacui* led to the barometer, to atmospheric pressure, and to the steam engine, while the microscope overturned Aristotelian biology and laid the foundation for germ theory. In the Americas, the patio process for silver extraction showed that human art

[40] Belloc et al. (2016) document this dynamic systematically: across medieval and early modern Italian city-states, earthquakes slowed the transition from autocratic to representative governance, but only in polities ruled by religious authorities who could claim interpretive authority over natural disasters.

could surpass the limits Aristotle had placed on natural processes (see Appendix C.9).

Figure 17 rescales devil-related frequencies in five European languages so that each curve encloses the same area, which sets aside differences in absolute scale and shows when each tradition concentrated its talk about the devil. German peaks earliest, around 1550, alongside the Reformation and the heavy demonological publishing that came with it. English and French peak in the early 17^{th} century. Spanish and Italian are more spread out, with an early peak around 1520 and a sustained presence into the 18^{th} century. By 1800, all five have settled onto a low, flat baseline: the displacement of diabolical vocabulary from European writing was complete across the continent within a generation of the Industrial Revolution (Appendix B.4.1 presents the full cross-language comparisons).[41]

Figure 17: Density of devil-related terms across European languages, 1500–2019



Notes: Each language's grouped devil-related terms are normalized as a probability density (area under curve = 1), which removes cross-language differences in absolute frequency. A five-year moving average is applied before normalization. Source: Google Books Ngram Viewer, 2019 edition corpora. Appendix A.8 lists the terms.

The Dominican channel of Subsection 4.5 is specific to the upper tail of the skill distribution. The medieval Dominican stock does not predict overall city population growth between 1500 and 1800, or between 1700 and 1800, or entry into the urban system by 1800 (Table B.33 in

[41] The cross-language density for witchcraft terms is sharply bimodal, and Spanish terms are negligible throughout, consistent with the Inquisition's suppression of popular witch-trial activity (Figure B.11 in Appendix B.4.1). The uptick after 2000 in every language reflects modern academic scholarship and fiction rather than renewed belief.

Appendix B.5.6). The same network that raises a cell's production of Science-cluster scholars leaves total urban growth unchanged.[42] A central question in the economics of religion is why religious institutions in Western Europe gave up their authority over knowledge of the physical world to secular inquiry while their counterparts elsewhere did not. Rubin (2017) argues that, where rulers depended on religious authorities for legitimacy, those authorities could block institutions and technologies that threatened their position, at a lasting cost to the accumulation and diffusion of useful knowledge. His leading example is the Ottoman restriction of the printing press. The Thomistic transition offers one explanation for why the Western European path was different. An institution committed to the principle that natural causes must be taken seriously before anyone invokes the supernatural cannot resist the accumulation of natural knowledge indefinitely without contradicting itself. The internal logic of Thomistic natural theology forced the Church to accept the very forms of inquiry that would eventually displace its authority over the physical world.

Losing physical explanation did not destroy religious institutions. Religious organizations supply goods that secular alternatives cannot easily copy: personal meaning, community solidarity, assurance about what comes after death, and the management of existential risk (Iannaccone, 1994, 1998). Institutions that had monopolized the explanation of physical catastrophe could retreat to the ground where naturalistic competitors were weaker. The Murcia data show that ceremonial activity did not disappear but migrated toward the occasions for which no secular substitute existed: communal grief, civic identity, and the marking of the agricultural calendar. The secularization of physical explanation was not a zero-sum loss for religious institutions. It was a forced specialization that left them in a more defensible competitive position, concentrated on the domains of meaning, morality, and community, which empirical science has not displaced and, by its nature, may be unable to displace.

[42] Squicciarini and Voigtländer (2015) document the same pattern for the knowledge elites of Enlightenment France, where upper-tail human capital bore no relation to city development at the time and began to pay only when industrial technology arrived to be absorbed.

6 Conclusion

A 13^{th}-century theological dispute about the limits of demonic power created institutional incentives for empirical research that shaped the long-run path of European economic development. Before Aquinas, every major world religion discouraged investigation of natural disasters. After Aquinas, investigating natural laws was a Christian duty: the devil used those laws to deceive, and humans needed to tell true miracles from false ones. The *Summa Theologica* replaced the Platonic *Sentences* as the standard university textbook, and it trained generations of educated Europeans in the Aristotelian methods of observation, categorization, and causal inquiry. The knowledge this research accumulated across the Age of Discovery, the Renaissance, the Enlightenment, and the Industrial Revolution eventually displaced religion from the physical world altogether.

Several questions remain open. The argument invites comparison with other religious traditions that met Aristotelian philosophy but ran it through different institutions (monasteries, madrasas, and imperial academies), and the consequences for the long-run accumulation of useful knowledge may differ across them. In Christianity, the devil was not refuted, but made redundant. The institutions that built their authority around combating him were forced, by the very tools they had forged, to find a more durable source of legitimacy. God expelled Lucifer from the metaphysical world. Lucifer, through science, expelled God from the physical world.

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Online Appendix

Sympathy for the Devil

José-Antonio Espín-Sánchez

A Data Construction

A.1 Murcia Ceremonial Records

The primary dataset comes from the Cathedral Archives of Murcia (Archivo Catedralicio de Murcia, c. 1300 to 2000). Each entry records the year (and the precise date where the source gives one), a description of the environmental event or disaster, the type of ceremony performed in response, and any further detail the source notes (participants, cost, duration, materials used). I sort the disasters into four categories: pest (locust, bird, insect, worm plagues), epidemic (peste, cólera, epidemia), weather (granizada, inundación), and other. The ceremonies fall into three groups: *rogativa* (prayer procession), *conjuro* (exorcism or conjuration), and other (mass, bell-ringing, charity, blessing, practical action, unknown). The finished dataset contains 218 *conjuros* spanning 1406–1941, along with rogativas and other ceremonial responses over the same period. Espín-Sánchez and Gil-Guirado (2026) describes the data in full, including the coding rules and a list of every recorded ceremony.

A.2 Witch Trials (Kieckhefer Calendar)

I build the witch trials dataset by digitizing and coding the "Calendar of Witch Trials" printed as an appendix (pp. 106–147) in Kieckhefer (1976). It is the fullest trial-level compilation of European witch prosecutions before 1500. The Calendar draws on the document collections of Hansen (*Quellen und Untersuchungen*, *Zauberwahn*), Lea (*Materials Toward a History of Witchcraft*), Kittredge (*Witchcraft in Old and New England*), and numerous regional studies. Each entry records one trial or a group of closely related proceedings, and it gives (where the sources allow) the date, the location, the identity and sex of the accused, the charges, the type of court, the outcome, and citations to both primary sources and secondary literature.

The dataset has 558 entries spanning 1242–1499, covering 15 modern countries. Kieckhefer puts square brackets around 82 of them (14.7 percent) to mark them as uncertain, and I treat

the remaining 476 as confirmed. The dataset contains the following fields.

Date. Two variables record the earliest and the latest year for each entry. For entries with a single year the two values coincide, and for entries with a date range (e.g., "1306–14, France") they record the endpoints.

Place and country. The place variable keeps the location exactly as the Calendar gives it, and I assign each entry to a modern country with a lookup table running from place names to national territories. The 15 countries represented are Austria, Belgium, Bohemia, England, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Poland, Savoy, Scotland, Spain, and Switzerland.

Number and sex of the accused. Three variables record the number of men tried, the number of women tried, and the total number of persons tried.

Sentence. I code the judicial outcome from keywords in the narrative. Categories include burned/executed, hanged/executed, beheaded/executed, acquitted, released, banished, imprisoned, fined, penance, purgation, excommunicated, and died under torture. One entry can carry more than one outcome.

Court type. I classify courts as ecclesiastical (including inquisitorial tribunals), secular, municipal, papal, or a combination, following explicit references in the text.

Demon or devil mentioned. A binary indicator equals one if the narrative mentions demons, the devil, diabolism, Lucifer, Satan, pacts with the devil, invocation, sabbats, or synagogues. The variable marks whether the trial record shows the "elaborated concept" of witchcraft, the idea that tied sorcery to the work of demons.

Confession under torture. A binary indicator equals one if the narrative explicitly mentions torture or a confession made under interrogation.

Specific crime. I match the narrative against a list of offenses: sorcery, witchcraft, diabolism, heresy, invocation, necromancy, love magic, weather magic, image magic, poison, killing, divination, enchantment, incantation, and others. One entry can carry several charges.

Bracketed. A binary indicator that keeps Kieckhefer's square-bracket notation for uncertain

entries.

Sources. I keep the primary source citations ("S:") and the secondary literature references ("L:") as the Calendar gives them.

Table A.1: Variable coverage in the witch trials dataset ($N = 558$)

Variable	Entries with data	Percent
Year (min/max)	558	100.0
Place	558	100.0
Country	558	100.0
Court type	427	76.5
Specific crime	436	78.1
Total persons tried	401	71.9
Gender of accused	383	68.6
Sentence / outcome	291	52.2
Source citation (S:)	346	62.0
Literature citation (L:)	409	73.3

Table A.1 reports the share of entries for which each variable is non-missing. The Calendar records the research as it stood in the mid-1970s, and since then Behringer (2004) and the Lausanne editions of the earliest sabbat texts (Ostorero et al., 1999) have added trials and clarified the Alpine origins of the elaborated concept. I am not aware of any compendium with relevant details at the individual level. The trial counts are therefore a lower bound.

A.3 Spanish Inquisition

The Spanish Inquisition analysis combines three data sources.

Source 1: EMID Individual Trial Data (DVV). Trial-by-trial records from the Early Modern Inquisition Database (EMID), shared by Drelichman, Vidal-Robert, and Voth (March 2026): 61,599 trials across sixteen tribunals and 3,815 municipalities, spanning 1476–1820. Of these, 61,492 carry a year identifier and 107 do not. Each record has four variables: the year, the municipality, the tribunal with jurisdiction, and the court that heard the case. Offense categories and sentences are not in the DVV release.

Source 2: Contreras and Henningsen (1986). Contreras and Henningsen (1986) classify 44,674 cases from the *relaciones de causas* covering 1540–1700 into ten categories: *judaizantes* (5,007), *moriscos* (11,311), *luteranos* (3,499), *alumbrados* (149), *proposiciones heréticas* (12,546), *bigamia* (2,645), *solicitación* (1,241), *contra el Santo Oficio* (3,954), *superstición/brujería* (3,532), and *varios* (790).

Source 3: Blázquez Miguel (1987). The case-level catalogue of the Murcia tribunal: 4,512 trials, 1476–1819, recording the offense category, the sentence, and gender. The density estimates of Figure 3 draw on the 4,457 entries of the catalogue that carry a machine-readable year.

Two limitations apply. First, the DVV records and the Contreras–Henningsen classification draw on overlapping but not identical sources, and the two cannot be linked case by case. Second, the *superstición/brujería* category is broad and covers witchcraft accusations, divination, love magic, and folk healing.

A.4 Canonization Dataset

The canonization dataset records 225 individual canonizations from 1594 to 2000, coded from the Hagiography Circle database. The Hagiography Circle tracks every beatification and canonization conducted under the Congregation for the Causes of Saints (and under the body that preceded it) since 1588. I code two variables for each entry: the year of canonization and the reigning pope. Where one ceremony covered several individuals, each got a separate row, though canonizations of a group of martyrs (e.g., "Pedro Bautista Blásquez, Paulus Miki, and 24 Companions") count as one observation, following the Hagiography Circle convention. The count of 225 therefore falls well short of the number of individuals canonized, above all in the 20^{th} century, when popes frequently canonized large groups of martyrs. Whether groups count as one or are expanded to their full headcount, the pattern over time is the same: few canonizations before the 18^{th} century, a steady rise across the 19^{th}, and a sharp acceleration in the 20^{th}.

The dataset begins with Jacek Odrowaz, canonized by Clement VIII on 17 April 1594, and ends with the canonizations John Paul II performed in 2000. Canonizations after 2000 and

beatifications are excluded. The Hagiography Circle does not record the nature or type of the miracles that supported each canonization: that information sits only in the Vatican's *positiones*, which Duffin (2009) and Parigi (2012) coded from archival sources.

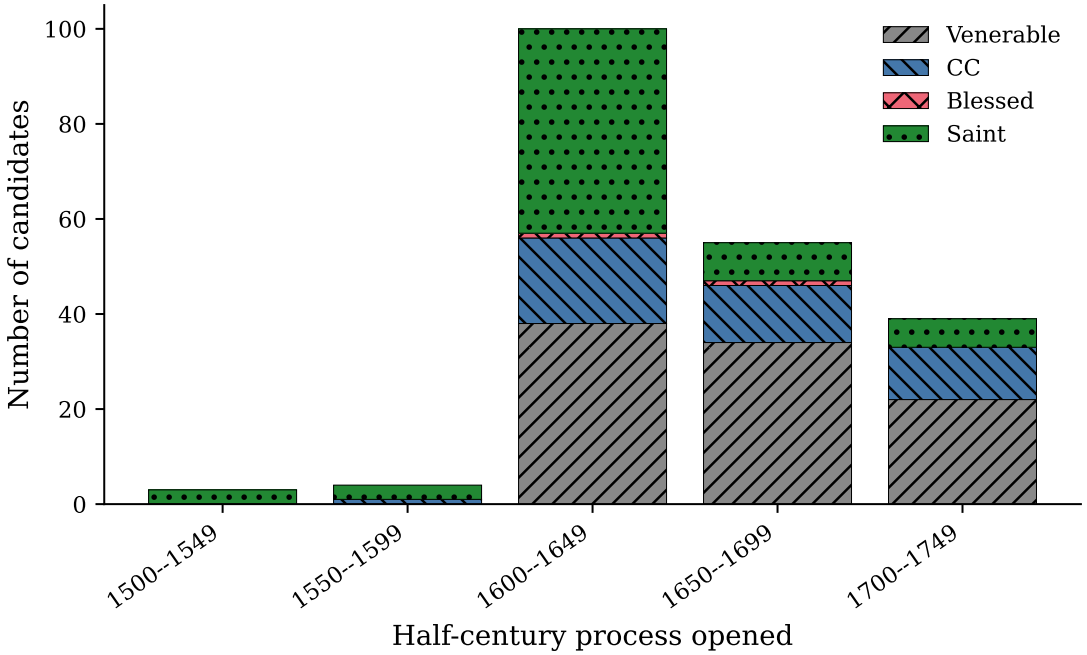
A.5 Canonization Process Data (Parigi)

Paolo Parigi shared the records he compiled for his 2012 volume on the rationalization of canonization, organized in three linked tables. The biographical table lists 228 candidates whose causes for sainthood were opened at the Vatican between about 1318 and 1968, with the archive of reference (Vatican Apostolic Archive, Congregation for the Causes of Saints, or Paris BN) and the candidate's order or status in life. It also gives the dates of birth and death, the dates of beatification and canonization where those apply, the dates on which the apostolic process (*Aperura PA*) and the ordinary or diocesan process (*Aperura PO*) were opened, and the highest rank the candidate ever reached (Venerable, Causa Coronata, Blessed, or Saint). A second table records 254 miracle claims attributed to 88 of these candidates, with free-text descriptions of each claim.

Two features make the Parigi data distinctive. First, it captures candidates who did not become saints: of the 228 candidates, 103 (45 percent) never advanced past Venerable, 44 (19 percent) reached Causa Coronata, 3 were Beatified and remained there, and only 78 (34 percent) were canonized. Second, the dates of process opening track cases as they entered the canonization machinery (Figure 11 in Subsection 4.4). The Hagiography Circle list does not.

Grouping candidates by the half-century in which their process opened sharpens the rationalization pattern. The 1600–1649 group has 100 candidates, of which 43 became saints (43 percent). The 1650–1699 group has 55 candidates and 8 saints (15 percent), and the 1700–1749 group 39 candidates and 6 saints (15 percent). Between the first and the second half of the seventeenth century the share of open processes ending in sainthood collapses, and Figure A.1 shows the mix of final statuses within each half-century.

Figure A.1: Number of candidates by final status and half-century of process opening



Notes: Data come from the biographical layer of the Parigi process records (228 candidates, 205 of them with a recorded process-opening year). Bins are 50 years wide. Half-centuries with fewer than three candidates are omitted. Bars stack in the order Venerable (grey), Causa Coronata (blue), Blessed (red), Saint (green).

A.6 Canonization Miracle Data (Duffin)

The miracle data come from the personal research files of Jacalyn Duffin (Duffin, 2009). Hers is the largest existing dataset of miracle claims from Vatican canonization proceedings, built from approximately 700 *Positio* files (complete dossiers), over 300 *Compendia* (shorter summaries), and other Vatican records.

The data she shared are organized by canonization year and saint name, and they contain 1,345 records spanning canonization years 1588–2025, covering 406 saints. Three further records in the healing file carry canonization years from long before the modern procedure, St Peter at 100, Trophimena at 890, and Domenico glorioso patriarci at 1234, and they fall outside every tabulation. The record is the miracle claim rather than the case: the 1,345 healing miracles attach to 438 distinct saint and canonization-year pairs, and 185 of those pairs carry more than one

claim. Healing miracles are classified by disease type: neurological (1,285 records), orthopedic (170), cancer (84), and tuberculosis (112). These labels are Duffin's own diagnoses, not terms from the original testimony. The categories overlap because one miracle can involve several conditions. The file of non-medical miracles has 100 records, 14 of which mention demons, and the physician testimony file lists 47 records for which Duffin recovered the number of doctors who testified.

Several limits shape what these records can show. The unit of observation is the miracle claim as the Vatican file records it, and the Church chose which claims to file and how to write them up. The canonization year can come centuries after the testimony behind it. Duffin's disease classifications are modern retrospective assessments.

A.7 Religious Orders: Dominicans, Franciscans, and Jesuits

Subsection 4.5 follows the spread of the Thomistic curriculum through the locations of three religious orders: the Dominicans, the Franciscans, and the Society of Jesus. Three inventories hold those locations everywhere in the paper: the refined Dominican inventory built on DARMC Layer 48 (885 houses, year-level dates), the Moorman (1983) Franciscan inventory as digitized and amended by Boranbay and Guerriero (2019) (2,977 houses), and a Jesuit catalogue built on Hamy (1892) and order records (686 houses). As explain below, I expand the information at the DARM with other sources to have more precise dates of foundation after 1500. Figure 14 maps the three networks together.

For Dominicans, the locations come from the Digital Atlas of Roman and Medieval Civilizations (DARMC), Layer 48, maintained by Harvard University and continued as the Mapping Past Societies (MAPS) project. In its native form DARMC codes each foundation only as one of five cohort ranges (*pre-1230*, *1230–1250*, *1251–1300*, *1301–1400*, *1401–1500*) plus a small *pre-1250* residual. The *1301–1400* and *1401–1500* cohorts in particular are too wide for the quarter-century periods of the panel tests in Appendix B.1.5, so I replace the cohort coding with years.

I refine the DARMC coding to year-level dates in three steps. First, I match each house against the Wikipedia article for the convent itself and the Wikipedia article for the town it sits in, in the language of the country (Italian for Italian houses, Spanish for Spanish, French for French). I then extract the first sentence pairing a Dominican keyword with a year. Second, I run a search for foundation verbs over the OCR text of the principal scholarly compilations available online: Mortier's *Histoire des maîtres généraux de l'Ordre des Frères Prêcheurs* (8 vols., 1903–1920, Internet Archive), Cottineau's *Répertoire topo-bibliographique des abbayes et prieurés* (Gallica, vol. II), Marchese's *Memorie dei più insigni pittori, scultori e architetti domenicani* (5 vols., 1854–1869, Internet Archive), Beltrán de Heredia's *Historia de la reforma de la provincia de España (1450–1550)* (Rome 1939, Internet Archive), Reichert's edition of the *Acta Capitulorum Generalium Ordinis Praedicatorum* in MOPH vols. III, IV, and XIV (Internet Archive), and the eight volumes of Ripoll and Brémond's *Bullarium Ordinis Praedicatorum* (Rome 1729–1740, Internet Archive). Third, for the houses that still lack a year, I take the earliest year mentioned within ±300 characters of the place name in any of these sources as a *terminus ante quem*, a date by which the house must already have existed, and assign the house to the quarter-century bin containing that first attestation. For the residual minority that no online source dates, we use the midpoint in the DARMC period, e.g., 1450 for 1401-1500.

The three steps together recover a year-level date for 396 of the 576 DARMC houses whose native cohort is wider than a single quarter century (68.8 percent), and the cohort midpoint is used for the remaining 180. In Western Europe (France, Spain, Portugal, the United Kingdom, Ireland, Italy, Germany, Austria, Switzerland, the Netherlands, Belgium, Luxembourg), coverage at year-or-better resolution reaches 86.9 percent, or 610 of 702 houses, and by country it runs to 100 percent for Switzerland, Belgium, and Luxembourg, 98 percent for France, 88 percent for Austria, 87 percent for Germany, 85 percent for Italy, 84 percent for the United Kingdom, 81 percent for Ireland, 81 percent for Spain, and 77 percent for Portugal and the Netherlands. The remaining 13 percent in Western Europe falls almost entirely in southern Italy, central and southern Spain, and Portugal.

The refined file has three weaknesses. First, DARMC records that a house existed and roughly when it was founded, but not how large it was, how many friars it held, or what it taught. Second, where a house's foundation year comes from an encyclopedic article, the year occasionally refers to the construction or the post-disaster rebuild of the church building rather than to the original Dominican *concessio*, the grant that established the house. A per-house source table flags those cases so they can be reviewed one by one. Third, the dataset does not distinguish houses that closed or were transferred to other orders from those that remained active throughout the period. The refined inventory is still the most complete year-level record of Dominican institutional presence available for medieval Europe. The per-house table records where each year came from and the literal sentence it was taken from, so individual entries can be audited.

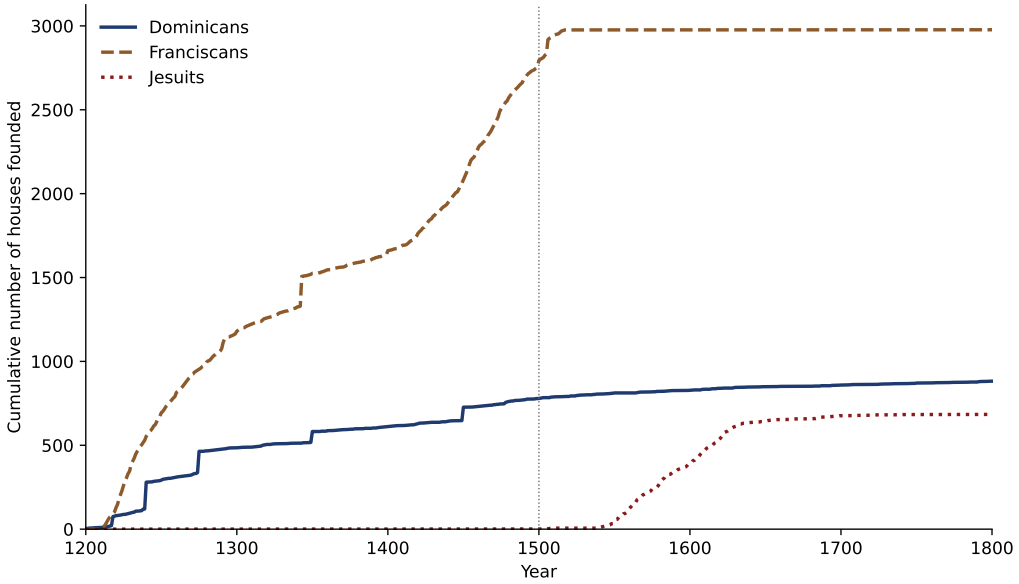
The Franciscan house locations and dates used throughout the paper come from Moorman (1983), *Medieval Franciscan Houses*, as digitized and amended by Boranbay and Guerriero (2019). The inventory carries 2,977 geocoded European houses, each with a foundation year and a closure year. That is roughly three times the coverage of the DARMC Franciscan layer, which has no dates at all. Foundations come in two waves, 1,164 houses in the 13^{th} century and 1,119 in the 15^{th}. The second wave reflects the Observant reform, and 94 percent of all houses are in place by 1500. Coverage is densest in Italy (1,363 houses), France (484), and Spain (360). The period-specific specifications in Table B.23 use the full Franciscan stock in every window, for comparability with the Dominican and Jesuit treatments.

The Jesuit inventory used throughout the paper contains 686 European houses, each geocoded and dated. The principal source is Hamy (1892), the catalogue of Jesuit domiciles from the foundation of the Society in 1540 to the suppression of 1773, which supplies foundation years for 568 houses, and the remaining years come from encyclopedic and reference works. Most entries are colleges (471) and seminaries (109), the schools through which the *Ratio Studiorum* curriculum operated, with smaller numbers of novitiate and professed houses. Italy again leads with 156 houses, then France with 149 and Spain with 98, the heartland of the Counter-Reformation.

Houses before 1550 are sparse by construction: the Society was founded in 1540, so the pre-1550 cells carry no usable Jesuit variation and the estimates for them are uninformative (Subsection 4.5).

Figure A.2 plots the cumulative number of houses founded by each order from 1200 to 1800, using the inventories described above. The Dominican and Franciscan series are all but complete by 1500, and the Jesuit series is a separate wave after 1540. Subsection 4.5 discusses that timing. The house data for the three orders enter the spatial correlation (Appendix B.1.3), spatial diffusion (Appendix B.1.4), and Granger causality (Appendix B.1.5) analyses, and the cell-level 2SLS specifications reported in Subsection 4.5 and Appendix B.5.1.

Figure A.2: Cumulative houses founded by order, 1200–1800



Note: Each line is the cumulative count of geocoded houses with a recovered foundation year inside the European frame of Figure 14. The Dominican line uses the 882 dated houses of the refined inventory that fall inside the European frame, three short of the 885 the inventory holds in all. Houses without a recovered year take DARMC cohort midpoints, which produce the visible steps. The Franciscan line uses 2,977 houses with foundation years from Moorman (1983), as digitized and amended by Boranbay and Guerriero (2019). Of the 686 dated European houses from Hamy (1892) and order records, the Jesuit line uses the 684 that fall inside the frame. The dotted vertical line marks 1500.

A.8 Google Books Ngram Data

I retrieve the word-frequency series in Figures 16 and 17 and Figures B.10 and B.11 from the Google Books Ngram Viewer API, using the 2019 edition of each language corpus.

I aggregate four groups of terms for each of five languages (English, Spanish, French, German, Italian). The "Devil" group sums frequencies for *devil*, *Satan*, *demon*, and equivalents, and the "Witchcraft" group sums *witchcraft*, *sorcery*, *witch*, and equivalents. The "Natural philosophy" group sums *natural philosophy*, *experiment*, and *observation* and equivalents, and the "Exorcism" group sums *exorcism* and *exorcist* and equivalents. Two normalizations are used: frequencies per million words in the dual-axis figures, and probability densities (area = 1) in the cross-language density figures. All series use a five-year centered moving average.

Google Books over represents religious and legal texts relative to ephemeral print, and the decades before 1550 contain so few books that frequency estimates for them are noisy. These figures are illustrative evidence of continental-scale shifts in published discourse. They do not replace the archival evidence in the main text. The series enter Figures 16 and 17 in the main text, Figures B.10 and B.11 in Appendix B.4.1, and the EarlyPrint comparison of Figure B.14.

A.9 Latin Reference Corpus

The Latin reference corpus assembled for this paper combines twenty-six sub-corpora of the Corpus Corporum digital collection hosted by the University of Zurich. The largest single source is the Patrologia Latina, Migne's 19^{th}-century collection of patristic and medieval Christian writing, which contributes roughly 5,200 documents. The Acta Sanctorum, the Bollandist collection of saints' lives, contributes long 17^{th}-century texts that dominate the word count after 1650. The other twenty-four sub-corpora hold theological, philosophical, mathematical, and historical writing, saints' lives, and several smaller collections of itineraries, dissertations, and digital-library holdings. Each text is dated by its author's reference year as the source records it. I drop documents with fewer than fifty Latin words, since short fragments add noise. The retained

sample contains 8,063 documents and 203 million Latin words spanning the second through the nineteenth centuries. Of these, 5,903 documents carry an author year that can be read directly. The corpus enters Figure 1 in the main text, the Latin-documents series of Figure 3, and, in Appendix B.4.2, Tables B.15 and B.16 and Figure B.12.

A.10 Incunabula Short Title Catalogue

The Incunabula Short Title Catalogue, hosted by the Consortium of European Research Libraries, records 30,681 editions of 15^{th}-century European printing. I retrieve the full catalogue through the public API. The working sample contains 30,680 unique records, all but one of the catalogued total. The same source is the basis for the press-location panel in Rubin (2014) and the printing-and-Reformation analysis in Boerner et al. (2021).

I define two content categories over the title and author fields and use them in Subsection 4.5 and Appendix B.5.2. An edition is classified as a devil book if its title or author contains demonological, witchcraft, sorcery, divinatory, or exorcism vocabulary (Latin and vernacular stems such as *daemon-*, *diabol-*, *malefic-*, *exorci-*, *sortileg-*, *necromant-*, *superstit-*, the *Malleus* by name, and their vernacular equivalents). An edition is classified as a natural-philosophy book if its title matches Aristotelian, medical, astronomical, mathematical, optical, or natural-history vocabulary (stems such as *physic-*, *meteor-*, *astronom-*, *mathemat-*, *medicin-*, *anatom-*, *perspectiv-*, *de anima*, *de caelo*, *quaestiones naturales*), or if its author is one of the standard Greco-Arabic naturalists (Aristotle and his commentators, Galen, Avicenna, Averroes, Albertus Magnus, Sacrobosco). Each edition is geocoded to the city named in its imprint, and editions without a readable city imprint are dropped. The catalogue records title, author, and imprint but holds no body text, so these classifications are searches of the title and author fields rather than of what the books say. The catalogue enters Table B.17 in Appendix B.4.3, supplies the devil-book and natural-philosophy edition outcomes of Table B.21 and the exposure measures of Table B.22, and its imprint field builds the printing-center control of Table B.20.

A.11 English Vernacular Print

The EarlyPrint project, hosted at Northwestern University and Washington University in St. Louis, provides an n-gram browser built on transcriptions of approximately 60,000 English books printed between 1473 and 1700 (the EEBO-TCP corpus). Unlike the Incunabula Short Title Catalogue, this corpus delivers full body text for each edition, so the queries I run search the actual content. I retrieve per-year frequencies of *devil*, *demon*, *witch*, *Satan*, *witchcraft*, *sorcery*, *conjure*, *enchantment*, *superstition*, *natural*, *philosophy*, and *reason*, and set them side by side with the Google Books English series for the window both cover, 1600–1700. These series enter Figure B.13 and the Google Books comparison of Figure B.14, both in Appendix B.4.3.

A.12 European Scholars Database

The Repertorium Eruditorum Totius Europae, compiled by De la Croix (2021), lists 60,001 scholars appointed to European universities or academies between 1000 and 1800. For each scholar I observe the affiliated institution, the dates of activity, and a geocoded location drawn from Wikipedia and reference works. A published k-means clustering assigns the 16,149 scholars with WorldCat publication records to ten academic fields (Science, Theology 1, Theology 2, Medicine, Philosophy, Law, Politics, Classics, Culture, Antiquities). The locations enter the geographic analyses reported in Appendix B.5.1.

A.13 Distance to Paris

The instrumental-variables specification reported in Appendix B.5.1 instruments the local density of Thomistic institutions with the great-circle distance from Paris (lat. 48.86, lon. 2.35). I compute that distance by the haversine formula from each scholar's institutional latitude–longitude in the RETE database. The matching Dominican-house panel is the dataset described in Appendix A.7, aggregated to $2^\circ \times 2^\circ$ grid cells of Europe. The same distance from Paris is the geographic regressor in the document-level corpus regression in Appendix B.4.2, where corpus

documents are geocoded by matching their authors to the RETE scholar database.

B Extended Empirical Analysis

B.1 Witch Trials

This subsection collects the extended results for the two witch-trial compilations and the econometric exercises that link trial activity to the Dominican network.

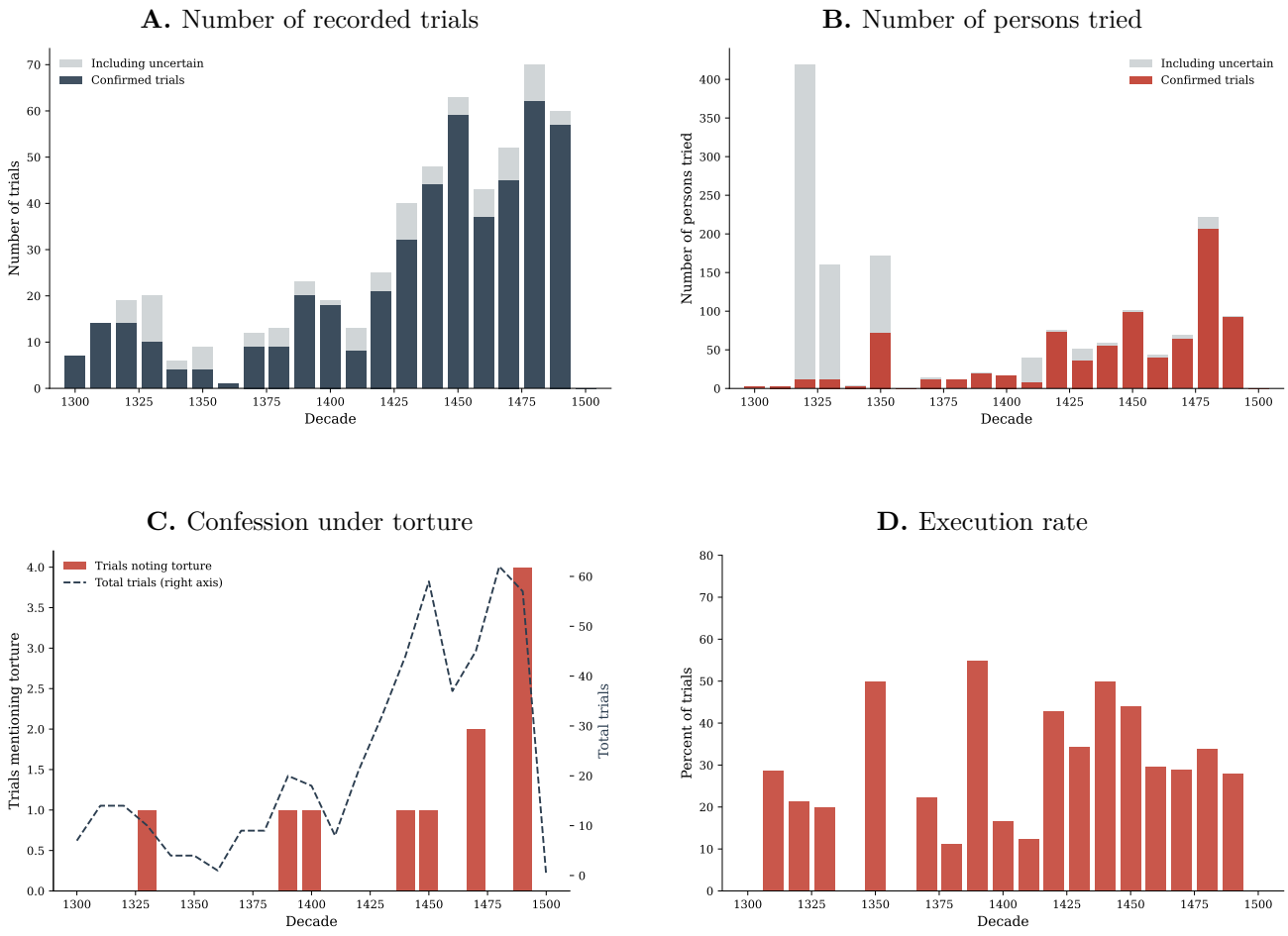
B.1.1 Kieckhefer Witch Trials

Figure B.1 counts medieval witch trials and the people tried in them, decade by decade. The acceleration comes in the 15^{th} century: trials were sparse before 1400 and then rose steeply through the 1480s.

Panels C and D of the same figure turn to two other features of these trials. Panel C plots the trials that explicitly mention a confession under torture alongside the total number of trials. Torture is mentioned rarely. Panel D gives the execution rate (the share of trials ending in a death sentence) among trials whose outcome is known. That rate rises through the 15^{th} century, over the same decades in which the elaborated concept of witchcraft, which tied sorcery to the work of demons, spread through the courts. Sentences grew more severe as the charges took on diabolical content, so the new concept entered judicial practice and did not merely change the language of indictment.

Bootstrap confidence intervals on charge shares. The main text gives point estimates, by 25-year period, for the share of trials carrying a witchcraft charge and the share carrying a charge of diabolism (dealings with the devil). Table B.1 puts 95 percent confidence intervals around those shares. The intervals come from a non-parametric bootstrap (B = 2000), which redraws the trials of a period at random, with replacement, and recomputes the share each time. Both the classification rule and the exclusion of political prosecutions follow Figure 5. In 1300–1349 the interval on the witchcraft share is close to zero, and the interval on the diabolism share

Figure B.1: Kieckhefer witch trials by decade: counts, torture, and executions (1300–1499)



Notes: In Panels A and B, dark bars show confirmed trials and light bars also include uncertain entries. Panel C counts, by decade, the trials that explicitly note a confession under torture. Panel D gives the execution rate by decade among trials whose outcome is known. Source: Kieckhefer Calendar of Witch Trials.

reaches up to about 0.4. By 1475–1499, the interval is $[0.36, 0.55]$ for witchcraft and $[0.20, 0.36]$ for diabolism. The early and late intervals do not overlap for witchcraft as an organized offense. For diabolism they do overlap: the early periods hold few trials, so the early interval is wide.

Table B.1: Bootstrap confidence intervals on Kieckhefer witchcraft and diabolism shares, by 25-year period.

Period	N	Witchcraft	95% CI	Diabolism	95% CI
1300–1324	18	0.000	[0.00, 0.00]	0.056	[0.00, 0.17]
1325–1349	15	0.000	[0.00, 0.00]	0.200	[0.00, 0.40]
1350–1374	9	0.333	[0.00, 0.67]	0.000	[0.00, 0.00]
1375–1399	25	0.120	[0.00, 0.28]	0.120	[0.00, 0.28]
1400–1424	28	0.179	[0.04, 0.32]	0.000	[0.00, 0.00]
1425–1449	70	0.229	[0.13, 0.33]	0.229	[0.13, 0.33]
1450–1474	97	0.299	[0.22, 0.38]	0.289	[0.21, 0.38]
1475–1499	118	0.458	[0.36, 0.55]	0.280	[0.20, 0.36]

Notes: 95 percent confidence intervals from $B = 2000$ non-parametric bootstrap draws of the confirmed trials within each period. Charges are classified as in Figure 5, and the same nine political prosecutions from the early 14^{th} century are dropped from the diabolism count. Source: Kieckhefer Calendar of Witch Trials.

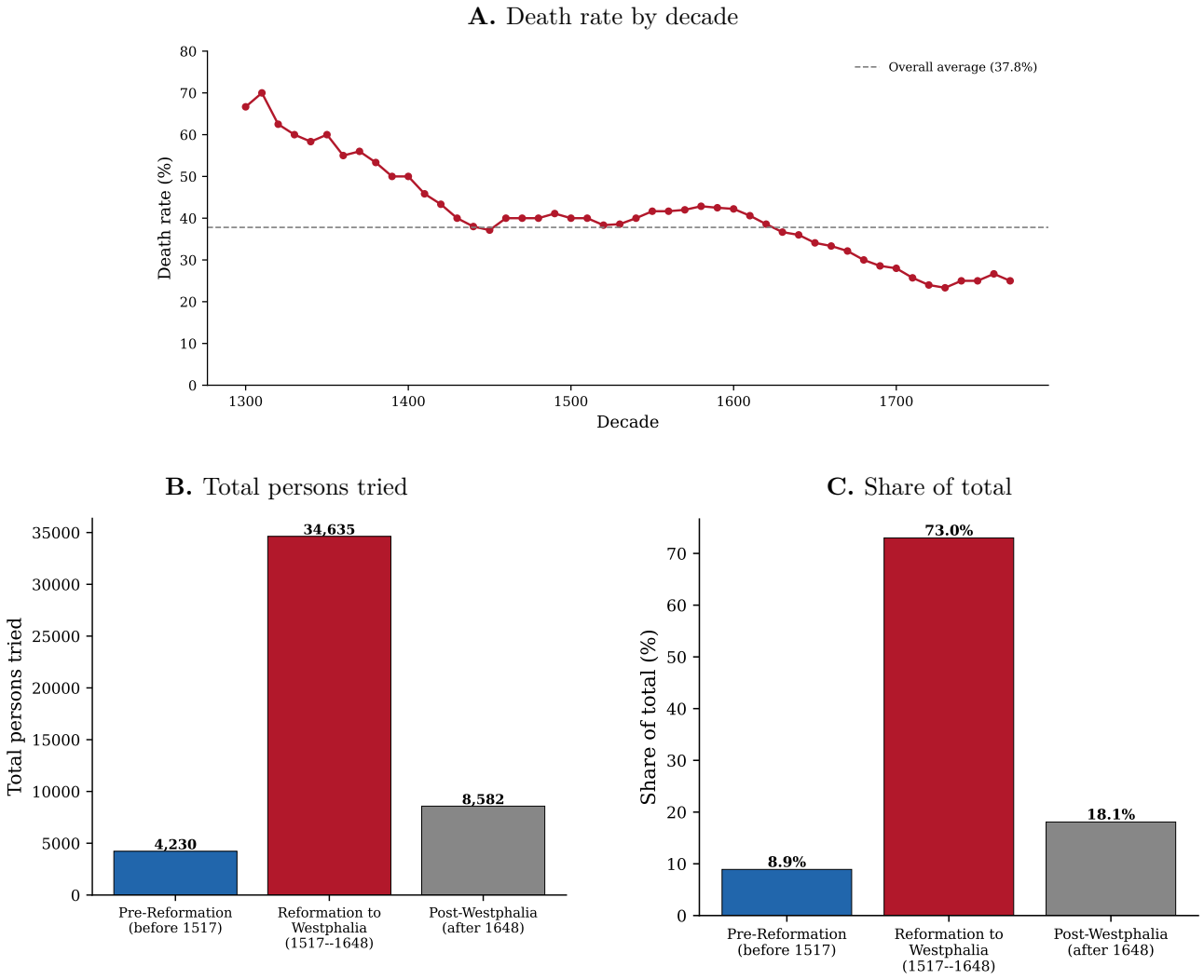
B.1.2 Leeson–Russ Witch Trials

Table B.2 reports summary statistics for the Leeson–Russ data: across all trials with a recorded outcome, 37.8 percent of the people tried died. That average covers wide differences between periods and between countries.

Figure B.2 plots the death rate by decade, and the rate moves up and down around the 37.8 percent average with no clear trend over the long run. Trials grew more frequent and then less frequent, but the share of the accused who died did not change systematically.

Panels B and C of the same figure split the people tried into four periods. The years before the Reformation (1300–1517) account for 7.3 percent of the total, and the Reformation era (1517–1648) for 64.5 percent. The period after Westphalia (1648–1750) accounts for 22.8 percent, and the late period (1750–1850) for 5.3 percent. Nearly a third of all the people tried were prosecuted after the major wars of religion had ended.

Figure B.2: Death rate and persons tried by period, Leeson–Russ data, 1300–1850



Notes: Panel A plots trial-related deaths as a share of persons tried; the dashed line marks the overall average of 37.8 percent. Panels B and C give total persons tried and the share of the total by historical period. Source: Leeson and Russ (2018).

Table B.2: Summary statistics: Leeson–Russ (2018) witch trials data

	Value
Total trial records	10,940
Total persons tried	43,240
Total deaths	16,333
Overall death rate	37.8%
Countries	19
Decade range	1300–1850
Records with exact year	10,009 (91.5%)
Records with death information	7,114 (65.0%)
Peak decade	1610s (6,035 persons)
Top countries by persons tried:	
Germany	16,474 (38.1%)
Switzerland	9,796 (22.7%)
United Kingdom	4,769 (11.0%)
France	4,159 (9.6%)
Spain	1,949 (4.5%)
Hungary	1,644 (3.8%)

Source: My calculations from Leeson and Russ (2018) replication data. Countries follow the GADM coding of the public release, which records England, Scotland, and Northern Ireland as the United Kingdom, though the paper's own count is 21.

Three econometric exercises test the spatial and temporal predictions of the argument made in the main text. The first two use witch trial data to ask whether Dominican houses, which taught the Thomistic curriculum, predict where trials happened and what they alleged. The third tests for Granger causality: whether the founding of Dominican houses helps predict later trial activity in the same place. All three draw on the same two independent datasets. The Kieckhefer Calendar of Witch Trials (558 records, 1242–1499) includes a variable for whether a trial mentions the demon or the devil, while the Leeson and Russ (2018) data (10,940 records, 1300–1850) cover a longer period and a wider geography but have no demon variable.

All grid-based analyses use $2^\circ \times 2^\circ$ cells as the baseline, with $1^\circ \times 1^\circ$ cells reported as a sensitivity check. In Europe a degree of longitude is not a fixed distance: it runs from roughly 70–78 km in the south (e.g., Greece and Spain) down to about 56 km in the far north (e.g., Norway and Sweden). I choose 2 degrees so that a cell holds an economic unit: an urban core together with the countryside around it. Smaller cells tend to capture areas that are only rural

or only urban, breaking the natural unit of analysis. A *period* in the panels below is a quarter-century (25 years), a compromise between the slow pace at which Dominican houses were founded and the higher frequency at which trials are recorded.

B.1.3 Spatial Correlation Between Dominican Houses and Witch Trials

The first exercise asks whether the map of Dominican houses predicts the map of late-medieval witch trials and the charges those trials brought. Dominican house coordinates come from the Digital Atlas of Roman and Medieval Civilizations (DARMC), which records 885 houses across Europe with founding dates and coordinates, refined to year-level dates by the procedure documented in Appendix A.7. Of the 558 Kieckhefer records, confirmed and uncertain together, 521 geocode to a specific place once vague country-level entries such as "France" or "Germany" are dropped. In the Leeson–Russ dataset, 5,137 of 10,940 records carry coordinates.

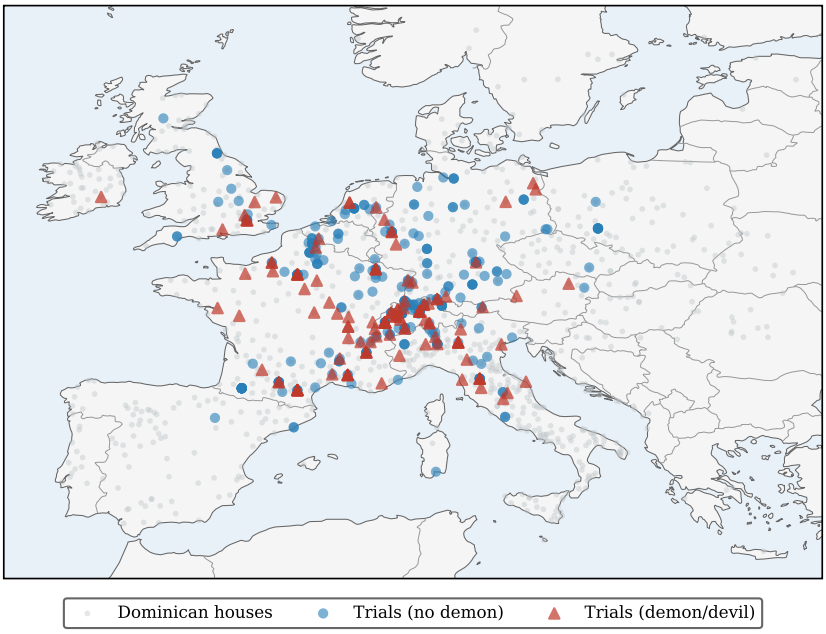
The median distance from a geocoded Kieckhefer trial to the nearest Dominican house founded before the trial date is 9.9 km. In the Leeson–Russ data it is 31.4 km, because that dataset includes later trials in regions well away from the original Dominican core. Figure B.3 maps Dominican houses together with trials from both datasets. Dominican houses and witch trials cluster in the same regions of Europe: northern France, the Rhineland, Switzerland, and northern Italy. The pattern holds across both datasets.

To move from a map to a formal test, I divide Europe into a grid of $2^\circ \times 2^\circ$ cells, count Dominican houses and trials in each cell, and compute Spearman rank correlations, which compare how cells are ordered rather than the raw counts. In the Kieckhefer data the correlation between the house count and the trial count across cells is 0.554 ($p < 0.0001$). For trials that mention the demon or the devil it is 0.455 ($p < 0.0001$). The Leeson–Russ dataset gives almost the same overall figure of 0.547 ($p < 0.0001$). A finer 1° grid pulls the correlations down somewhat, to 0.405 for Kieckhefer and 0.410 for Leeson–Russ, but they stay statistically significant. Figure B.4 plots the cell-level relationship for the Kieckhefer data.

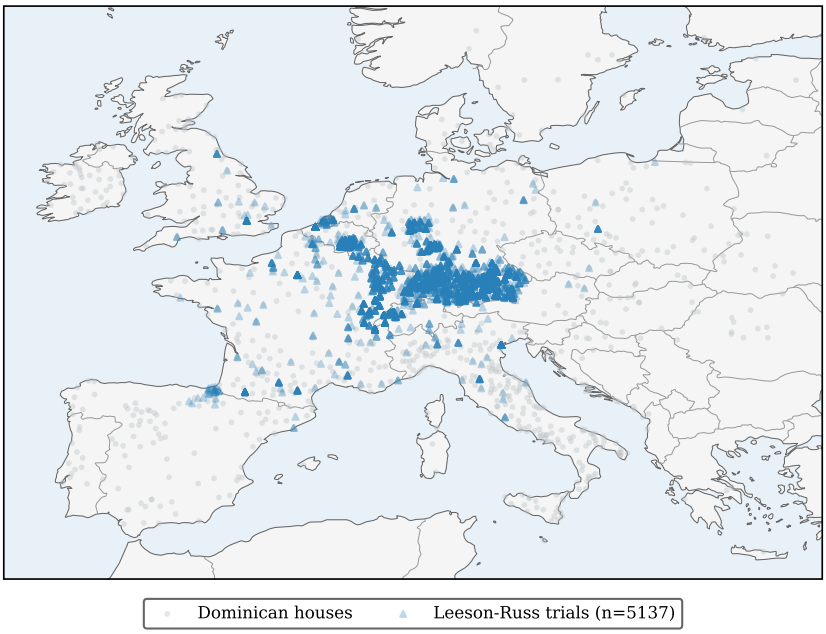
Cell-level correlations could pick up common geography, such as urbanization or the survival

Figure B.3: Dominican houses and witch trials

A. Kieckhefer trials

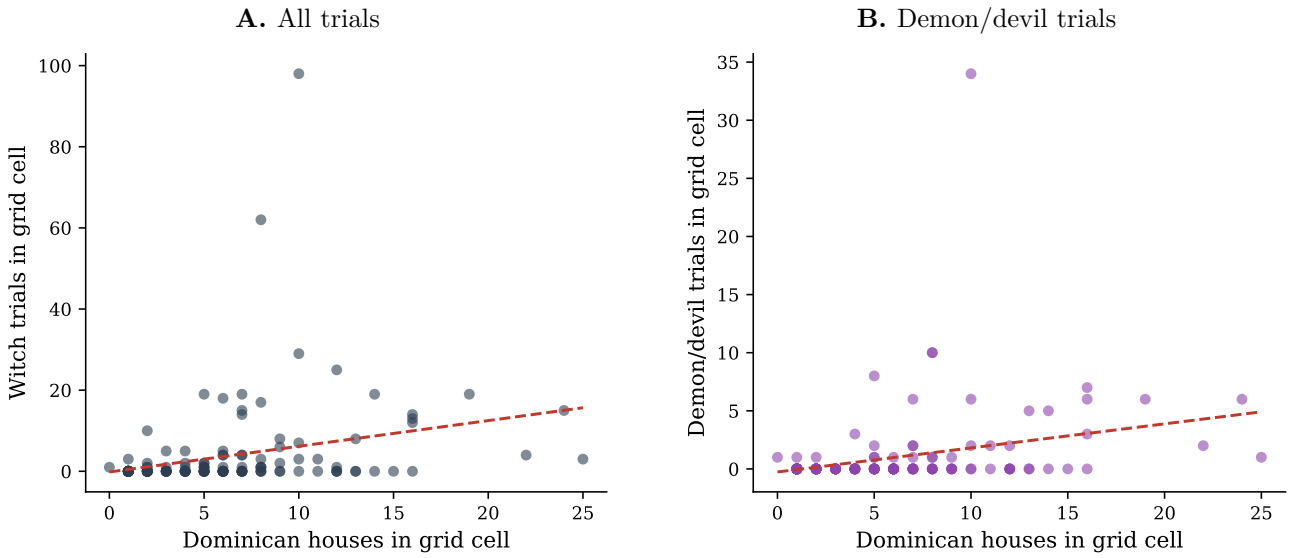


B. Leeson–Russ trials



Notes: Country borders and coastlines from Natural Earth (50m). Sources: Kieckhefer, Leeson and Russ (2018), and the refined Dominican inventory built on DARMC Layer 48 (Appendix A.7).

Figure B.4: Grid-cell scatter: Dominican houses vs. witch trials (Kieckhefer, 2° grid)



Notes: Each point is one 2° × 2° grid cell. The horizontal axis counts Dominican houses in the cell; the vertical axis counts geocoded Kieckhefer trials (Panel A) and trials with an explicit demon or devil mention (Panel B). Dashed lines are OLS fits. Cells with more houses record more trials of both kinds: the Spearman rank correlations are 0.554 in Panel A and 0.455 in Panel B, both $p < 0.0001$. Sources: Kieckhefer Calendar and the refined Dominican inventory built on DARMC Layer 48 (Appendix A.7).

of records, rather than a causal link running from Dominican presence to trial activity. Table B.3 reports OLS estimates of a linear probability model in which the dependent variable is a dummy for whether the trial record mentions the demon or the devil. In column (1), a one-log-point increase in distance to the nearest Dominican house founded before the trial date lowers the probability of a demon mention by 5.3 percentage points ($p < 0.001$), a large effect on a base rate of 28 percent. Column (2) replaces log distance with the count of Dominican houses within 100 km, and that coefficient is positive and significant at the 10 percent level. With half-century fixed effects in column (3) it keeps its size but loses significance. Columns (4)–(5) add country fixed effects and the coefficient shrinks. The shrinkage fits the Thomistic-diffusion story: much of the spatial variation is between countries rather than within them, and the Dominican order was strongest in the regions where the Thomistic curriculum entered university teaching earliest.

Figure B.5 shows the same relationship without imposing a shape on it: trials are sorted into quintiles by distance to the nearest Dominican house and the demon share is plotted in each

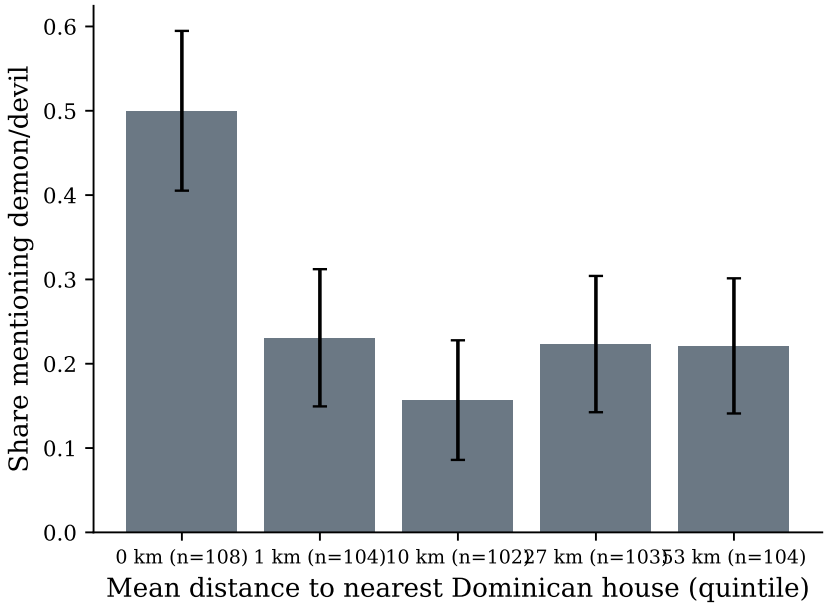
Table B.3: Trial-level regressions: Dominican proximity and demon mentions (Kieckhefer)

	(1)	(2)	(3)	(4)	(5)
Log dist. nearest Dominican	-0.0527[a]				
	(0.0140)				
Dominican houses within 100km		0.0098[c]	0.0087	0.0055	0.0040
		(0.0055)	(0.0055)	(0.0070)	(0.0071)
Country FE	No	No	No	Yes	Yes
Half-century FE	No	No	Yes	No	Yes
Observations	521	521	521	521	521
R^2	0.0294	0.0070	0.0190	0.0420	0.0535

Dep. var.: demon/devil mentioned (=1). Kieckhefer data. Robust SEs in parentheses.
[a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$.

bin. Trials closer to a Dominican house are more likely to mention demons, and the gradient is concentrated in the nearest quintile.

Figure B.5: Demon share by distance to nearest Dominican house (quintiles, Kieckhefer)



Notes: The 521 geocoded Kieckhefer trials are sorted into quintiles by distance to the nearest Dominican house founded before the trial date; bars show the share of trials in each quintile whose record mentions the demon or the devil, with 95 percent confidence intervals. Bin labels give the mean distance and the number of trials in each quintile. The gradient is concentrated in the nearest quintile. Sources: Kieckhefer Calendar and the refined Dominican inventory built on DARMC Layer 48 (Appendix A.7).

B.1.4 Spatial Diffusion of Witch Trials

The second exercise asks whether witch trials spread outward from clusters of Dominican houses over time. If the Thomistic curriculum moved from those houses into the communities around them, early trials should sit tight around Dominican centers and later trials should appear further away.

Table B.4 reports the diffusion summary by period for both datasets in two panels, with half-centuries in the Kieckhefer panel and centuries in the Leeson–Russ panel. In both datasets trials end the period further from the nearest Dominican house than they began it: the average runs from roughly 10 km to 19 km in Kieckhefer (1300–1499), and from 8 km to 41 km in Leeson–Russ (1300–1799). The Leeson–Russ average rises in every century. The Kieckhefer average peaks at 21 km in the first half of the 15^{th} century and comes back to 19 km in the last half-century. The early-14^{th}-century political prosecutions listed in the footnote in Subsection 4.2 stay in the trial counts, but their demon indicator is set to zero.

Table B.5 tests the same idea formally in both datasets. I regress the year of a trial on the log distance to the nearest Dominican house founded before it, and if trials close to a house happen earlier the coefficient should be positive. It is positive in all three columns. In the Kieckhefer data, a one-log-point increase in distance moves the trial date 5.15 years later, with a standard error of 1.57. For demon trials alone the coefficient is 1.77 with a standard error of 2.59, which is not distinguishable from zero. The Leeson–Russ data give a larger coefficient of 16.79, with a standard error of 0.93, since diffusion in that dataset operated over a longer time span.

Figure B.6 maps trial locations by half-century for the Kieckhefer data and by century for the Leeson–Russ data, with the centroid of each period marked by a star. The centroid moves over time and the scatter of trials widens. Figure B.7 plots the mean distance to the nearest Dominican house by quarter-century in the Kieckhefer data, isolating the distance trend (the demon-share series appears in the main text as Figure 6.A).

Table B.4: Spatial diffusion of witch trials, by period

Panel A: Kieckhefer (half-centuries)

Period	Trials	Demon trials	Dist. to Dom. centroid (km)	Mean min. dist. (km)	Demon share
1300–1349	36	11	266	10	0.31
1350–1399	41	10	92	12	0.24
1400–1449	120	32	119	21	0.27
1450–1509	248	70	134	19	0.28

Panel B: Leeson–Russ (centuries)

Period	Trials	Dist. to Dom. centroid (km)	Mean min. dist. (km)
1300–1399	110	194	8
1400–1499	384	108	17
1500–1599	1399	187	31
1600–1699	2997	181	33
1700–1799	245	307	41

Notes: A *period* is a half-century in Panel A and a century in Panel B. Distances are great-circle distances over the surface of the earth (haversine). The demon share in Panel A leaves the early-14^{th}-century political prosecutions out of the diabolical count (see the main text footnote in Subsection 4.2). Sources: Kieckhefer Calendar, Leeson and Russ (2018), and the refined Dominican inventory built on DARMC Layer 48 (Appendix A.7).

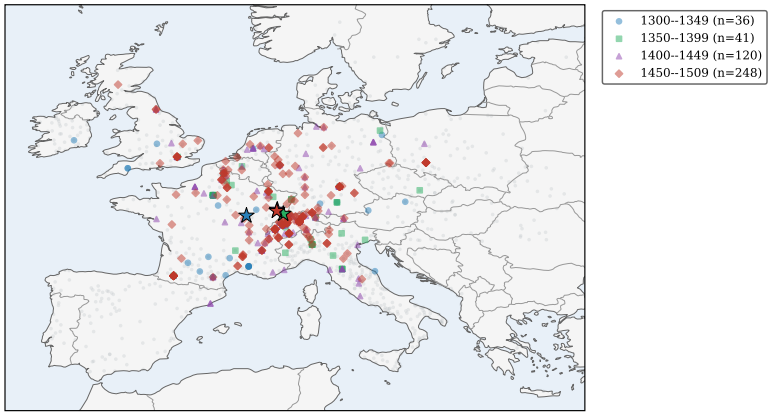
Table B.5: Diffusion regression: trial year and distance to Dominican houses

	Kieckhefer		Leeson-Russ
	All trials	Demon trials	All trials
Log dist. to nearest Dominican	5.15[a]	1.77	16.79[a]
	(1.57)	(2.59)	(0.93)
Observations	446	123	5137
R^2	0.0229	0.0033	0.0880

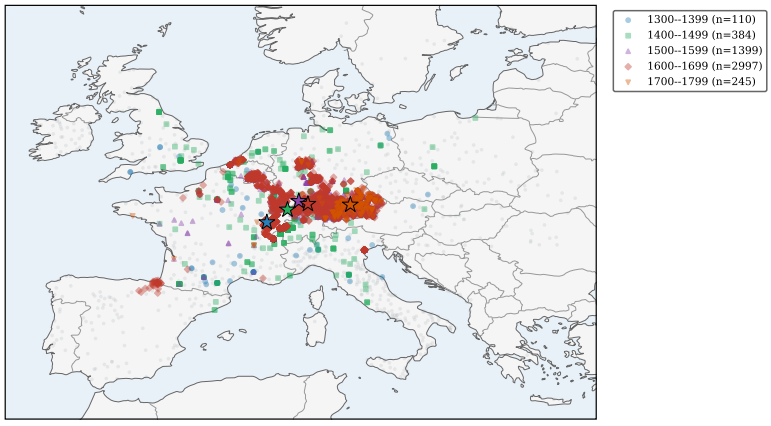
Dep. var.: trial year. Robust SEs in parentheses.
[a]$p < 0.01$, [b]$p < 0.05$, [c]$p < 0.10$.

Figure B.6: Trial locations and centroids over time

A. Kieckhefer (half-centuries)

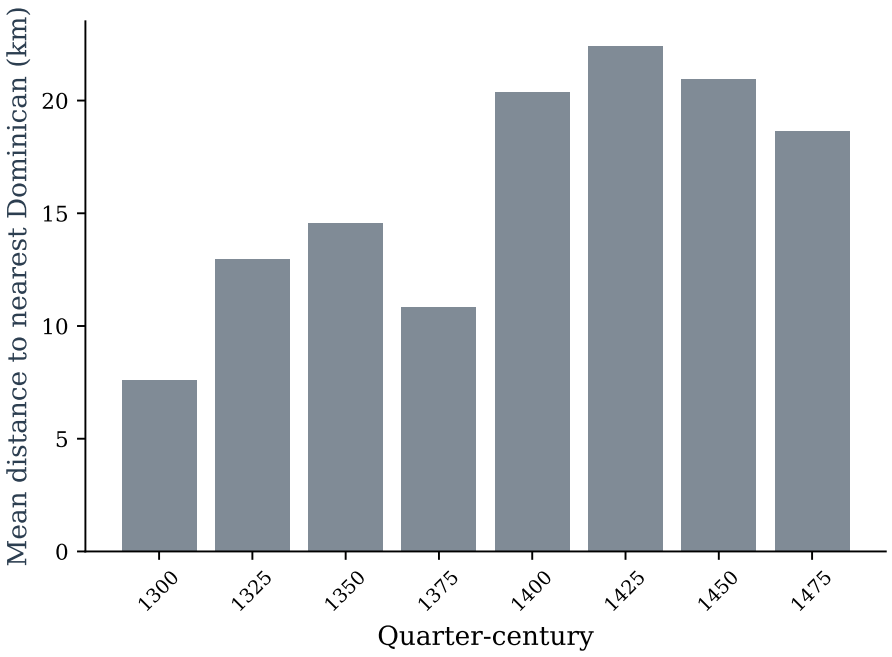


B. Leeson–Russ (centuries)



Notes: A *period* is a half-century in Panel A and a century in Panel B. Country borders from Natural Earth (50m). Stars mark the trial centroid in each period, and the faint gray dots underneath are the Dominican houses of the refined inventory built on DARMC Layer 48 (Appendix A.7). Sources: Kieckhefer Calendar (Panel A) and Leeson and Russ (2018) (Panel B).

Figure B.7: Mean distance to nearest Dominican house over time (Kieckhefer)



Notes: A *period* is a quarter-century. Bars show the mean great-circle distance (km) from each Kieckhefer trial to the nearest Dominican house founded before that trial. The distance roughly doubles between the early 14^{th} century and the 15^{th}, consistent with trial activity diffusing outward from the Dominican-served core. Sources: Kieckhefer Calendar and the refined Dominican inventory built on DARMC Layer 48 (Appendix A.7).

B.1.5 Granger Causality: Dominican House Founding and Witch Trials

The third exercise builds a panel of regions by quarter-century and tests whether new Dominican houses in a region help predict witch trial activity there in later periods, once past trial activity is taken into account. Europe is divided into $2^\circ \times 2^\circ$ grid cells, and for each cell and quarter-century I count the number of new Dominican houses founded and the number of witch trials recorded. The panel spans 1200–1500.

Table B.6 reports the results for both datasets, using the refined Dominican inventory with year-level dates (Appendix A.7). Houses with no extracted year keep the DARMC cohort mid-point. In the Kieckhefer data (columns 1–4), the cumulative stock of Dominican houses in a region predicts later trial counts: the stock coefficient is 0.0446 ($p = 0.019$) for all trials and 0.0147 ($p = 0.041$) for trials with an explicit devil or demon mention. The Leeson–Russ data

(columns 5–6) give a stock coefficient of 0.1284 ($p < 0.001$). In every specification the lagged dependent variable is positive and significant, so trial activity persists from one period to the next.

The reverse Granger test in Panel B asks whether lagged witch trials predict new Dominican foundations. It runs on the same $2° \times 2°$ grid cells for both datasets, and for the Kieckhefer data adds a version in which the regressor counts only trials with an explicit devil or demon mention (column 2). The trials-to-Dominican coefficient is small and statistically indistinguishable from zero in all three series, and its sign does not hold steady across them: negative for all Kieckhefer trials, positive for the demon subset and for Leeson–Russ. The data give no evidence that the Dominicans were founding houses in places where witch trials, or demon-related trials in particular, were already happening. Trials follow the establishment of Dominican houses, not the other way around.

B.1.6 Break in the Murcia Pest-Conjuro Share

The descriptive evidence in the main text shows that the share of Murcia *conjuros* aimed at pests falls from near unity in the 15^{th}–17^{th} centuries to zero by the 20^{th} century. Table B.7 reports the formal test behind that pattern: a Hansen (2000) single-threshold test on the decade-level pest share, weighted by the number of *conjuros* recorded in each decade and with 15 % trimming. The trimming keeps the break search away from the extreme ends of the sample. The data identify a single statistically significant break at decade 1800 (sup-$F = 21.4$, bootstrap p-value of 0.018 from $B = 999$ resampled residuals under the null of a constant mean). Before 1800 the weighted pest share is 0.60. After 1800 it is 0.14. The estimated break date sits between the 18^{th}-century decline phase and the 19^{th}-century volume peak documented in the main text. It marks the point at which the ceremony stopped being aimed at pests, even as the ceremony itself carried on.

Table B.6: Granger causality: Dominican houses and witch trials (2° grid)

Panel A: Dominican houses predict later trials

	Kieckhefer (all)		Kieckhefer (demon)		Leeson-Russ	
	(1)	(2)	(3)	(4)	(5)	(6)
New Dom. houses$_{t-1}$	0.027		0.023		0.064	
	(0.041)		(0.018)		(0.113)	
Cum. Dom. houses$_{t-1}$		0.045[b]		0.015[b]		0.128[a]
		(0.019)		(0.007)		(0.033)
Trials$_{t-1}$	0.530[a]	0.511[b]	0.492[b]	0.475[b]	0.277[a]	0.262[a]
	(0.195)	(0.201)	(0.235)	(0.240)	(0.098)	(0.096)
Observations	1500	1500	1500	1500	1500	1500
R^2	0.282	0.289	0.243	0.250	0.074	0.083

Dep. var.: trial count in region-period (demon-trial count in cols. (3)–(4)).
$2° \times 2°$ grid, quarter-century panels. Robust SEs. Demon variable unavailable in Leeson-Russ.
[a]$p < 0.01$, [b]$p < 0.05$, [c]$p < 0.10$.

Panel B: Reverse test, lagged trials and new foundations

	Kieckhefer (all)	Kieckhefer (demon)	Leeson-Russ
	(1)	(2)	(3)
Trials$_{t-1}$	-0.002	0.021	0.002
	(0.007)	(0.025)	(0.005)
New Dom. houses$_{t-1}$	0.052[c]	0.051[c]	0.051[c]
	(0.028)	(0.028)	(0.028)
Observations	1500	1500	1500
R^2	0.003	0.003	0.003

Dep. var.: count of new Dominican houses in region-period. Robust SEs.
Quarter-century panels on $2° \times 2°$ grid cells, region fixed by grid cell.
[a]$p < 0.01$, [b]$p < 0.05$, [c]$p < 0.10$.

Table B.7: Hansen single-threshold test on the Murcia pest-*conjuro* share.

	Value
Sup-F statistic	21.37
Bootstrap p-value ($B = 999$)	0.018
Estimated break decade	1800
Pre-break weighted pest share	0.603
Post-break weighted pest share	0.143
Pre-break conjuros (count)	78
Post-break conjuros (count)	140
Decades	32

Notes: Sup-F from the Hansen (2000) sample-splitting estimator on the decade-level pest share, weighted by the number of *conjuros* per decade, with 15 % trimming. Bootstrap p-value from $B = 999$ residual bootstrap draws under the null of a constant mean. Source: Cathedral of Murcia archives (Espín-Sánchez and Gil-Guirado, 2026).

B.2 Canonization and Miracle Evidence

Table B.8 reports linear probability models of the indicator *is Saint* on candidate and miracle features. The coefficients read directly as percentage-point shifts in the probability of canonization. A candidate whose death lies in 1600–1699 is 33 percentage points less likely to reach Saint than the 1500–1599 baseline (column 1). Dominicans are 26 to 27 points below the secular baseline, Franciscans 16 to 17 points below, both at high significance. Jesuits and other religious orders are not distinguishable from secular candidates. The proximate predictor of sainthood, however, is the existence and thickness of the miracle dossier itself: an indicator for whether the candidate has a structured miracle record raises P(Saint) by 52 percentage points (column 2), and each additional miracle claim adds 2.9 points. Once these complexity proxies are in, the cohort gradient and the order effects roughly halve, and the R^2 doubles from 0.29 to 0.56. Adding indicators for whether the dossier contained cancer, tuberculosis, resurrection, plague, or neurological miracles (column 3) raises the R^2 by only 0.002. The Vatican's promotion decision relies on whether a thick evidentiary file existed, not on the specific content of that file.

Table B.9 lists all 14 demon-related miracle claims in the Duffin canonization data. Eleven of

Table B.8: Linear probability model of reaching Saint status, Parigi sample

	(1) Candidate traits	(2) + Miracle access	(3) + Miracle categories
Constant	0.446[a] (0.085)	0.285[a] (0.069)	0.285[a] (0.070)
Death cohort: 1600–1699	-0.326[a] (0.077)	-0.215[a] (0.057)	-0.208[a] (0.059)
Death cohort: 1700–1799	-0.396[a] (0.099)	-0.190[a] (0.071)	-0.183[a] (0.071)
Order: Dominican	-0.269[a] (0.081)	-0.263[a] (0.067)	-0.264[a] (0.062)
Order: Franciscan	-0.171[b] (0.072)	-0.167[a] (0.060)	-0.163[a] (0.061)
Order: Jesuit	0.171 (0.173)	0.149 (0.121)	0.133 (0.123)
Order: Other religious	-0.039 (0.106)	-0.066 (0.078)	-0.078 (0.080)
Founder of order	0.085 (0.129)	-0.021 (0.104)	-0.007 (0.111)
Bishop / Cardinal	-0.058 (0.102)	-0.114 (0.082)	-0.112 (0.085)
Martyr	-0.176 (0.160)	-0.195 (0.145)	-0.207 (0.148)
Archive: CCS (vs ASV)	0.329[a] (0.067)	0.199[a] (0.058)	0.185[a] (0.058)
Has miracle dossier		0.524[a] (0.078)	0.638[a] (0.069)
Number of miracle claims		0.029[a] (0.011)	
Has cancer miracle			0.091 (0.082)
Has TB miracle			-0.244 (0.223)
Has resurrection miracle			0.160 (0.100)
Has plague miracle			-0.195 (0.207)
Has neuro miracle			-0.017 (0.076)
Observations	225	225	225
R^2	0.288	0.563	0.565

Notes: Source: Parigi (2012) (original records). 225 candidates with a valid death cohort. "Has miracle dossier" indicates that the candidate appears in the miracle table of the Parigi records; "Number of miracle claims" is the count of claims recorded there (zero for candidates without a dossier).

them occur before 1700, and the last entry (Alexander Sauli, canonized 1904) rests on testimony from the 17^{th} century.

Panel A of Figure B.8 plots individual canonizations year by year from 1594 to 2000. Through the 18^{th} century they come slowly and at irregular intervals, and the rate then climbs across the 19^{th} century before turning sharply upward in the 20^{th}. Panel B breaks the same total down by pope. John Paul II alone accounts for more canonizations through 2000 than all popes before the 19^{th} century combined.

B.3 Spanish Inquisition: Extended Results

Table B.10 summarizes the individual trial records in the DVV/EMID data.

Table B.11 reports the Contreras–Henningsen breakdown of cases by offense. Superstition

Table B.9: Demon-related miracle claims in canonization files

Canonization year	Saint
1588	Didacus Diego d'Alcala
1588	Didacus Diego d'Alcala
1588	Didacus Diego d'Alcala
1600	Raimuni Peñaforte
1610	Carlo Borromeo
1629	(Cajetan) Gaétano de Tieni
1629	Andrea Corsini
1629	Andrea Corsini
1669	Maria Maddalena de Pazzi
1690	Ioannis di Capistrano
1696	Zita
1726	Alyoisius Gonzaga
1881	Clara a Cruce de Montefalco
1904	Alexander Sauli

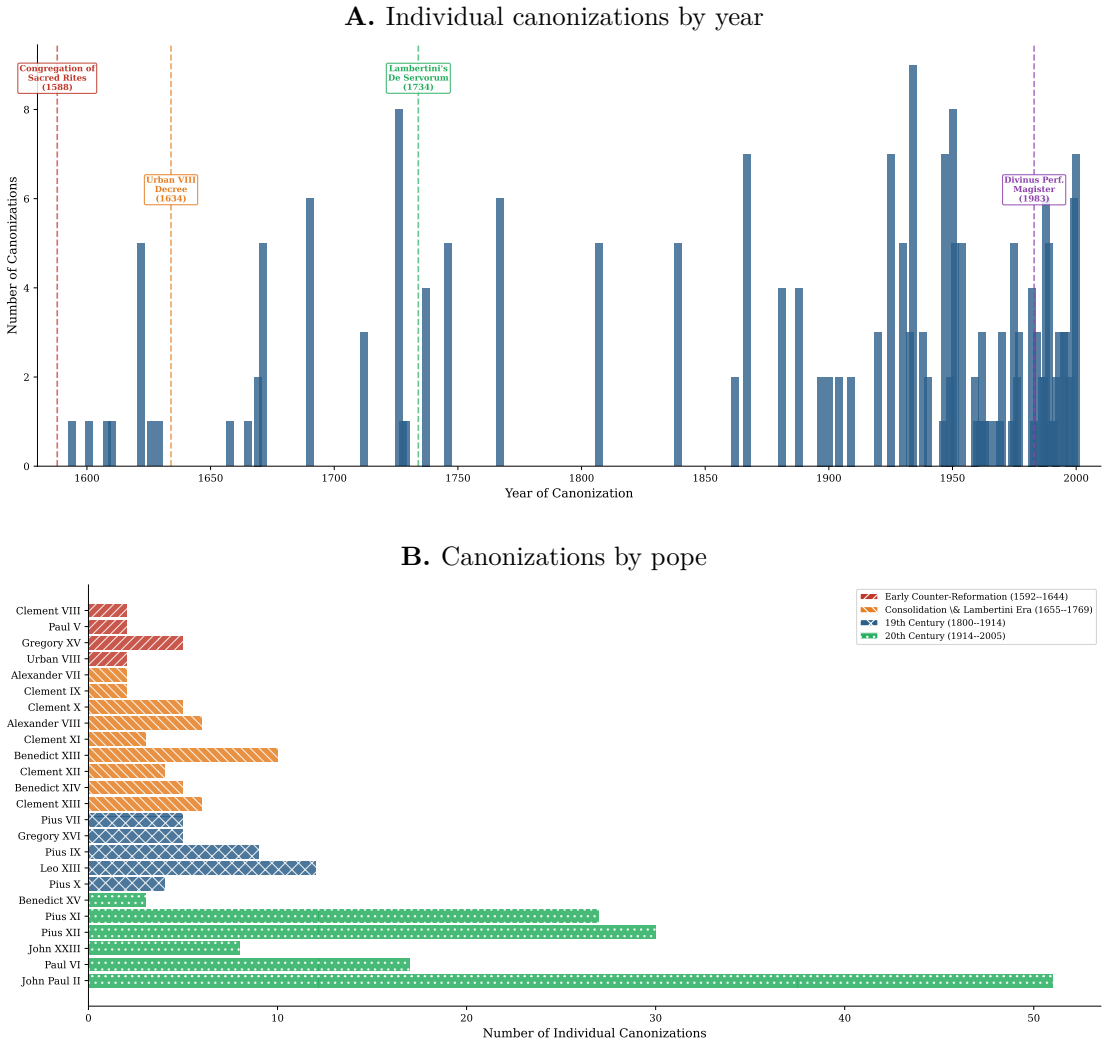
Notes: The table lists every miracle claim classified as involving demons or demonic activity. Year is the year of canonization, which can fall centuries after the testimony behind it. Source: Duffin (2009) and original data.

Table B.10: Spanish Inquisition individual trial data: summary statistics

Statistic	Value
Total individual trial records	61,599
Records with date	61,492
Records without date	107
Date range	1476–1820
Tribunals	16
Unique municipalities	3,815
Trials pre-1700	56,132
Trials post-1700	5,360
Municipalities active pre-1700	3,679
Municipalities active post-1700	644
Municipalities active in both periods	513

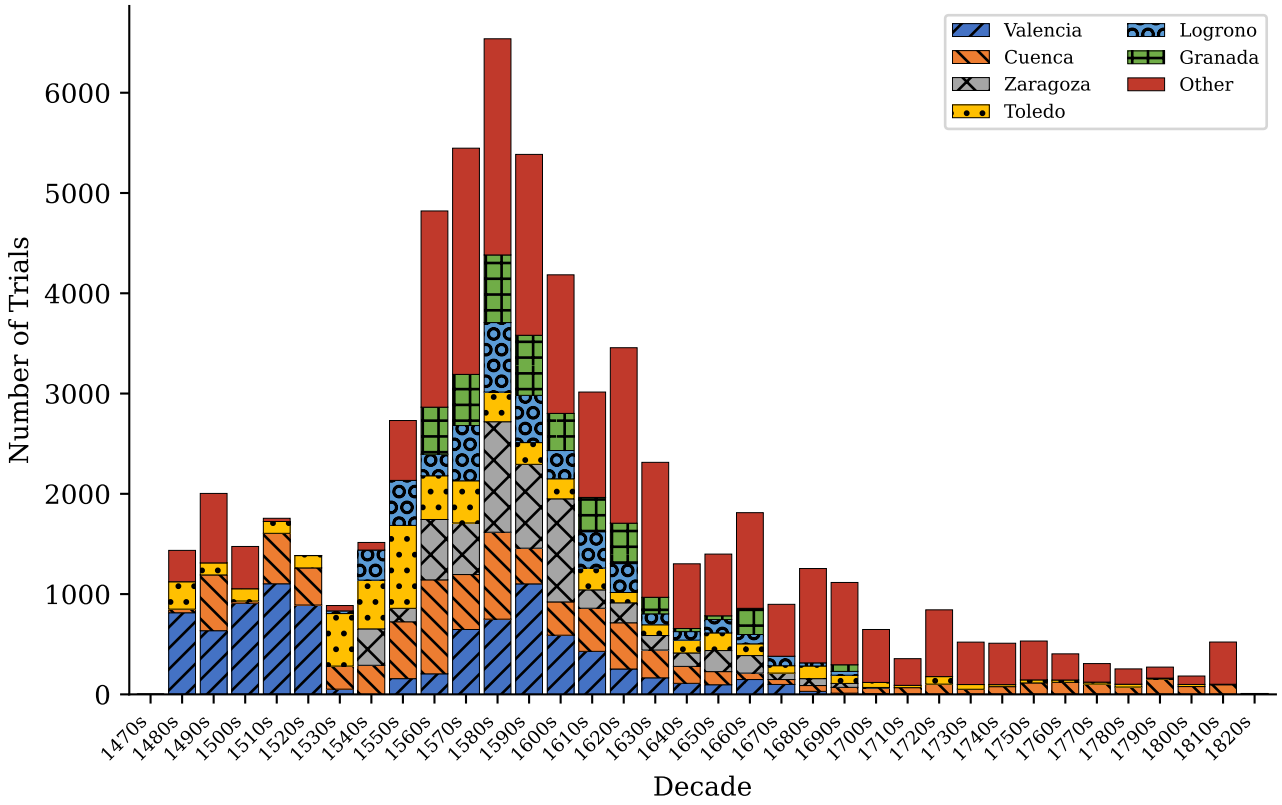
Notes: The unit of observation is one trial. Source: DVV/EMID individual trial data.

Figure B.8: Canonizations by the Catholic Church, 1594–2000



Notes: In Panel A each bar is the number of individuals canonized in that year, and a group martyrdom counts as one entry. In Panel B colors mark broad eras. Source: Hagiography Circle.

Figure B.9: Spanish Inquisition trials by decade, by tribunal, 1476–1820



Notes: Six tribunals appear on their own. The remaining ten are grouped as "Other." Source: DVV/EMID individual trial data.

and witchcraft together account for only 7.9 percent of them.

Structural break in newly active municipalities. The main text shows that the Salazar reforms produced a structural break in total Inquisition trial activity around 1614 (Figure 9.A). I repeat the exercise on *newly active municipalities*, the count of municipalities whose first recorded trial falls in a given year. That series tracks geographic reach: whether the Inquisition was still arriving in places it had never touched. Table B.12 reports Chow and Quandt–Andrews tests on it, using the same DVV/EMID individual trial data and the same Salazar break date as the main text. Both tests reject the hypothesis that the years before and after 1614 follow the same relationship. Left to pick its own date, the sup-F search puts the strongest break in the late 16^{th} century, which matches the pattern of geographic reach in Figure 9.B.

Table B.11: Distribution of Spanish Inquisition cases by offense category, 1540–1700

Offense Category	Cases	%
Judaizantes (crypto-Jews)	5,007	11.2
Moriscos (crypto-Muslims)	11,311	25.3
Luteranos (Protestants)	3,499	7.8
Alumbrados (Illuminists)	149	0.3
Proposiciones hereticas	12,546	28.1
Bigamia	2,645	5.9
Solicitacion (by clergy)	1,241	2.8
Contra el Santo Oficio	3,954	8.9
Supersticion/Brujeria	**3,532**	**7.9**
Varios (miscellaneous)	790	1.8
Total	44,674	100.0

Notes: Data from Contreras and Henningsen (1986). There are 44,674 cases in all.

Table B.12: Structural break tests: newly active municipalities series

	Newly Active Municipalities
Panel A: Structural break tests	
Chow F at 1614	119.83[a]
p-value	0.0000
Quandt-Andrews sup-F	249.68
Estimated break year	1589
Panel B: Pre- vs. post-1614 comparison	
Mean new municipalities/year (pre-1614)	22.123
Mean new municipalities/year (post-1614)	3.657
Decline	83.5%
Welch t-statistic	9.38[a]
N (years)	345

Notes: Newly active municipality = first year a trial is recorded.
[a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$.

Multiple-breaks and placebo tests. The main-text result rests on a Quandt–Andrews search for a single break, which is also the baseline of this appendix and the $m = 1$ row of Table B.13: that break is at 1611, with mean annual trials of 297 before it and 102 after. Allowing more breaks does not move it. The extra breaks split the pre-1611 and post-1611 periods into finer pieces. I search over $m \in \{0, \ldots, 5\}$ breaks under the same specification, with each segment fit by a constant and a linear trend. The breakpoints are estimated by dynamic programming in the spirit of Bai and Perron (1998, 2003), with a minimum segment length of ten years, and the number of breaks is the one that minimizes the BIC.

The BIC-optimal specification has $m^* = 5$ breaks at 1492, 1549, 1594, 1614, and 1629. The six segments have mean annual trials of 135, 140, 505, 420, 300, and 82 (middle panel of Table B.13). The sequence reads as the institutional history of the Spanish Inquisition. The low baseline before 1492 is the early Castilian inquisitorial apparatus, before the *decreto de la Alhambra*, and the jump after 1492 opens the era of *converso* prosecution. The surge after 1549 is the *morisco* buildup and the late-16^{th}-century peak. The 1594 break marks the start of the decline that ends in Salazar's investigation. The 1614 break is the policy itself: the year *La Suprema* issued the new evidentiary instructions. The 1629 break closes the implementation period and opens the long post-Salazar regime, which runs from the second quarter of the 17^{th} century to the abolition of the Inquisition in the 19^{th}.

The bottom panel of Table B.13 reports a placebo exercise on the single-break specification. On the full sample the sup-F statistic locates the strongest break at 1611 with $F = 221.1$. Excluding the 1611–1614 Salazar window moves the strongest break in what remains to 1615 ($F = 223.0$), immediately after the excluded years: the break does not depend on which year within the Salazar episode the test singles out. With the wider 1605–1625 window excluded, the strongest break moves back to 1598 ($F = 222.2$), an institutional moment in the *morisco* buildup rather than any post-Salazar date. The 1611 break is not a generic feature of the late period. Narrow the exclusion and the break stays beside 1611. Widen it and the next-strongest break is earlier, not later.

Table B.13: Multiple-breaks analysis of the aggregate Spanish Inquisition trial series, 1476–1820.

m (# breaks)	BIC	Estimated break years	Min. segment length
0	3535.89	n/a	345
1	3266.52	1611	135
2	3158.57	1559, 1640	81
3	3094.71	1559, 1594, 1640	35
4	3071.23	1492, 1549, 1594, 1640	16
5*	3066.61	1492, 1549, 1594, 1614, 1629	15
Segment means, BIC-optimal model ($m^* = 5$)			
1476–1491	mean trials/year = 135, length = 16 years		
1492–1548	mean trials/year = 140, length = 57 years		
1549–1593	mean trials/year = 505, length = 45 years		
1594–1613	mean trials/year = 420, length = 20 years		
1614–1628	mean trials/year = 300, length = 15 years		
1629–1820	mean trials/year = 82, length = 192 years		
Placebo sup-F tests (Andrews, 1993), constant + linear trend model			
Full series	sup-F = 221.13 at year 1611		
1611–1614 excluded	sup-F = 222.97 at year 1615		
1605–1625 excluded	sup-F = 222.24 at year 1598		

Notes: The top panel reports the BIC ($\equiv n\log(\hat{\sigma}^2)+(3m+3)\log n$) for $m \in \{0,\dots,5\}$ breaks, with dynamic-programming estimation in the spirit of Bai and Perron (1998, 2003). Each segment is fit with a constant and a linear trend, the same specification used for the main-text Quandt–Andrews test. The starred row is the BIC-optimal specification ($m^* = 5$), and the $m = 1$ row reproduces the single-break result reported in the main text. The middle panel gives segment-by-segment means for the BIC-optimal $m = 5$ specification. The bottom panel reports placebo Quandt–Andrews sup-F tests (Andrews, 1993) on three samples: the full series, the series with the 1611–1614 Salazar window excluded, and the series with the wider 1605–1625 window excluded. Source: DVV/EMID individual trial data.

Separating the expulsion from the reform. Table B.14 collects the Salazar statistics. Panel A gives the Quandt–Andrews break search on the national series: the strongest break falls at 1611, with mean annual trials of 299 before 1614 and 98 after. Panel B reports the decade-level Poisson difference-in-differences at the Murcia tribunal, and the superstition caseload rises relative to the tribunal's other business after 1614, whether the comparison group includes or excludes the morisco and judaizante series. Panel C turns to severity: no superstition or witchcraft defendant was executed at Murcia in the entire record, against a 12 percent execution share for other offenses before 1614.

Table B.14: The 1614 reform versus the 1609–1614 expulsion: breaks, composition, and severity.

Panel A: Quandt–Andrews break search, annual trials (EMID), constant + trend				
Series	Break year	sup-F	Mean pre-1614	Mean post-1614
All tribunals	1611	221.1	299	98
Panel B: Poisson difference-in-differences, Murcia tribunal, decade × offense group				
Superstition × post-1614			Coefficient	Rate ratio
vs. all other known offenses			1.262^{b} (0.607)	3.53
vs. other offenses excl. moriscos and judaizantes			0.872^{c} (0.518)	2.39
Panel C: Execution (relajado) shares, Murcia tribunal				
Offense group	Pre-1614	N	Post-1614	N
Superstition / witchcraft	0.000	38	0.000	280
All other known offenses	0.124	1440	0.014	2583

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Panel A reports a Quandt–Andrews sup-F break search (Andrews, 1993) on annual trial counts (constant + linear trend, 15 percent trimming), by tribunal group. The source is DVV/EMID individual trial data, 1476–1820. Panel B reports a Poisson difference-in-differences on decade × offense-group counts at the Tribunal of Murcia, with offense-group and decade fixed effects and robust standard errors. The post period begins with the 1620s, the first full decade after the 1614 instructions. The source is the Blázquez Miguel (1987) catalogue, restricted to trials with a known offense. Panel C reports the share of trials ending in *relajado* (execution in person or in effigy), by offense group and period, from the same source.

B.4 Textual Evidence

This subsection collects the extended textual results: the Google Books frequency series, the Latin corpus term counts, and the print-catalogue and vernacular full-text series.

B.4.1 Google Books Ngram Results

Figure B.10 plots devil terms and natural-philosophy terms for French, German, and Italian, each group on its own axis. The scissors shape found in English and Spanish appears in all three. German has the sharpest early peak in devil terms, around 1550–1600, and the French peak follows at 1580–1620. Italian devil terms hold on longer, through much of the 17^{th} century. In all three languages, natural-philosophy terms overtake devil terms by 1800.

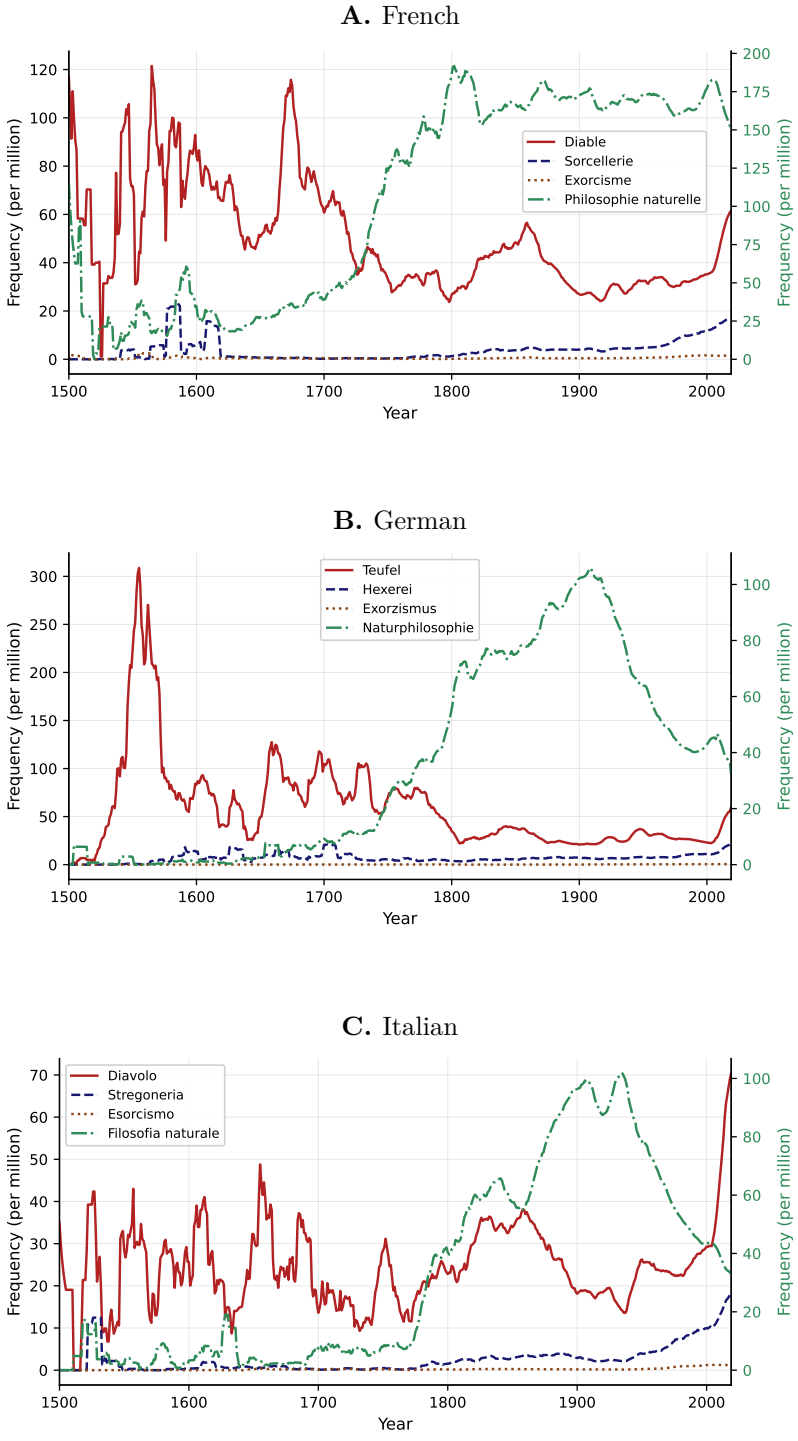
Figure B.11 compares the timing of witchcraft terms across the five languages. English and French witchcraft writing concentrates around 1580–1620. The German peak has a similar shape and comes somewhat earlier. Spanish witchcraft terms are negligible throughout, consistent with the Inquisition's suppression of popular witch-trial activity.

B.4.2 Latin Corpus Term Frequencies

I count exact occurrences of two groups of Latin word stems in each of the 8,063 documents of the Latin corpus described in Appendix A.9. The "diabolical" group includes *daemon**, *diabol**, *malefic**, *exorciza**, *satan**, and *superstit**. The "naturalist" group includes *natural**/*natura*, *ratio**, *philosoph**, and *experi**. I track the *miracul** stem in the underlying dataset but keep it out of the naturalist group, because miracle words appear on both sides of the natural–supernatural line the group is meant to draw. The naturalist stems are chosen conservatively: each one belongs to a Latin word family that Aquinas himself uses and that is unambiguous in context.

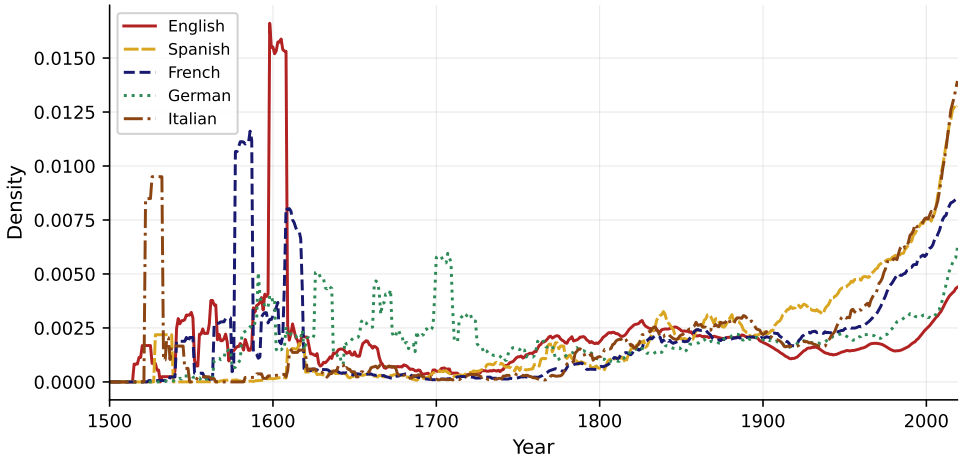
Table B.15 reports the sample by sub-corpus. Panel A of Figure B.12 plots the naturalist series over time, and Figure 1 in Subsection 2.2 plots the diabolical one. Panel B gives the ratio

Figure B.10: Devil, witchcraft, and natural-philosophy terms in French, German, and Italian books, 1500–2019



Notes: The left axis is the combined frequency per million of devil, witchcraft, and exorcism terms. The right axis, in green, is the combined frequency of natural-philosophy terms. Both series are five-year moving averages. Source: Google Books Ngram Viewer, 2019 edition corpora. Appendix A.8 lists the terms.

Figure B.11: Density of witchcraft-related terms across European languages, 1500–2019



Notes: For each language, the grouped witchcraft-related terms are normalized as a probability density (area under curve = 1). Series are five-year moving averages. Source: Google Books Ngram Viewer, 2019 edition corpora. Appendix A.8 lists the terms.

of naturalist to diabolical occurrences by half-century.

Diabolical vocabulary does *not* fall cleanly and steadily across the Thomistic transition (Figure 1). The record of the church fathers was already steeped in demon-talk, the Carolingian record stayed near that baseline, and the 13^{th}-century half-century is inside the pre-modern range. The naturalist vocabulary is what changes in 1250: *natura** and *ratio** jump to roughly twice their previous levels (Panel A of Figure B.12), and the ratio of naturalist to diabolical occurrences crosses parity for the first time (Panel B). The pattern is consistent with the mechanism proposed in the main text: Aquinas's synthesis did not put an end to demonic language. It widened the language available for talking about nature.

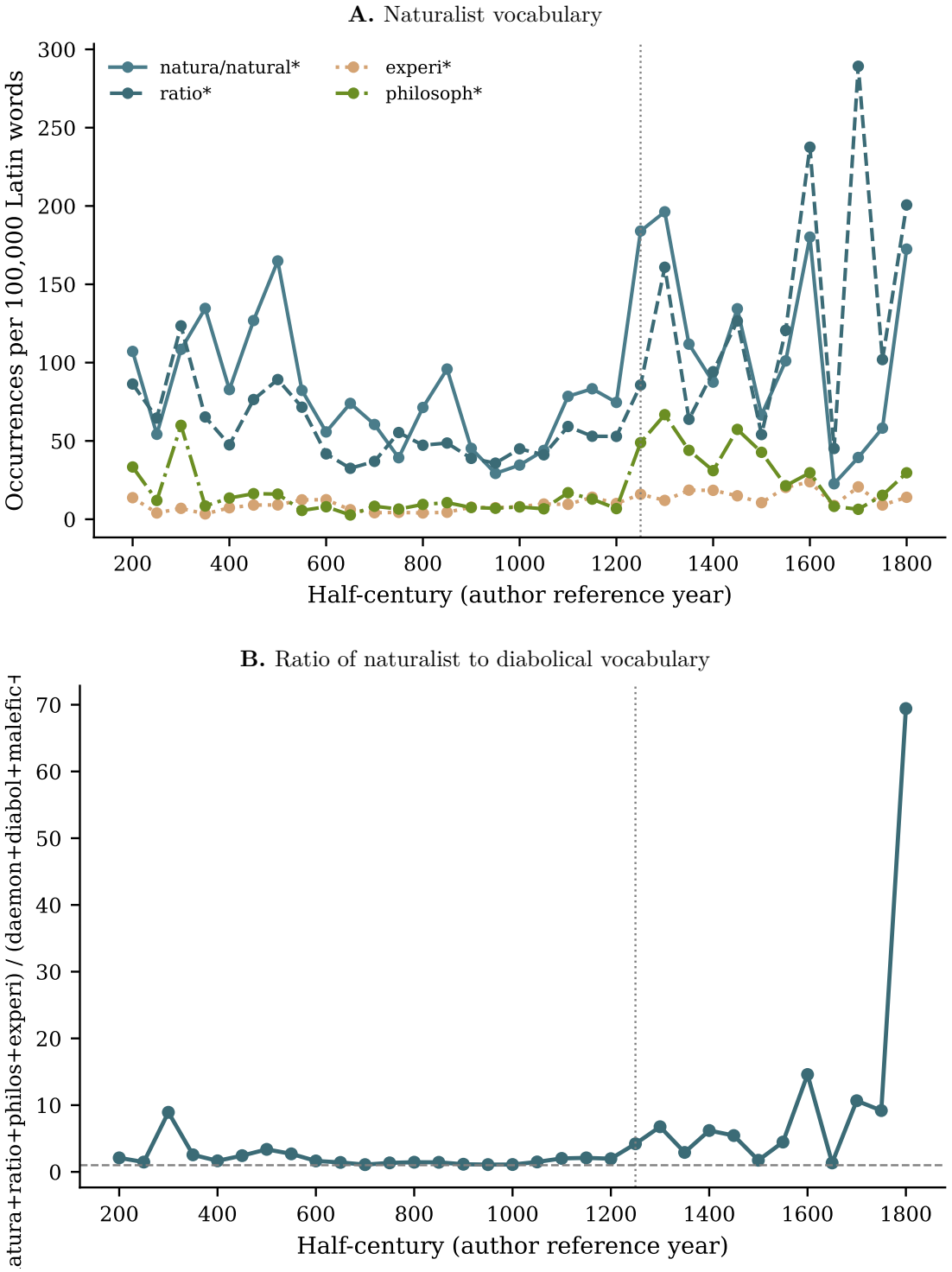
Composition of the corpus at the 1250 boundary. The Patrologia Latina contributes 1,082 of the 1,104 documents with devil terms dated before 1250 in the 1000–1500 window, and only 22 of the documents dated after 1250. The mix of sub-corpora therefore turns over almost completely at the date of interest, and the gap between *diabol** and *daemon** in Figure 1 could in principle come from a change in which texts are in the sample rather than from a change in how writers used the two words. Table B.16 tests this document by document. The outcome is

Table B.15: Coverage of the Latin reference corpus, by sub-corpus.

Sub-corpus	Docs	Mn words	Earliest yr	Latest yr
noscemus	3	0.08	316	1652
Philosophica	47	1.94	254	1650
Hagiographica	10	0.28	621	1471
Auctores scientiarum varii	87	6.51	-148	1992
Rinascimento	148	4.55	1110	1837
Richard Rufus Project	11	0.42	-321	1292
Croatiae auctores Latini	325	4.71	1149	2004
Neolatinitas	29	8.18	1508	1706
Theologica	11	0.13	400	1564
Antiquitas Posterior	189	2.98	-150	1547
Historica	3	0.09	1352	1647
Versiones latinae	13	0.23	1187	1867
Scriptores Ecclesiastici	265	9.15	220	1159
Encyclopediae	1	0.81	1264	1264
Latinità Italiana del Medioevo	345	4.41	547	1661
Monumenta Germaniae Historica	401	6.88	395	1550
Mathematica	12	0.42	1175	1855
Mirabile Digital Library	101	1.93	400	1540
Grammatici Latini	103	1.07	79	1050
Dissertationes	4	0.04	1865	1897
Ptolemaeus Latinus	30	0.91	170	1577
Acta Sanctorum	66	53.82	1665	1665
Corpus epistolarum Bullingeri	475	1.90	1560	1586
Itinera	11	0.26	1236	1754
Latinitas antiqua	168	5.39	-183	735
Patrologia Latina	5205	86.09	105	1847

Notes: Each row reports the number of documents retained after dropping items shorter than fifty Latin words, the total word count, and the range of author reference years recorded in the Corpus Corporum download log. The Patrologia Latina dominates the word count for the medieval period, and the Acta Sanctorum dominates it for the seventeenth century.

Figure B.12: Naturalist vocabulary and the naturalist-to-diabolical ratio, by half-century.



Notes: Source and method as in Figure 1. The naturalist group excludes *miracul**. In Panel A, the *natura**, *ratio**, and *philosoph** stems all rise sharply in the 1250 half-century, the period when Aristotle was recovered and the *Summa* was written; *experi** is rare across the whole pre-modern record but rises visibly after 1500. In Panel B the numerator is the sum of *natura**, *ratio**, *philosoph**, and *experi** occurrences and the denominator the sum of *daemon**, *diabol**, *malefic**, and *exorciza** occurrences; the horizontal dashed line marks parity, and the series crosses it in the thirteenth century. Few documents carry a date in 1600–1650, so each of those two bins rests on a small number of texts: the 1600 bin sits high because a handful of Renaissance authors use naturalist vocabulary heavily, while the Acta Sanctorum saints' lives dominate the 1650 bin.

the *daemon* share of a document's combined *daemon** and *diabol** counts, and the explanatory variable is an indicator for dates after 1250. The baseline correlation is 0.33. Sub-corpus fixed effects cut it to 0.22, and restricting the sample to the four sub-corpora sampled continuously on both sides of 1250 leaves it at 0.23. Adding a linear year trend, so that the step is measured against smooth drift rather than against a flat line, brings it to 0.16, and weighting documents by their devil-term counts gives 0.24. All the estimates are significant at the one percent level. Roughly half of the gap in the aggregate series is corpus composition, and the other half is a shift in the words themselves within a given sub-corpus, in the direction and at the date the theological account predicts.

Table B.16: The *daemon* share after 1250: composition versus specialization.

	(1)	(2)	(3)	(4)	(5)
Post-1250	0.330^{a} (0.018)	0.215^{a} (0.030)	0.229^{a} (0.032)	0.158^{a} (0.045)	0.242^{a} (0.062)
Sub-corpus FE	No	Yes	Yes	Yes	Yes
Sample	All	All	Spanning	Spanning	Spanning
Linear year trend	No	No	No	Yes	No
Weighted by devil-term count	No	No	No	No	Yes
N (documents)	1515	1515	1358	1358	1358

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Unit: documents in the Latin corpus dated 1000–1499 with at least one *daemon** or *diabol** occurrence. Outcome: *daemon** occurrences over combined *daemon** + *diabol** occurrences. "Spanning" restricts the sample to sub-corpora with at least ten such documents on each side of 1250 (Patrologia Latina, Latinità Italiana del Medioevo, Monumenta Germaniae Historica, Mirabile Digital Library). Column (5) weights each document by its combined devil-term count.

B.4.3 Print Catalogues and Vernacular N-grams

The full ISTC catalogue (Appendix A.10) is the source for the keyword counts in Table B.17. A record counts under a keyword when the term or one of its variants appears as a whole word in the title, or, for Thomas Aquinas and Aristotle, in the author field. On that rule Aristotle accounts for 587 editions, Thomas Aquinas for 380, Bible and scripture for 342, medicine for 163, theology as a title word for 145, natural philosophy for 123, and astrology and astronomy for 96.

Demonological terms appear at far smaller counts: eighty *malefic**, *malleus*, or witch editions (including nine of the *Malleus Maleficarum*), twenty-five *satan**, eleven *daemon**, nine *diabol**, eight *demon**, twelve *superstit**, and four *magia*. The titles of these earliest printed books are short and formulaic, so a title count misses books whose subject never reaches the title page: most editions of Aquinas circulate under titles like *Summa* or *Quaestiones* with no "theologia" in them. The presses of the first half-century of print turned out an order of magnitude more Aristotelian, medical, and scriptural volumes than demonological ones. Almelhem et al. (2026) classify English volumes printed 1500–1900 by their full contents, using the bag-of-words representations of the HathiTrust library. No machine-readable full text exists at that scale for the incunabula, so classification here runs on the title page text.

Table B.17: Subject keyword counts across the full ISTC database.

Keyword	Editions
Thomas Aquinas	380
Theology	145
Bible/Scripture	342
Medicine	163
Aristotle	587
Natural philosophy	123
Astrology/Astronomy	96
Maleficium/Witch	80
Satan	25
Demon	8
Daemon	11
Diabolus	9
Superstition	12
Magic	4

Notes: Counts run across all 30,680 unique records retrieved from the CERL ISTC API. A record counts under a keyword when any variant of the term appears in the title, or, for "Thomas Aquinas" and "Aristotle," in the author field. One edition can match more than one keyword.

The EarlyPrint English series (Appendix A.11) covers the EEBO-TCP corpus of roughly 60,000 English books printed between 1473 and 1700. Figure B.13 tracks the standard demonological words through that corpus. Throughout the period "devil" dominates the diabolical vocabulary, and "witch" rises sharply after the English Witchcraft Act of 1542. As a compound

noun "witchcraft" barely exists before the 1560s, and the crossing of "superstition" and "philosophy" around 1600 traces the same shift in vocabulary that the Latin corpus shows a century earlier.

The EarlyPrint and Google Books English corpora overlap roughly between 1600 and 1700. If the two draw on the same stock of English printing and select from it in similar ways, their per-million frequencies for devil and witchcraft words should move together over that window. Figure B.14 puts the two series side by side, for devil and witch words in Panel A and for witchcraft and sorcery words in Panel B. The two corpora agree that the devil term peaks during the Civil War and Interregnum (1640–1660) and falls after the Restoration, and that witchcraft peaks earlier, in the 1610s and 1620s, and falls steadily into the eighteenth century. The Google series carries the EarlyPrint pattern past 1700: the decline that begins in the late 17^{th} century runs on through the 18^{th} without a break.

B.5 The Dominican Network and the Diffusion of Science

This subsection collects the estimates behind Subsection 4.5: the distance-to-Paris IV designs, the print-economy exposures, the three-order comparisons, and the conditioning and robustness tests.

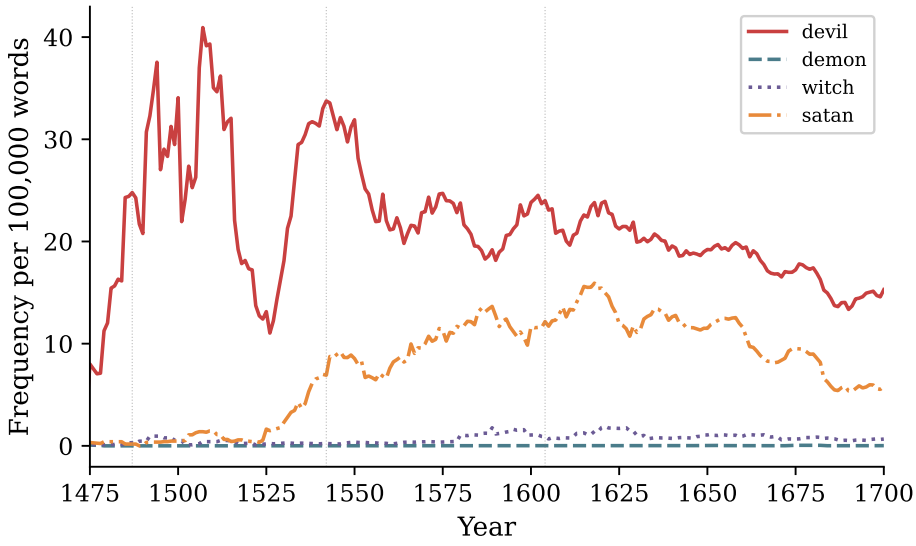
B.5.1 Academic Fields, the Distance-to-Paris IV, and the Geography of Science

The Repertorium Eruditorum Totius Europae (Appendix A.12) supplies the field composition in Figure B.15, the cluster summary in Table B.18, and the geographic exercises below. I take the published k-means field assignment at $k = 10$, which sorts scholars into ten groups by the subjects they published on. For the headline display I collapse those ten groups into four: Theology, Science, Law/Politics, and Humanities.

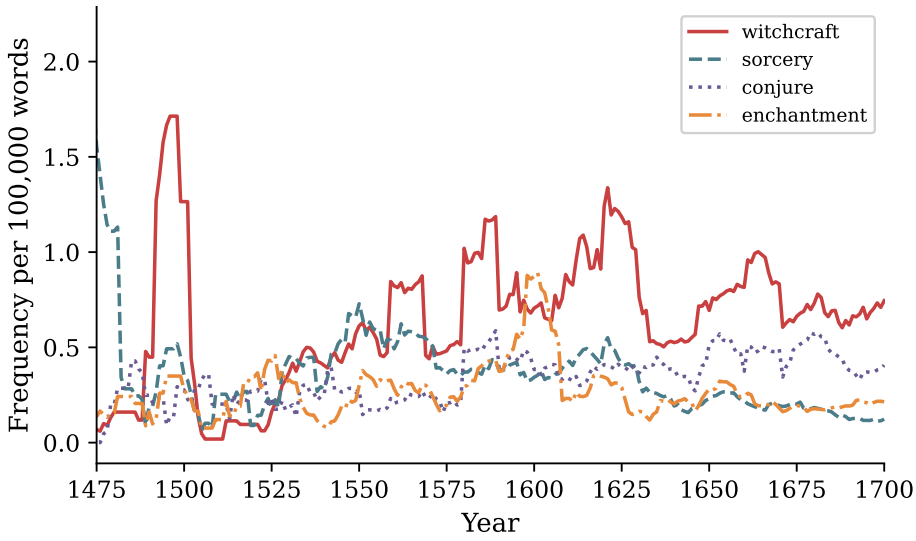
Figure B.15 shows the composition of European academia by half-century under the four-group collapse. Theology, the group that holds Aquinas with the Catholic and Protestant clergy clusters, peaks at roughly forty percent in the thirteenth century and falls through the sev-

Figure B.13: Demonological and naturalist vocabulary in English printed books, 1473–1700.

A. "Devil," "demon," "witch," and "satan"



B. "Witchcraft," "sorcery," "conjure," and "enchantment"



C. "Superstition," "natural," "philosophy," and "reason"

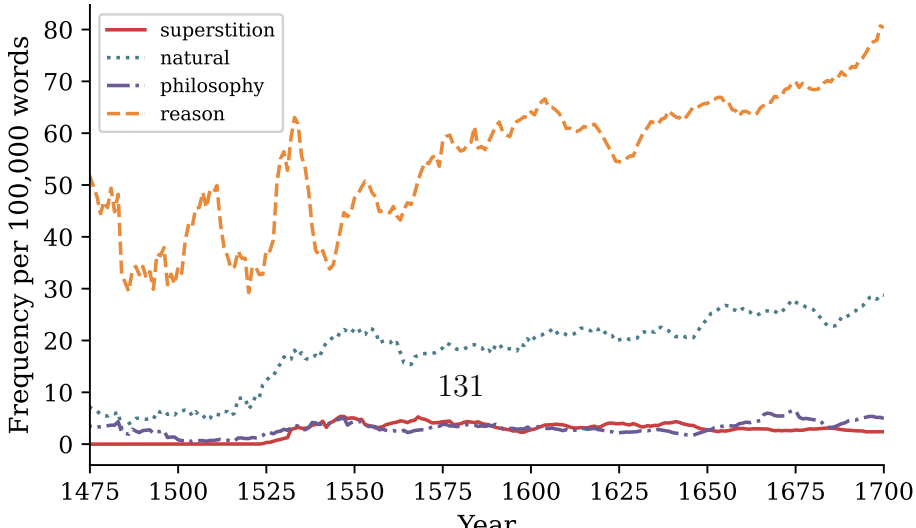
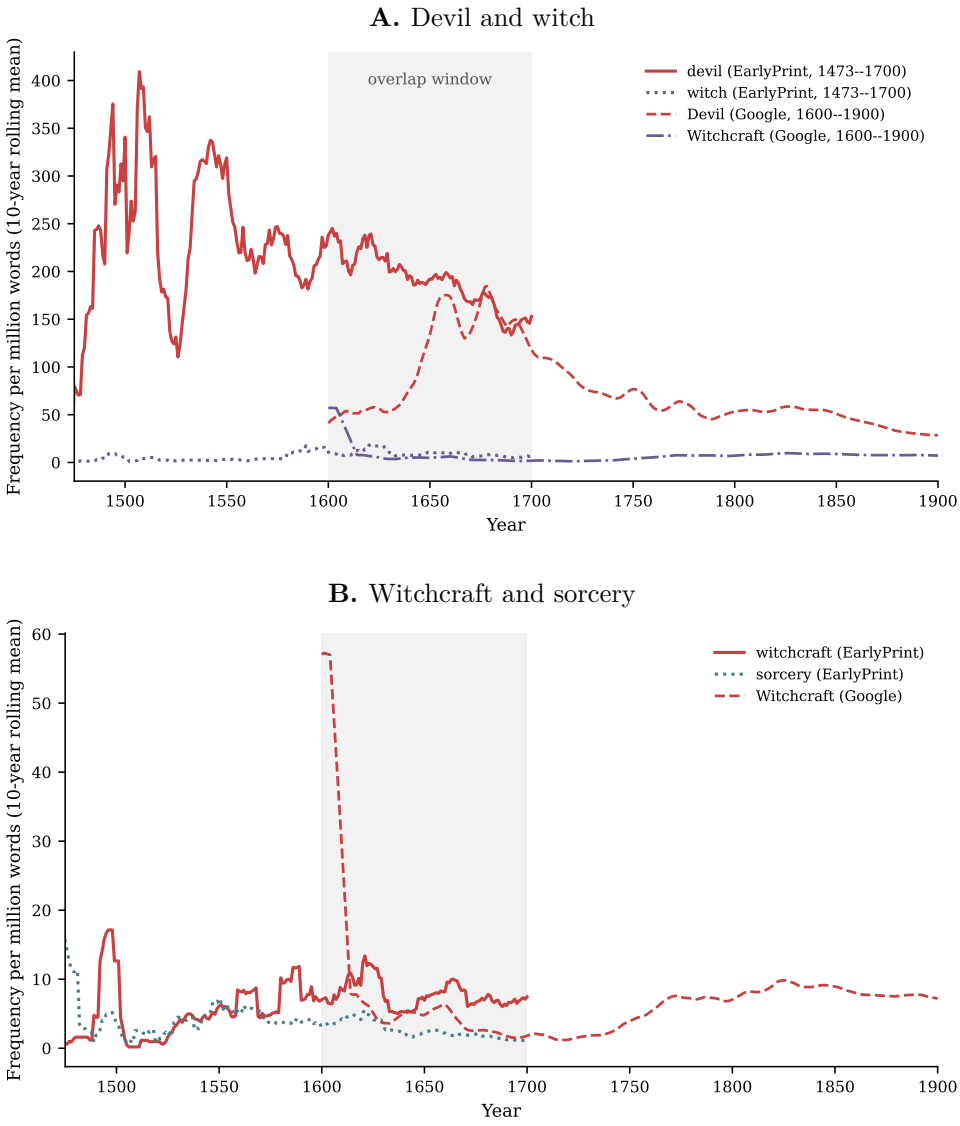


Figure B.14: EarlyPrint and Google Books English series, 1475–1900.



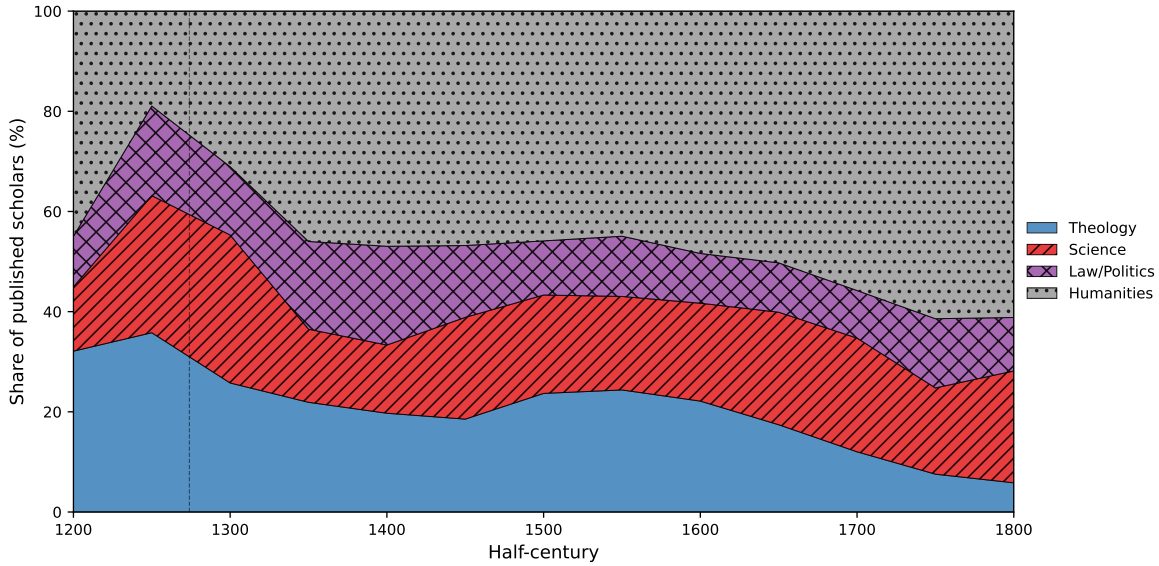
Notes: Solid lines give EarlyPrint frequencies, converted from per-100k to per-million words; dashed lines give Google Books English frequencies. In Panel A the Google series is "Devil" and "Witchcraft" (a slightly different word than "witch," though the two series track closely in the overlap window); in Panel B sorcery is shown for EarlyPrint only. All series are ten-year centered rolling averages. The shaded band marks the 1600–1700 overlap between the two corpora, which agree closely on the position and shape of the witchcraft peak in the 1610s–1620s.

Table B.18: Academic field clusters from the RETE scholars database.

Field	N	Med. Publ.	Earliest	Med. Year	Top 3 Names
Classics	6805	30	970	1717	von, Erasmus, Metastasio
Philosophy	619	121	980	1696	Kant, Rousseau, Diderot
Science	825	74	1116	1704	Galilei, Newton, Euler
Medicine	1745	71	1025	1699	Rabelais, von, Trew
Theology 2	911	168	1039	1671	Luther, Melanchthon, Lessing
Theology 1	1575	80	975	1615	Aquinas, Pascal, Bossuet
Culture	1096	108	1140	1754	Arouet, Homann, Cook
Law	931	82	1090	1638	Stryk, Böhmer, Cujas
Politics	958	82	1043	1757	Franklin, Swift, Machiavelli
Antiquities	684	148	1115	1674	Racine, Piranesi, Corneille

Notes: Clusters estimated by k-means clustering on a 16,149 × 1,360 scholar–subject matrix at $k = 10$. Aquinas falls in Theology 1. Newton, Galileo, Euler, Copernicus, and Kepler fall in Science.

Figure B.15: Composition of European academia by four collapsed field groups, 1200–1800.

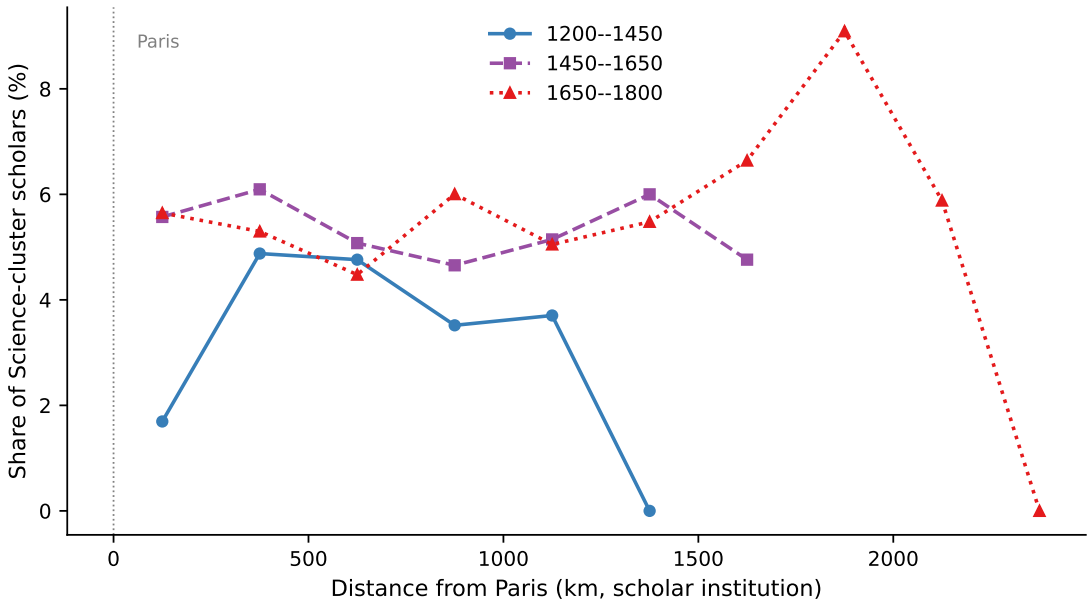


Notes: The four groups collapse the original ten RETE clusters as follows. Theology = Theology 1 + Theology 2. Science = Science + Philosophy + Medicine. Law/Politics = Law + Politics. Humanities = Classics + Culture + Antiquities. Sample: 16,149 scholars with WorldCat publication records and known dates of activity.

enteenth. Science, which contains Newton, Galileo, Kepler, Euler, and Copernicus along with the medical and natural-philosophical clusters, is small in absolute terms before 1500 and grows steadily afterwards. The two shares cross around 1700, and the absolute count of Science scholars accelerates sharply after 1550, consistent with the lag in the spread of the Thomistic curriculum reported in Appendix C.6.

Distance-to-Paris descriptive gradient. For each RETE scholar with a geocoded institution location, I compute the great-circle distance from Paris and sort scholars into 250-km bands. Figure B.16 plots the share of Science-cluster scholars in each band, separately for three periods. The gradient is flat in 1200–1450 and modest in 1450–1650, but in 1650–1800 it is clear: Science shares are highest within roughly 750 km of Paris and fall as distance rises.

Figure B.16: Share of Science-cluster scholars by distance from Paris.



Notes: Each marker is the share of Science-cluster scholars among RETE scholars with geocoded institutions in a 250-km distance band from Paris, plotted separately for three periods. The horizontal axis is capped at 1600 km, the upper limit of the 1450–1650 cohort. Source: De la Croix (2021).

Two-stage least squares. This gradient motivates the two-stage least-squares estimates discussed in Subsection 4.5 and reported in Table B.21 at the end of this subsection. I instrument

the local intensity of Thomistic institutional infrastructure with distance from Paris, and I measure that intensity in two ways. The first is the count of Dominican houses in a $2° \times 2°$ grid cell (Appendix A.7). The second is the count of pre-1500 Latin devil-related words in the cell, taken from the corpus described in Appendix A.9, with each document placed at its author's location. Table B.19 reports both channels, and Figure B.17 shows the two first stages: how strongly distance shifts each measure. The Dominican-channel first-stage F is 32.0 under classical standard errors and 19.4 under heteroskedasticity-robust standard errors, both above the conventional threshold for a weak instrument. The classical F is 7.2 on the Latin devil-book.

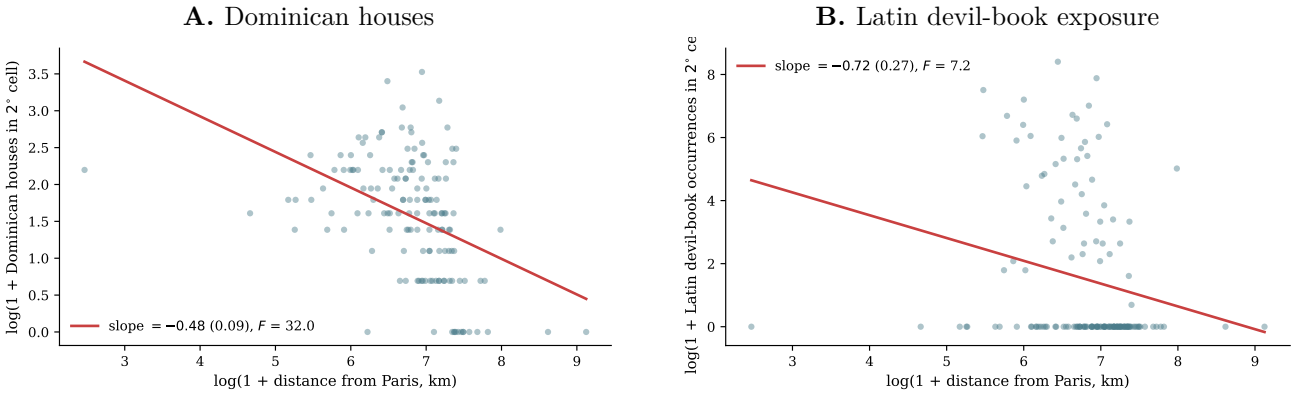
Table B.19: Distance to Paris as an instrument for Thomistic infrastructure, both channels.

	Dominican channel	Devil-book channel
First stage: log(1+channel) on log(distance from Paris)		
log(dist Paris)	-0.483^a	-0.723^a
	(0.085)	(0.269)
First-stage F	32.0	7.2
R^2	0.180	0.047
Reduced form: log(1+Science scholars) on log(distance from Paris)		
log(dist Paris)	-0.701^a	-0.701^a
	(0.100)	(0.100)
2SLS: log(1+Science scholars) on log(1+channel), instrument = log(dist)		
log(1+channel)	1.451^a	0.970^a
	(0.207)	(0.138)
OLS for comparison		
log(1+channel)	0.710^a	0.214^a
	(0.083)	(0.030)
N (grid cells)	148	148

Significance: $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.10$. Standard errors in parentheses.

Notes: The unit of observation is a $2° \times 2°$ grid cell of Europe with at least five RETE scholars active 1450–1800 ($N = 148$). The outcome is log(1 + Science-cluster scholars) produced in the cell. The first stage regresses log(1 + channel) on log(1 + distance from Paris). The reported first-stage F is the classical one. Its heteroskedasticity-robust counterpart on the same sample is 19.4 for the Dominican channel and 4.1 for the devil-book channel. Standard errors in parentheses. Sig.: $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.10$. The exercise is the analogue of the distance-to-Wittenberg and distance-to-Mainz designs in Becker and Woessmann (2009); Cantoni (2015); Dittmar (2011).

Figure B.17: First stages: distance from Paris and the two exposure channels.



Notes: Each marker is a 2° × 2° grid cell of Europe with at least five RETE scholars active 1450–1800, and the horizontal axis is log(1 + km from Paris). The vertical axis in Panel A is log(1 + Dominican houses in the cell), refined inventory (Appendix A.7); in Panel B it is log(1 + count) of *daemon**, *diabol**, and *malefic** occurrences in pre-1500 Latin corpus documents whose authors appear in the RETE database with geocoded coordinates. The lines are OLS fits, and their slopes are the first-stage coefficients in Table B.19. The classical first-stage F of 7.2 in Panel B falls below the conventional weak-instrument threshold, so the corresponding 2SLS estimate in Table B.19 is weakly identified.

Conley standard errors and control variables. The spatial structure of the data raises two concerns. The first is that the grid cells are not independent: scholar production and Dominican density are both correlated across space. Table B.20 estimates the Dominican-channel 2SLS of Table B.21 below with Conley (1999) standard errors, which allow the errors of any two cells within a stated distance of each other to be correlated. The kernel is Bartlett, with cutoffs at 500, 1000, and 1500 km. The Conley standard errors come out slightly larger than the ones computed under independence, but the main coefficient stays statistically significant at the one percent level under every specification.

The second concern is the exclusion restriction discussed in the main text, which requires distance from Paris to reach scholar production only through Thomistic infrastructure and could fail if distance instead stands in for proximity to other early centers of human capital. Columns (2)–(4) of Table B.20 add controls for log(1+km to nearest pre-1250 university other than Paris) and for log(1 + km to nearest pre-1500 printing center other than Paris). The catalogue of pre-1250 universities excludes Paris. Keeping it in the control would reproduce the instrument and

leave the two variables nearly collinear. Built from the ISTC imprint field, the printing-center catalogue follows the same exclusion. The IV estimate is larger in columns (2)–(4) than in column (1), as it should be if the controls take up variation in scholar production that the specification without them wrongly assigns to the Dominican channel. The classical first-stage F reported in the table remains above the conventional threshold in every column.

Spatial correlation. If witch trials and Science-cluster scholars are joint products of the same institutional infrastructure, the two should be positively correlated across space: concentrated in the same urbanized, institutionally dense regions of Europe. Panel B of Table B.20 reports Spearman rank correlations between the two counts across $2^\circ \times 2^\circ$ grid cells in three periods. The correlations rise from essentially zero in 1300–1550 to weakly positive in 1550–1650 and significantly positive in 1650–1800: the regions that produced the most Science-cluster scholars in the late period are also the regions that tried the most people for witchcraft.

Table B.21 holds the two estimates Subsection 4.5 argues from, and it sits here, beside the devil-book channel and the first stages they should be read against. Panel A is the baseline Dominican-channel design, with the first stage, the reduced form, the 2SLS estimate, and OLS for comparison on the 148-cell frame. Panel B holds that design fixed and moves the outcome across four layers of the knowledge economy, from universities active by 1500 to the editions printed in the first half-century of print.

B.5.2 The Print Economy as Exposure

Table B.21 above treats the early print economy as an outcome of the Dominican network. Here I turn the design around and make print the treatment. From the Incunabula Short Title Catalogue I take the 30,013 editions printed 1455–1500 whose imprint records a city I can identify, place each at its city, and sort them by title and author into two groups. The first group is editions on the devil, witchcraft, demonology, or sorcery, and the second is editions on natural philosophy in the broad Aristotelian sense, which covers Aristotle and his commentators, Galen and the

Table B.20: Spatial robustness: Conley standard errors, distance controls, and the science–trials correlation.

Panel A: Conley standard errors and controls for other early human-capital channels

	(1) No controls	(2) + Uni. dist.	(3) + Print dist.	(4) + Both
2SLS: $\log(1+$ *Sci scholars*$)$ *on* $\log(1+$ *Dom*$)$*, with IV* $=\log($*dist Paris*$)$				
$\log(1+\text{Dom})$ coef.	1.451	3.323	2.178	3.909
iid SE	(0.207)	(0.623)	(0.419)	(0.784)
Conley SE, 500 km	(0.252)	(0.755)	(0.437)	(0.831)
Conley SE, 1000 km	(0.257)	(0.757)	(0.438)	(0.872)
Conley SE, 1500 km	(0.229)	(0.577)	(0.388)	(0.755)
First-stage F (classical)	32.0	62.9	51.8	50.1
N (grid cells)	148	148	148	148
Pre-1250 univ. control	no	yes	no	yes
Pre-1500 print control	no	no	yes	yes

Panel B: Spearman correlation between Science scholars and witch trials, 2° grid

Period	Grid cells	Science scholars	Persons tried	Spearman ρ	p-value
Early (1300-1550)	64	74	1259	0.040	0.7514
Middle (1550-1650)	71	182	13022	0.114	0.3429
Late (1650-1800)	107	491	2735	0.266	0.0056

Notes: In Panel A each column reports the 2SLS coefficient on log(1 + Dominican houses in cell) from a separate regression. The instrument throughout is log(km from Paris). The iid SE row gives the conventional 2SLS standard error. The Conley SE rows give Conley (1999) spatial-HAC standard errors, with a Bartlett kernel at the indicated cutoff. The pre-1250 university control is log(1 + km to nearest pre-1250 university other than Paris), with the catalogue {Bologna, Oxford, Cambridge, Salamanca, Padua, Naples, Toulouse, Siena, Valladolid, Montpellier, Vercelli}. The pre-1500 printing control is log(1 + km to nearest pre-1500 printing center other than Paris), with the catalogue drawn from the imprint field of the Incunabula Short Title Catalogue. Sig.: $^{a}p<0.01$, $^{b}p<0.05$, $^{c}p<0.10$. $N=148$ grid cells. Panel B reports Spearman rank correlations between Science-cluster scholars and Leeson–Russ persons tried over $2^\circ \times 2^\circ$ grid cells covering Europe; sources: De la Croix (2021) and Leeson and Russ (2018).

Table B.21: Distance to Paris as an instrument for Thomistic infrastructure: Dominican channel and four outcome layers.

Panel A: Baseline Dominican-channel design

	(1) First stage log(1+Dom)	(2) Reduced form log(1+Sci)	(3) 2SLS log(1+Sci)	(4) OLS log(1+Sci)
log(1+dist Paris)	-0.483^{a}	-0.701^{a}		
	(0.110)	(0.085)		
log(1+Dom)			1.451^{a}	0.710^{a}
			(0.284)	(0.073)
Estimator	OLS	OLS	2SLS	OLS
First-stage F	19.4	n/a	19.4	n/a
N (grid cells)	148	148	148	148

Panel B: One design, four outcome layers

	(1) Universities by 1500	(2) Science scholars 1450–1800	(3) Devil editions 1455–1500	(4) Nat.-phil. editions 1455–1500
OLS: log(1+Dom)	0.283^{a} (0.038)	0.710^{a} (0.073)	0.235^{a} (0.058)	0.876^{a} (0.131)
2SLS: log(1+Dom)	0.333^{a} (0.079)	1.451^{a} (0.282)	0.599^{b} (0.265)	1.683^{a} (0.478)
Mean of outcome (count)	0.5	4.9	0.6	16.2
First-stage F			19.4	
N (grid cells)			148	

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. The unit of observation is a $2^\circ \times 2^\circ$ grid cell of Europe with at least five RETE scholars active 1450–1800. In Panel A, the outcome in columns (2)–(4) is the log count of Science-cluster scholars in the cell, and the outcome in column (1) is the log count of Dominican houses in the cell; the endogenous regressor in column (3) is the log count of Dominican houses, refined inventory (Appendix A.7); the instrument is log great-circle distance from Paris; column (4) reports OLS of log(1+Sci) on log(1+Dom) for comparison. In Panel B all outcomes are in $\log(1 + \text{count})$ form, with the same treatment and instrument; universities are cities with a university active in 1500 (Bosker et al., 2013), and editions are ISTC imprints 1455–1500 (Appendix A.10). See Table B.19 above for the parallel devil-book channel and the first-stage figures.

Greco-Arabic medical tradition, astronomy, mathematics, optics, and the natural-history corpus (Appendix A.10 lists the classification rules). Adding the editions up within the same 2° grid cells gives two treatment variables: the count of devil-book editions printed in the cell and the count of natural-philosophy editions printed in the cell.

Table B.22 reports the 2SLS estimates with log distance from Paris as the instrument, and a robustness check replaces Paris with Mainz, the source of the printing technology and the location in Dittmar (2011). Both channels have a strong first stage under both anchors. Under classical standard errors the natural-philosophy first-stage F runs between 24 and 52 and the devil-book first-stage F between 22 and 35. Both channels give 2SLS coefficients that are positive, large, and significant at the one percent level. The natural-philosophy elasticity is 0.86 under Paris and 0.76 under Mainz. The devil-book elasticity is 2.4 under both. Cities that printed many devil books also printed many natural-philosophy books, so the two counts move together, and the comparison between them should be read as a robustness exercise on the print economy as a whole rather than as a clean split between the two kinds of content.

B.5.3 Single-Order and Joint Order Specifications

Table B.23 reports the single-order estimates that Figure 15 plots, in three broader outcome windows and with the per-window samples. The Dominican channel runs strongest in the early-modern window 1550–1700 and stays significant in 1700–1800. Doubling the count of Dominican houses in a cell is associated with roughly a $2^{1.57} \approx 3$-fold increase in the count of Science-cluster scholars over 1550–1700. The Franciscan channel is positive and significant in the windows after 1550, and it runs about half the Dominican size. Read on its own, that estimate would suggest that what mattered was the number of friars of any order preaching in a cell, but the joint specification of Table B.24 shows it does not survive once the Dominican count sits in the same regression.

Table B.24 is the table behind Figure 15.C: an OLS regression of log(1+Sci) on all three order counts at once, with log distance from Paris as a control. Only the Dominican coefficient survives.

Table B.22: Print-location instrumental variables: devil and natural-philosophy editions.

	Instrument: log dist Paris		*Instrument: log dist Mainz*	
	Devil books	Nat-phil books	Devil books	Nat-phil books
First stage: log(1+channel) on log(distance to anchor)				
log(distance)	-0.289^a	-0.813^a	-0.395^a	-1.254^a
	(0.061)	(0.165)	(0.067)	(0.173)
First-stage F	22.5	24.3	35.2	52.4
2SLS second stage: log(1+Science scholars) on log(1+channel)				
log(1+channel)	2.424^a	0.862^a	2.411^a	0.760^a
	(0.346)	(0.123)	(0.265)	(0.084)
OLS for comparison				
log(1+channel)	0.886^a	0.431^a	0.886^a	0.431^a
	(0.126)	(0.040)	(0.126)	(0.040)
N (grid cells)	148	148	148	148

Notes: Sig.: $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.10$. Standard errors in parentheses. Outcome is log(1 + Science-cluster scholars) in the cell, 1450–1800. Channel counts come from ISTC editions placed at their imprint city. Editions without a city imprint are dropped. Devil-book counts are sparse, which produces wide standard errors on that channel.

It is positive in every window: 0.61 ($p < 0.01$) in the pooled specification, 0.23 ($p < 0.10$) in 1550–1700, and 0.49 ($p < 0.01$) in 1700–1800. The Franciscan and Jesuit coefficients are statistically indistinguishable from zero in every window, and their point estimates change sign from one window to the next. The single-order specifications of Table B.23 pick up Franciscan and Jesuit effects only because of where the orders sat relative to each other. Both networks are on average in places the Dominicans had reached earlier, and once Dominican presence enters the regression neither adds anything of its own.

Table B.25 shows the city-panel version used as a diagnostic in Subsection 4.5: a 2SLS specification on the Bosker et al. (2013) set of cities when a house arrived in a given city rather than on where the houses were located. The Dominican coefficient stays positive. The Jesuit coefficient turns sharply negative. This is the sign flip to expect when the order chose its sites in response to the Counter-Reformation.

Table B.23: Distance-to-Paris IV by religious order and outcome window.

	Pooled 1450–1800	Pre-1550	1550–1700	1700–1800
Dominican channel				
2SLS log(1+order)	1.451^a	1.789	1.563^a	0.836^a
	(0.207)	(1.607)	(0.232)	(0.144)
First-stage F	32.0	0.3	16.9	50.9
OLS log(1+order)	0.710^a	0.365^a	0.469^a	0.514^a
	(0.083)	(0.087)	(0.084)	(0.068)
N cells	148	95	125	155
Franciscan channel				
2SLS log(1+order)	0.817^a	0.718	0.837^a	0.511^a
	(0.117)	(0.645)	(0.124)	(0.088)
First-stage F	36.1	0.8	19.6	48.3
OLS log(1+order)	0.336^a	0.223^a	0.252^a	0.247^a
	(0.053)	(0.054)	(0.049)	(0.043)
N cells	148	95	125	155
Jesuit channel				
2SLS log(1+order)	1.609^a	0.791	1.567^a	1.027^a
	(0.229)	(0.711)	(0.232)	(0.177)
First-stage F	14.8	0.6	8.6	20.7
OLS log(1+order)	0.323^a	0.180^a	0.179^a	0.214^a
	(0.076)	(0.055)	(0.068)	(0.065)
N cells	148	95	125	155

Notes: Sig.: $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.10$. Standard errors in parentheses. Instrument throughout: log great-circle distance from Paris. Outcome: log(1 + Science-cluster scholars) in the $2° \times 2°$ grid cell. The pooled column matches the headline specification of Table B.21. First-stage F statistics in this table are computed under classical standard errors. The pooled column is therefore 32.0 where Table B.21 reports 19.4 for the same first stage on the same 148 cells, the two being the classical and the heteroskedasticity-robust versions of one statistic. The period columns use cells with at least three scholars active in the window. Jesuit cells are sparse before 1550 because the Society was founded in 1540. House inventories as in Figure A.2 (Appendix A.7).

Table B.24: Joint OLS specification with three religious orders.

	1450–1800	1550–1700	1700–1800
log(1+Dominican)	0.613^{a}	0.236^{c}	0.491^{a}
	(0.128)	(0.121)	(0.124)
log(1+Franciscan)	-0.072	0.099	-0.036
	(0.090)	(0.086)	(0.087)
log(1+Jesuit)	0.037	-0.071	-0.057
	(0.087)	(0.080)	(0.082)
log(1+dist Paris)	-0.450^{a}	-0.460^{a}	-0.252^{a}
	(0.100)	(0.090)	(0.087)
N cells	148	125	155
R^2	0.418	0.359	0.315

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Standard errors in parentheses. Outcome: log(1 + Science-cluster scholars) in the $2^\circ \times 2^\circ$ grid cell. Each column is one joint OLS regression with the three order counts on the right-hand side together with log distance from Paris. A joint 2SLS specification would need three plausible distance anchors, and over a European grid these are highly correlated, so the joint 2SLS is not identified. The single-order 2SLS estimates appear in Table B.23.

Table B.25: City-panel 2SLS by order: within-city identification.

	Dominican	Franciscan	Jesuit
2SLS log(1 + order stock)	$+7.151^{a}$	$+0.573^{a}$	-4.749^{a}
	(1.005)	(0.081)	(0.981)
OLS log(1 + order stock)	+0.019	+0.005	-0.023
	(0.016)	(0.016)	(0.020)
First-stage F	44.2	21.2	73.9
N city-bin obs.	4182	4182	3624
Cities	904	904	902

Notes: All three orders at the baseline + full Bosker covariate specification. Always-on: bin FE, country FE, lat, lon, lat × lon, log dist coast, log pre-1450 RETE, sea/port, river, bishop, archbishop, capital, university, free-prince, soil, elevation, ruggedness. Jesuit restricted to bins ≥ 1550. Significance: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$.

Each of the three order counts reflects a choice the orders made, so each would need its own instrument, and the joint 2SLS would require three plausible distance anchors that are not too tightly correlated. In practice the candidate anchors (Paris, Bologna, Mainz, Rome) are nearly the same variable over a European cell grid, so the three-instrument 2SLS is not useful. Reading Table B.24 as evidence on the Thomistic channel therefore rests on the OLS specification being conservative rather than on a separate exclusion restriction for the Franciscan and Jesuit channels.

B.5.4 Conditioning the Dominican Design

Subsection 4.5 compresses four further tests of the Dominican design into a paragraph. The first runs the Dominican–Franciscan horse race through every control a reader might ask for. The second re-estimates the design as a count model on the full European grid, including the cells that produced no scientists at all. The third asks what the distance instrument can and cannot pin down. The fourth is the dissolution test in Protestant Europe.

Conditioning the Horse Race. Table B.26 adds further controls to the Dominican–Franciscan comparison. Column (1) pools the two orders in a single OLS regression over 1450–1800: the Dominican elasticity is 0.69 and the Franciscan one is 0.02. Column (2) adds the distance-to-Paris control, column (3) replaces it with macro-region fixed effects and the cell's city population in 1300, and column (4) includes all three. The Dominican coefficient falls to 0.36 but stays significant at the one percent level in every column, while the Franciscan coefficient never exceeds 0.16 and is not significant once every control is in. Column (5) explains scholar output by the *composition* of the local mendicant mix rather than by its size, taking $\log(1+\text{Dom}) - \log(1+\text{Fra})$ (Dominican Tilting) as the regressor and holding fixed the total mendicant density, the region, the medieval population, and the distance gradient. Nothing in this specification compares mendicant-rich places to mendicant-poor ones: it compares places whose mendicant houses leaned Dominican to places where they leaned Franciscan. The coefficient on that difference is also 0.16.

Even at the same overall mendicant density, the places whose friars taught the *Summa* produced more scientists than the places whose friars followed Bonaventure, Scotus, and Ockham.

Table B.26: The Dominican–Franciscan differential: conditioning the horse race.

	(1)	(2)	(3)	(4)	(5)
log(1+Dom)	0.688^{a} (0.113)	0.611^{a} (0.112)	0.396^{a} (0.115)	0.361^{a} (0.112)	
log(1+Fra)	0.017 (0.070)	−0.051 (0.070)	0.162^{c} (0.093)	0.097 (0.090)	
Dominican tilt					0.159^{c} (0.091)
log(1+Dom+Fra)					0.360^{a} (0.090)
log(1+dist. Paris) control	No	Yes	No	Yes	Yes
Macro-region FE	No	No	Yes	Yes	Yes
log(1+city pop. 1300)	No	No	Yes	Yes	Yes
N (grid cells)	148	148	148	148	148

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Unit of observation: the 148 grid cells of Table B.21. Outcome: log(1+Science-cluster scholars active 1450–1800). Dominican stock: refined v5 inventory (Appendix A.7). Franciscan stock: Moorman (1983) as digitized by Boranbay and Guerriero (2019). "Dominican tilt" is log(1+Dom) − log(1+Fra). Macro-regions: Iberia, France, Italy, British Isles, Low Countries, Central Europe, Scandinavia, Southeast. City population 1300 aggregates Bosker et al. (2013) city populations over the cell.

Counts, Zeros, and the Full Grid. The 148-cell frame used in Subsection 4.5 and in the subsections above keeps only cells with at least five RETE scholars, which selects the sample on the outcome. The $\log(1 + x)$ transformation of a count with many zeros is known to behave badly (Chen and Roth, 2024). Table B.27 therefore re-estimates the design as a Poisson model of the count itself on the full European grid, keeping every cell that contains at least one Bosker city, mendicant house, or RETE scholar and including the 59 percent of cells that produced no Science-cluster scholar at all. Macro-region fixed effects and medieval city population enter every column. The Poisson elasticity is 0.98 at two degrees and 0.81 at one degree. The control-function columns instrument the Dominican stock with distance from Paris and add the residual from that first stage to the count regression. On the full grid the first stage is strong, with heteroskedasticity-robust F of 74 and 35, and the instrumented elasticities are 2.0 and 3.4. The count models bracket the headline 2SLS estimate of Table B.21 and do so without selecting cells

on the outcome and without logging the count.

Table B.27: Poisson estimates on the full European grid, including zero-scholar cells.

	(1)	(2)	(3)	(4)
	2° cells		1° cells	
	Poisson	Poisson CF-IV	Poisson	Poisson CF-IV
log(1+Dom)	0.981[a] (0.181)	2.020[a] (0.508)	0.809[a] (0.184)	3.370[a] (0.596)
Macro-region FE	Yes	Yes	Yes	Yes
log(1+city pop. 1300)	Yes	Yes	Yes	Yes
First-stage F	n/a	74.3	n/a	34.6
Share of cells with zero scholars	0.59	0.59	0.66	0.66
N (grid cells)	291	291	726	726

Notes: Sig.: [a]$p < 0.01$, [b]$p < 0.05$, [c]$p < 0.10$. Outcome: count of Science-cluster scholars active 1450–1800 in the cell. Poisson QML with heteroskedasticity-robust standard errors. The control-function (CF-IV) columns add the residual from the first stage of log(1+Dom) on log distance from Paris, with bootstrap standard errors (500 cell resamples). Grid universe: all cells between 35–62°N and 10°W–30°E containing at least one Bosker et al. (2013) city, mendicant house, or RETE scholar. Macro-region fixed effects and log(1 + city population 1300) included throughout.

What the Instrument Can and Cannot Identify. Distance-to-origin instruments can return significant estimates even when the spread they are meant to capture did not follow distance (Zhao, 2023; Kelly, 2019). The best way to learn what the Paris gradient picks up is to run the design from every origin it might have had. Appendix B.5.6 below does that twice, once by replacing Paris with each of the large European cities recorded in the 1500 population panel (Figure B.19) and once by re-running the Paris IV controlling for distance to each named rival origin (Table B.32). The same appendix reports the IV in levels under macro-region fixed effects and population controls, with weak-instrument-robust confidence sets (Table B.31). Those exercises show that the IV in levels summarizes a corridor gradient rather than a Paris gradient, so identification does not rest on it alone. It rests on the conditioned horse race and the count models on the full grid reported above, on the timing evidence of Figure 15 in Subsection 4.5, and on the dissolution test that follows.

The Dissolution Test. If the Dominican effect works through the order's continuing presence (its preaching, its inquisitors, its libraries in operation), it should vanish where the institution was destroyed. If instead it works through what the order had already put in place (the trained people, the teaching traditions, the books), the medieval stock of houses should go on predicting science after the buildings were seized. The Reformation ran this experiment: England and Wales dissolved every mendicant house in 1536–1540, Sweden from 1527, Denmark–Norway in 1536, Scotland in 1560, and the northern Netherlands in 1572–1580. Table B.28 compares the two groups on the grid frame, classifying each cell by the confession of its territory around 1600 and dropping the confessionally mixed territories (Germany, Switzerland, Bohemia, Hungary), where any cell-level coding would be arbitrary.

The pre-1500 Dominican stock predicts scholars active 1550–1800 with an elasticity of 0.55 in Protestant cells and 0.46 in Catholic cells, and the interaction term in the pooled regression is a tight zero. Sixty years after the last friar left Cambridge or Uppsala, the cells where the *Summa* had been taught for three centuries were still producing more scientists, in the same proportion as in the lands where the order still operated. The curriculum outlived the buildings. That is what a human-capital channel predicts, and what a channel running through the order's continuing presence cannot explain. The result also disposes of the objection that the Dominican effect stands in for continuing Catholic patronage of science: the effect is at full strength exactly where that patronage had been expelled. Protestant universities, it bears remembering, did not discard scholastic method, and Melanchthon rebuilt the Lutheran curriculum around Aristotle (Kusukawa, 1995), so the Aristotelian training the Dominican network had seeded continued under new management.

B.5.5 Alternative Covariates and an Alternative Scientists Outcome

The comparison with Arruñada and López-Manuel (2026) suggests two checks on the distance-to-Paris design of Subsection 4.5. The first adds to my grid-cell specification a control for starting conditions of the kind they use in their regional analysis. The second runs my four-column

Table B.28: The dissolution test: Dominican stock and post-1550 science, by confession.

	(1) Pooled	(2) Protestant only	(3) Catholic only
log(1+Dom)	0.467^a (0.104)	0.551^a (0.162)	0.462^a (0.107)
log(1+Dom)× Protestant	0.064 (0.159)		
Protestant	0.622^a (0.222)		
log(1+city pop. 1300)	0.177^a (0.055)	0.153 (0.148)	0.181^a (0.059)
N (grid cells)	117	33	84
R^2	0.42	0.45	0.41

Notes: Sig.: $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Unit of observation: grid cells of the 148-cell frame, classified by the confession of their territory c. 1600. Protestant cells lie in Britain, the northern Netherlands, and Scandinavia, the territories where every mendicant house was dissolved by 1580. Catholic cells lie in Iberia, Italy, France, the southern Low Countries, Ireland, Austria, and Poland. Confessionally mixed territories (Germany, Switzerland, Bohemia, Hungary) are dropped. Outcome: log(1 + Science-cluster scholars active 1550–1800).

design on their regional frame, swapping the RETE Science-cluster outcome for their alternative measure of scientists: notable individuals active in discovery and science from the cross-verified Wikipedia/Wikidata database of Laouenan et al. (2022), assigned to the region where each scientist died.

Table B.29 reports the grid-cell specification with the outcome and instrument of Table B.21, adding a control for starting conditions: the log count of RETE scholars active in the cell before 1200, which plays the role of the year-1000 scientist stock in Arruñada and López-Manuel (2026). Latitude is left out on purpose. Over a European grid, distance from a single point and latitude move together almost exactly, so a latitude control would soak up the instrument's variation mechanically. Zhao (2023) documents this trap in the "distance from" family of instruments.

The 2SLS coefficient is 1.51, against 1.45 in the baseline of Table B.21. Adding this control reduces first-stage power. The first-stage F in this specification is 6.1 under heteroskedasticity-robust standard errors. The pre-1200 stock of scholars was itself concentrated near Paris, so taking it out removes part of the variation. The point estimate holds up, and that is what the check is for: holding fixed where medieval scholarship already stood in 1200 does not change

Table B.29: Distance-to-Paris IV with added covariates: RETE Science-cluster scholars, 1450–1800.

	(1) First stage log(1+Dom)	(2) Reduced form log(1+Sci)	(3) 2SLS log(1+Sci)	(4) OLS log(1+Sci)
log(1+dist Paris)	-0.323^{b}	-0.488^{a}		
	(0.131)	(0.120)		
log(1+Dom)			1.512^{a}	0.571^{a}
			(0.371)	(0.077)
Initial-condition control	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	2SLS	OLS
First-stage F	6.1	n/a	6.1	n/a
N (grid cells)	148	148	148	148

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Robust standard errors in parentheses. Unit of observation: $2° \times 2°$ grid cell with at least five RETE scholars active 1450–1800, as in Table B.21. Control for starting conditions: log count of RETE scholars active in the cell before 1200. Instrument: log great-circle distance from Paris.

what the Dominican network predicts about where science stood after 1450.

Table B.30 turns to the alternative outcome. The unit of observation is the NUTS-2 region of Arruñada and López-Manuel (2026). The outcome is the log count of Laouenan et al. (2022) notable scientists dying in the region between 1450 and 1800. The treatment is their standardized measure of Dominican exposure (the share of a region's population living within 25 km of a Dominican house, weighted by the HYDE population grid and averaged over 1300–1500). Franciscan exposure, their geographic controls other than latitude (ruggedness, landlockedness, land suitability), and the year-1000 scientist stock enter every column.

The pattern matches the grid results. OLS puts the Dominican coefficient at 0.79. 2SLS raises it to 2.20. A different scientists dataset, built from Wikipedia rather than from university rosters, assigned by place of death rather than by place of work, on administrative regions rather than grid cells, and with exposure weighted by population rather than counted. The sign, the movement from OLS to 2SLS, and the Dominican–Franciscan asymmetry all come out as they do in the RETE design.

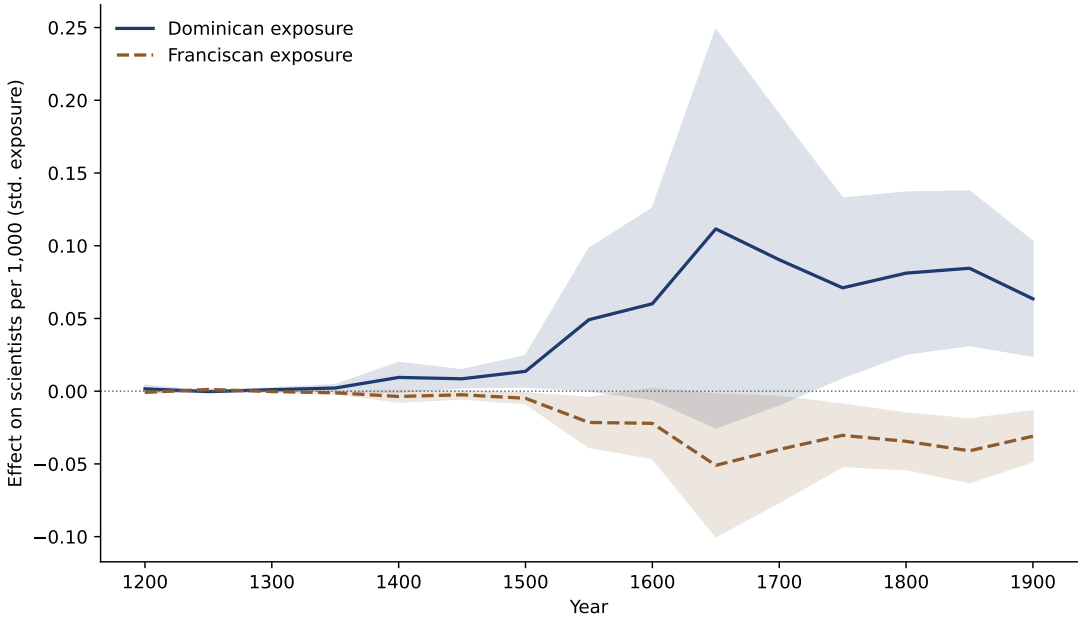
Table B.30: Distance-to-Paris IV on the regional frame: notable scientists, 1450–1800.

	(1) First stage	(2) Reduced form	(3) 2SLS	(4) OLS
	Dom. exposure (std.)	log(1+Sci)		
log(1+dist Paris)	−0.363[a]	−0.797[a]		
	(0.118)	(0.183)		
Dominican exposure (std.)			2.195[a]	0.790[a]
			(0.504)	(0.194)
Franciscan exposure	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Initial-condition control	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	2SLS	OLS
First-stage F	9.5	n/a	9.5	n/a
N (NUTS-2 regions)	323	323	323	323

Notes: Sig.: [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$. Standard errors clustered at the country level in parentheses. Unit of observation: NUTS-2 region (data from Arruñada and López-Manuel, 2026). Outcome: log(1+count) of notable scientists (Laouenan et al., 2022, fields Discovery and Science, assigned to region of death) over 1450–1800. Treatment: standardized Dominican exposure (HYDE-population share within 25 km of a Dominican house, averaged over 1300/1400/1500). Geographic controls: Franciscan exposure, ruggedness, landlockedness, land suitability. Control for starting conditions: scientists per 1,000 in 1000 CE. Instrument: log great-circle distance from Paris.

Figure B.18 shows an OLS regression of scientists per 1,000 inhabitants on the standardized Dominican and Franciscan population-weighted exposures together. The figure is the population-weighted version of the horse race in Figure 15C. The Dominican path is zero before 1500 and positive and growing after, while the Franciscan path is negative from 1500 onward. Dividing by population is what pushes the Franciscan coefficient below zero rather than to zero: the regions with Franciscan houses and no Dominican ones are populous, and at the same exposure they produce few scientists for their size, so the Franciscan zero of the count specification becomes a negative effect once the outcome is per head.

Figure B.18: Population-weighted horse race



Notes: Each point is the coefficient on standardized order exposure (share of regional HYDE population within 25 km of a house, averaged over 1300/1400/1500) from one OLS regression per 50-year period. The outcome is scientists per 1,000 inhabitants (Laouenan et al., 2022, assigned to region of death), and both exposures enter together, with absolute latitude, ruggedness, landlockedness, land suitability, the year-1000 scientist stock, and country dummies. Shaded bands are 95 percent confidence intervals from standard errors clustered at the country level. Unit: NUTS-2 regions, European sample of Arruñada and López-Manuel (2026) ($N = 323$).

B.5.6 Robustness of the Dominican Design

Here I show further robustness checks: the levels IV under region fixed effects and population controls (with weak-instrument-robust confidence sets), the placebo-origins exercise, the event study on the timing of placement, and city growth as an outcome.

Region fixed effects, population controls, and Anderson–Rubin sets. Table B.31 re-estimates the headline 2SLS of Table B.21 adding macro-region fixed effects, the cell's Bosker et al. (2013) city population in 1300, and both. The point estimate moves from 1.45 to between 1.78 and 1.81 and is stable, but the controls take away much of the variation: the first-stage F falls from 19.4 to 4.9 under heteroskedasticity-robust standard errors. Every column therefore also reports an Anderson–Rubin confidence set, which stays valid however weak the instrument

is. Those sets are bounded away from zero throughout, with lower bounds between 0.75 and 1.04. The estimates that do not lean on the Paris gradient are in Appendix B.5.4.

Table B.31: The levels IV under region fixed effects and population controls.

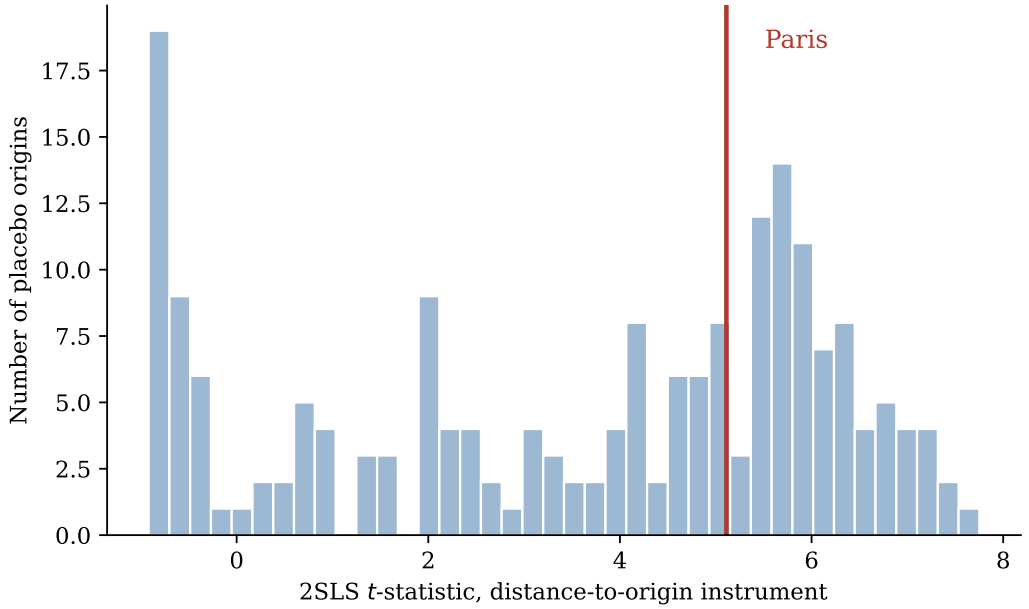
	(1) Baseline	(2) + Region FE	(3) + Population	(4) + Both
2SLS: log(1+Dom)	1.451^{a} (0.284)	1.779^{a} (0.570)	1.809^{a} (0.670)	1.797^{b} (0.886)
AR 95 % confidence set	[1.04, 2.38]	[1.00, 4.29]	[1.00, ∞)	[0.75, ∞)
Macro-region FE	No	Yes	No	Yes
log(1+city pop. 1300)	No	No	Yes	Yes
First-stage F	19.4	10.7	5.7	4.9
N (grid cells)	148	148	148	148

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Same frame, outcome, treatment, and instrument as Table B.21 (v5 Dominican inventory). The Anderson–Rubin row inverts the robust AR test over a grid of candidate coefficients. A right bracket of ∞ means the set is unbounded above at the search limit.

Placebo origins. Figure B.19 reruns the baseline 2SLS replacing Paris with each of the 195 European cities recorded with at least ten thousand inhabitants in 1500 in the Bosker et al. (2013) panel. About two-thirds of these origins deliver a heteroskedasticity-robust first-stage F above ten and a 2SLS coefficient significant by the usual standard, and Paris sits at the 62nd percentile of the t-statistic distribution. Distance to almost any point in the northwest-European core recovers the corridor gradient, which is exactly the caution of Zhao (2023) and Kelly (2019). Table B.32 reports the more demanding exercise on ten named alternatives: Rome, Bologna, Cologne, Oxford, Mainz, Wittenberg, London, Madrid, Vienna, and Kraków. The left columns use the alternative as the instrument, and the right columns re-run the Paris IV *controlling* for log distance to the alternative. The Paris coefficient stays positive against every alternative and lies between 0.9 and 1.8. It stays significant against nine of the ten. Bologna, whose solo first stage exceeds Paris's own, leaves it significant at the one percent level. Mainz, the print origin, is the exception: with log distance to Mainz in the regression the Paris estimate falls to 0.922 with a standard error of 0.616. What the Paris instrument cannot do, and is not asked to do, is

separate the Thomistic curriculum from everything else the northwest-European corridor held. That is the job of the Franciscan differential and the dissolution test in Appendix B.5.4 above.

Figure B.19: Distribution of placebo 2SLS t-statistics across 195 alternative origins.



Notes: Each observation is one placebo origin: a Bosker et al. (2013) European city with recorded population of at least ten thousand in 1500. For each origin, the baseline 2SLS of Table B.21 is re-estimated with log distance to that origin as the instrument. The histogram shows the resulting t-statistics, with Paris marked.

Placement timing. Figure B.20 reports a Callaway and Sant'Anna (2021) event study of scholar production around the first Dominican foundation in a cell. It gives one coefficient for each quarter century before and after the foundation, uses cells that never received a house as the comparison group, and covers the periods from 1000 to 1800. The coefficients before the foundation are negative and rise monotonically toward the foundation date.

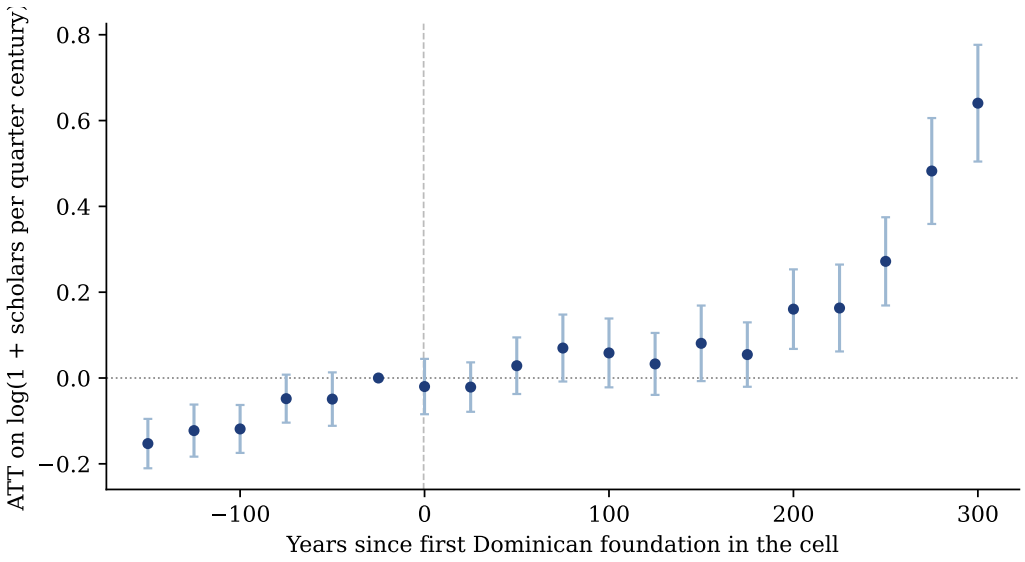
City growth. Table B.33 estimates the Dominican effect on city population growth in the Bosker et al. (2013) panel: growth over 1500–1800 and over 1700–1800 among cities recorded at ten thousand or more inhabitants at both ends, and crossing the ten-thousand mark by 1800 among cities below it in 1500. All the coefficients are zeros with tight standard errors. The network that predicts scientist production does not predict ordinary urban growth. Section 5

Table B.32: Named alternative origins: solo placebos and Paris-conditional estimates.

	Alternative origin as instrument		Paris IV, controlling dist. to alternative	
Origin	2SLS coef.	First-stage F	2SLS coef.	First-stage F
Paris (baseline)	1.451^{a} (0.284)	19.4	n/a	n/a
Rome	0.747^{a} (0.148)	21.1	1.630^{a} (0.320)	19.5
Bologna	1.067^{a} (0.167)	64.7	1.754^{a} (0.453)	15.1
Cologne	1.743^{a} (0.312)	26.0	1.000^{c} (0.519)	7.7
Oxford	1.351^{a} (0.281)	26.0	1.602^{a} (0.478)	6.8
Mainz	1.692^{a} (0.279)	57.2	0.922 (0.616)	6.7
Wittenberg	2.295^{a} (0.661)	13.0	1.291^{a} (0.317)	16.9
London	1.469^{a} (0.290)	21.9	1.423^{a} (0.470)	6.6
Madrid	−0.241 (0.388)	6.0	1.806^{a} (0.326)	17.1
Vienna	1.144^{a} (0.287)	26.0	1.487^{a} (0.300)	20.5
Krakow	1.081 (0.824)	2.3	1.450^{a} (0.280)	20.5

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Left columns: baseline 2SLS with log distance to the named origin as instrument. Right columns: 2SLS with the Paris instrument, adding log distance to the named origin as an exogenous control. Frame and outcome as in Table B.21.

Figure B.20: Event study: scholar production around the first Dominican foundation.



Notes: Callaway and Sant'Anna (2021) estimator with never-treated controls, no covariates. Units: the full-grid cells of Table B.27 (152 cells first treated by 1500, 38 never treated). Outcome: log(1 + RETE scholars active in the quarter century). Cohort: quarter-century of the cell's first dated Dominican foundation. Bars are 95 percent confidence intervals from 500 cell-level bootstrap resamples.

takes up why that pattern favors an effect on the thin upper tail of human capital over one in which Dominican presence is a proxy for urbanization.

Table B.33: Dominican stock and city population growth, 1500–1800.

	(1)	(2)	(3)	(4)
	Δ log(pop.) 1500–1800		Δ log(pop.) 1700–1800	Entry by 1800
	OLS	OLS	OLS	OLS (LPM)
log(1+Dom within 25 km)	0.012	0.032	0.012	0.015
	(0.139)	(0.166)	(0.051)	(0.031)
log(initial pop.)	-0.162^{c}	-0.179^{b}	-0.070^{a}	n/a
	(0.089)	(0.088)	(0.024)	
Geography & university by 1500	No	Yes	Yes	Yes
Country FE	No	Yes	Yes	Yes
First-stage F, dist. to Paris	1.3	2.2	3.6	0.2
N (cities)	164	164	281	481

Notes: Sig.: $^{a}p < 0.01$, $^{b}p < 0.05$, $^{c}p < 0.10$. Heteroskedasticity-robust standard errors in parentheses. Unit: Bosker et al. (2013) European cities. Treatment: log(1 + Dominican houses within 25 km), v5 inventory. Columns (1)–(2): Δ log population 1500–1800, cities with recorded population (≥ 10,000) in both years. Column (3): the same for 1700–1800. Column (4): linear probability of recording ≥ 10,000 inhabitants by 1800 among cities below the threshold in 1500. The first-stage row reports the regression of log(1 + Dominican houses within 25 km) on log(1+km from Paris) in each column's own sample with that column's controls and fixed effects, with the robust F given as the squared t-statistic on the instrument. The instrument has no power at the city level in any of the four samples, so no 2SLS column is reported.

C Theological Appendix

C.1 The Devil and the Natural Philosophers

This appendix presents the case studies summarized in Subsection 3.4.

Theophrastus Bombastus von Hohenheim, known as Paracelsus (c. 1493–1541), publicly burned Avicenna's *Canon* at Basel in 1527, treated miners for their occupational diseases in the Tyrol, and wrote some two hundred treatises in German. Writing in the vernacular was itself a challenge to the Latin monopoly of the universities. The devil runs through nearly all of it

(Ball, 2006; Moran, 2019). The portrait Augustin Hirschvogel engraved in 1538 bore a Latin motto, *Omne donum perfectum a Deo, imperfectum a Diabolo*, or "Every perfect gift is from God, every imperfect [gift] from the Devil." The phrase comes from the Epistle of James (1:17), but Paracelsus turns it into a rule of method. A physician who wants to heal must know which gifts belong to God's order and which to diabolical disorder.

His treatise *De causis morborum invisibilium* (c. 1531–32, Paracelsus (1933, Part I, vol. 9)) takes up directly what a physician should do when occult or magical knowledge promises a cure. Paracelsus answers that practical knowledge of natural effects belongs to God's creation, whatever route the physician took to it. The devil does not create. He imitates and corrupts. "We should not accord such an honor to the devil. For what could possibly please him more … than receiving such praise as when we say that he [rather than God] is the one who has done this?" (Paracelsus, 2008, 911). Aquinas had made the same argument three centuries earlier: what looks supernatural may be merely natural, but only the devil knows how to produce it. Paracelsus sharpened Ovid's maxim into a harder rule: one should learn even from the devil. Ball (2006) states the paradox. Contemporaries accused Paracelsus of being in league with the devil precisely because he claimed knowledge that exceeded received authority. His own theology insisted on the opposite: to credit the devil with healing power was to dishonor God.

Paracelsus drew a line between natural magic, which works through hidden virtues God had implanted in creation, and openly diabolical practice, which he condemned. In *De causis morborum invisibilium* he sorted the invisible diseases into classes, and spiritual and demonic causes counted among them as proper medical categories, even while he denied the devil any power to act in the natural world. He set himself consistently against the university physicians, who traced every illness to an imbalance of the bodily humors, and against the popular magicians, who gave the devil too much credit (Webster, 1982; Debus, 1977). Paracelsus did not dismiss the devil. What separated him from the demonologists was his refusal to let the devil come first in any explanation. He stood at the threshold of the change: demons were still real to him, but by insisting that every effect traces back to God's creative order he was already moving toward

a science with no necessary role for the devil.

Johannes Kepler's involvement with the devil was literary and personal at once. In his *Somnium* ("The Dream"), composed around 1608 and published posthumously in 1634, Kepler made a fictional daemon the narrator of a journey to the Moon. The hero's mother, a healer named Fiolxhilde, summons a spirit at a crossroads, and the spirit describes the astronomy of the lunar surface. The daemon explains how travelers are chosen, noting with dark humor that "we especially like dried-up old women, experienced from an early age in riding he-goats at night or forked sticks" (Kepler, 1967). Most of the book is the daemon's account of Copernican astronomy as it would look from the Moon, which puts the case for heliocentrism in the mouth of the devil's agent.

The device cost Kepler dearly. Fiolxhilde resembled his own mother, Katharina, who was known locally for mixing herbal drinks. When a manuscript copy of the *Somnium* circulated in Tübingen around 1611, it "fueled the rumour" that Katharina was a witch (Connor, 2004). In 1615, Katharina was accused of witchcraft during a wave of witch trials in Leonberg (Rublack, 2015). The fable her son had written was introduced at her trial "as evidence of both Katharina's and Johannes's odious associations with the devil" (Connor, 2004). Kepler himself was viewed in some quarters as "far worse" than his mother, "a witch himself, a follower of Copernicus and a heretic" (Connor, 2004). Katharina spent fourteen months in prison, chained to the floor of her cell, and was subjected to the *territio verbalis*, in which a torturer showed her the instruments and warned her what refusing to confess would bring. She refused, and the Duke of Württemberg ordered her acquitted in 1621. After her release, Kepler spent the rest of his life annotating the *Somnium* so that no reader could miss that it was an allegory.

René Descartes (1596–1650) put one of the most famous devil-figures in the history of philosophy into the First Meditation of his *Meditationes de Prima Philosophia* (1641). He imagined that an all-powerful and cunning evil demon (the *malin génie*) might be deceiving him about the very nature of reality, so that "the sky, the air, the earth, colours, shapes, sounds and all external things are merely the delusions of dreams" (Descartes, 1984, p. 15, AT VII 22). The *malin génie*

was a philosophical device rather than a statement of demonological belief, but it shows how readily the devil came to hand when an early modern writer wanted to frame a basic question about knowledge and perception. Newton, as Snobelen (2004, 179) observes, would have had no need for Descartes' demon: since evil spirits did not exist in Newton's mature system, "the banishment of evil spirits would have allowed him to avoid the natural philosophical anxieties caused by Descartes' demon, who for Newton did not exist to deceive human perception."

Isaac Newton wrote over one million words on theology, nearly all of it unpublished in his lifetime. Recent scholarship has found how much of that writing went to the devil: his nature, his reality, and his eventual dismissal. Newton's position on Satan moved a long way over his career, from orthodox belief in a literal devil to a radically heterodox denial of evil spirits (Snobelen, 2004).

In the General Scholium appended to the second edition of the *Principia Mathematica* (1713), Newton wrote: "This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being." Studying natural law was for him a way of reading the mathematical principles God had embedded in creation (Dobbs, 1991). In his early prophetic writings from the 1670s, Newton treated Satan as a real being, writing that "the Apocalyptic Dragon is a very proper emblem as well of ye Roman Emperors & Empire … as of ye Devil that arch-enemy to mankind" (Yahuda MS 1.1a, fol. 38r, quoted in Snobelen, 2004, 163).

By the mid-to-late 1680s, Newton had shifted to a non-literal view. "the old Serpent was no more a real serpent then ye Dragon in ye Apocalyps is a real Dragon … Tis only a symbol of the spirit of delusion" (Yahuda MS 9.1, fol. 20v, quoted in Snobelen, 2004, 165). In a 1692 letter to John Locke, Newton stated flatly that the language of casting out demons "was ye language of ye ancients for curing Lunatics" (quoted in Snobelen, 2004, 169–170). His late writings made the equation explicit: "To forsake the Devil is to forsake the worship of Demons or Ghosts & of all fals Gods whatsoever collectively called the Devil" (Keynes MS 3, p. 43, quoted in Snobelen, 2004, 173). As Snobelen (2004, 174) observes, Newton's final position was "almost identical to

the Jewish teaching of *yetzer ha-ra* ('the evil inclination'), in which sinful desires are personified as Satan." In May 1694, when Newton came upon a group of Cambridge scholars gathered outside a supposedly haunted house, he told them: "Oh! yee fools … will you never have any witt, know yee not that all such things are meer cheats and impostures?"[43] This position was serious heresy. Denial of the devil was, as Snobelen (2004, 157) puts it, "viewed as tantamount to atheism." Newton hid these views from all but a few trusted associates for his entire life.

Thomas Hobbes (1588–1679) devoted Chapter 45 of *Leviathan*, titled "Of Demonology, and Other Relics of the Religion of the Gentiles," to a sustained argument that belief in demons is a pagan inheritance contaminating Christianity. He traced the word "demon" from the Greeks through the Jews and into the early Church, and concluded that so-called demoniacs were simply people with mental illness: "they called Demoniacs, that is, possessed by the devil, such as we call madmen or Lunatics, or such as had the Falling-sickness, or that spoke anything, which they for want of understanding, thought absurd" (Hobbes, 1996, pt. IV, ch. 45, spelling modernized). The whole fourth part of *Leviathan*, "Of the Kingdom of Darkness," is built around what Hobbes calls the "Demonology of the heathen Poets" and the "fabulous Doctrine concerning Daemons, which are but Idols, or Phantasms of the brain, without any real nature of their own." His position on demons was one of the chief grounds on which he was accused of atheism in his lifetime, and later writers including Koerbagh and Bekker extended his arguments (Champion, 2012; Israel, 2001).

Henry More (1614–1687), the Cambridge Platonist and Newton's colleague, took the opposite view from Hobbes. Book III of his *An Antidote against Atheism* (1662, first edition 1653) collects and verifies accounts of witchcraft, demonic possession, and spectral apparitions as empirical evidence that spirits exist. Anyone who denied spirits, More argued, was opening the door to atheism. He reported the story of an Elizabethan witch who, "when she was called upon to repent and forsake the Devil, said there was no reason for that, for he had been faithfull to

[43] The original source is the diary of Abraham de la Pryme, published by the Surtees Society (Durham, 1870), vol. 54, p. 42.

her these threescore years, and she would be so to him so long as she lived, and thus she died in this obstinacy" (More, 1662, III.2). He gave chapters to "the most remarkable exploits of that invisible Devil of Mascon" (More, 1662, III.3) and to the "supernaturall effects which are observed in them that are bewitch'd or possess'd," symptoms that "can be no symptomes nor signes of any thing else but of the Devil got into the body" (III.4, with the spelling of the 1653 first edition). Henry (2025) describes More's return to "the reality of spiritual phenomena as revealed in accounts of witchcraft, apparitions, and the like" as a central feature of his later natural theology. More's insistence on the reality of evil spirits was part of the intellectual atmosphere in which Newton formed his own heterodox denial of the devil.[44]

The oddest meeting of science and the devil in the 17^{th} century may be the campaign by leading members of the Royal Society to collect empirical evidence of witchcraft, demons, and evil spirits. Robert Boyle (1627–1691), the founder of modern chemistry, believed in a separate supernatural order and actively sought experimental proof of its reality. Boyle and his correspondents gathered accounts of poltergeists, witches, second sight, and other supernatural phenomena from across Scotland and England, looking for the kind of empirical proof that would satisfy London's skeptics (Hunter, 2009, 2001).

Boyle's Cambridge ally Henry More stated the logic of the project: "No Spirit, no God."[45] If evil spirits could be established empirically, that would confirm the reality of the spiritual world and refute atheism. Joseph Glanvill, a Fellow of the Royal Society and chaplain to Charles II, took the project furthest.[46] His *Saducismus Triumphatus* (1681) tried to put belief in the devil

[44] Snobelen (2004, 157) observes that "More shared Glanvill's position on evil spirits and witchcraft and the editing of the latter's *Sadducismus Triumphatus* (1681) is attributed to him."

[45] More's full sentence, at the close of the preface to the *Antidote*: "that Saying was nothing so true in Politicks, No Bishop, no King, as this is in Metaphysicks, No Spirit, no God" (More, 1662, preface).

[46] The Society's membership included devil-believers and devil-deniers alike. Balthasar Bekker (1634–1698), a Dutch Reformed minister, was defrocked for arguing in his *De Betoverde Weereld* (1691–93) that spirits, being immaterial, could not act on the material world (Attfield, 1985; Israel, 2001). He was elected a Fellow of the Royal Society anyway, in July 1698, weeks after his death. Snobelen (2004, 170–75) places Newton in a line running from the Radical Reformation thinkers David Joris and Hans Denck, through the Dutch Mennonite Anthonie van Dale, to Bekker and Hobbes. In England, the Ranter Jacob Bauthumley had argued in 1650 that "Men fear a Devill without them, and so fancy him to be terrible in their apprehensions, never considering that he is in them" (Bauthumley, 1650). Newton's manuscripts show him using almost identical language half a century later.

on a scientific footing. Glanvill argued that those who denied the existence of witches and demons were modern-day Sadducees, and that their skepticism would lead inevitably to atheism. Denying demons was, in his words, a delusion inspired by the devil himself, "whose influences they will not allow in Actions ascribed to such Causes, hath a greater hand and interest in their Proposition than they are aware of" (Glanvill, 1668, 2–3). Glanvill went in person to investigate the "Demon Drummer of Tedworth," a poltergeist haunting that became a centerpiece of his book. The *Saducismus Triumphatus* later crossed the Atlantic and strongly shaped Cotton Mather's defense of the Salem witch trials (Webster, 1982, 75–103).

Cotton Mather (1663–1728) was a practicing natural philosopher and a devil-hunter at once. No one combined the two more completely. Elected a Fellow of the Royal Society in 1713 (one of the first Americans so honored), Mather kept up a large scientific correspondence with learned Europeans. He also wrote *The Wonders of the Invisible World* (1693), the single most influential defense of the Salem witch trials. Mather wrote that "the New-Englanders are a People of God settled in those, which were once the Devil's Territories."

C.2 Roger Bacon and Thomas Aquinas

The University of Paris in the mid-13th century was the intellectual center of Latin Christendom, and it was there that the newly translated works of Aristotle threw Christian thought into crisis. Two of the most important men who confronted that crisis were the Franciscan Roger Bacon (c. 1214–1294) and the Dominican Thomas Aquinas (1225–1274), both of whom read Aristotle closely and answered him in sharply different ways.

Roger Bacon arrived at Paris in the 1240s after studying at Oxford, where he absorbed the English tradition of interest in natural philosophy and mathematics. He lectured on Aristotle's *Physics* and *Metaphysics* while Church authorities were still trying to restrict the teaching of Aristotle's natural philosophy. Bacon concluded that Aristotle was wrong on many points. He named "four stumbling blocks to truth": undue reliance on authority, the force of custom, popular opinion, and the concealment of ignorance behind a pretense of knowledge. His *Opus*

Majus (1267), addressed to Pope Clement IV, called for sweeping reform, with less scholastic logic and more mathematics and experimental science (Bacon, 1928). His Franciscan order reportedly imprisoned him in 1278, possibly for his association with radical poverty movements. The earliest source for the imprisonment is the *Chronicle of the Twenty-Four Generals*, written a century later.

Thomas Aquinas came to Paris for his second term as master in 1268, at the height of the quarrel over the Latin followers of Averroes (Van Steenberghen, 1970). Where Bacon wanted to correct Aristotle by experiment, Aquinas wanted to reconcile him with faith by reason. His *Summa Theologica* works by posing a question, lining up the objections, and settling them by careful distinctions, the method Bacon found sterile. The synthesis worked so well that Aristotelian-Thomistic philosophy eventually became the official philosophy of the Catholic Church. Yet in 1277, just three years after his death, Bishop Étienne Tempier of Paris condemned 219 propositions associated with Aristotelian and Averroist teaching, some of them touching positions Aquinas himself had defended (Wippel, 1995; Bianchi, 1998). Appendix C.6 follows the sequence from condemnation to canon.

The contrast also reflects a broader difference between their religious orders. The Franciscans stressed Divine Omnipotence and the freedom of God's will, which meant that the natural world could not be fully understood by reason alone, since God was free to arrange it however He pleased. That emphasis opened space in principle for empirical research: if the world is the product of free divine choice and not of logical necessity, one has to observe it instead of deducing its structure from first principles. The Dominicans put more confidence in human reason. The space the Franciscan position left for observation does not show up in the geography of the two networks. Subsection 4.5 finds that Franciscan presence predicts scientists only as a proxy for Dominican presence, and that per capita it predicts fewer of them.

C.3 *Diabolus* and *Daemones*: Two Latin Registers of Evil

Latin Christian writing about evil draws together two distinct Greek inheritances and keeps them as separate words. *Diabolus*, from the Greek *diábolos* ("slanderer" or "accuser"), names one personified figure: Satan, the chief adversary, a metaphysical entity coextensive with the cosmic struggle between God and the fallen creation. *Daemon*, from the Greek *daimōn*, originally meant a divinity or guiding spirit (the *daimónion* that warned Socrates). In the hands of the church fathers it came to mean instead the lower-order spirits that act in the physical world, producing possessions, illnesses, weather events, and local mischief. The two words sit at different levels of the same metaphysical hierarchy: *diabolus* is the one adversary, and the *daemones* are his many subordinates, who work on matter. Russell (1981) and Kelly (2006) document the patristic consolidation of these two registers, and Frankfurter (2006) shows that Christian demonology grew not out of stamping out local spirits but out of absorbing them into the *daemones* category beneath *diabolus*.

The grammatical distinction entered canon law at the Fourth Lateran Council of 1215, whose canon *Firmiter* reads "*Diabolus enim et alii daemones a Deo quidem natura creati sunt boni*" ("The Devil and the other demons were indeed created good by God in their nature"). The drafters needed two words because the working theology requires two: the Devil is one and the demons are many. He is the metaphysical adversary, and they are the operators on matter. Russell (1984) and Kelly (2006) both treat the canon as the locus classicus of the medieval distinction.

The split between the two words sharpens at the Thomistic moment. Boureau (2006) argues that scholastic theologians took little systematic doctrinal interest in demons before the late thirteenth century, but that this changed with Aquinas's *De malo* (*c.* 1272) and with the questions on the angels (I, qq. 50–64) and on demonic activity (I, q. 114) in the contemporary *Summa Theologica*. The *daemones* now had a newly elaborated body of doctrine of their own: they are fallen angels with complete knowledge of natural causes, and they operate on matter by

manipulating physical processes rather than by supernatural fiat (see Subsection 3.1 of the main text). The Devil himself remains the singular cosmic adversary, and the demons become the agents that empirical inquiry can reach. Clark (1997) traces how the distinction flowered in the early modern demonological treatises of Bodin, Del Río, and Remy, and shows that early modern witch hunters drew far harder on the daemonological half of the doctrine than on the diabological half. Kieckhefer (1989) traces the same split in medieval magical practice: clerical necromancers invoked *daemones*, not the *diabolus*, because ritual was thought to work on the lower spirits and not on the Devil.

The textual record shows this divergence empirically. Figure 1 in Subsection 2.2 plots how often *diabol** and *daemon** appear per word across more than two hundred million words of medieval Latin from the second through the nineteenth centuries, and Appendix B.4.2 gives the corpus construction. The two stems track each other closely through the patristic and Carolingian centuries, then diverge between 1250 and 1300: *diabol** declines and *daemon** stays high. In light of the Thomistic synthesis the pattern has a natural reading: the *daemones*, the operators on matter, are what an empirical theology can investigate, and the volume of writing about them rises as that project takes shape. The *diabolus*, the singular cosmic adversary, belongs to the part of the doctrine that empirical inquiry cannot touch, and his vocabulary falls away as the demonological discussion narrows onto the lower spirits. Vernacular print shows the same pattern three centuries later. In the EarlyPrint English series (Figure B.13), the word "devil" remains a common popular term right through the early modern period while the Latinate "demon" stays rare. The separation of ranks is the same one the Latin record imposes on learned writing.

C.4 The Demonological Library

Table C.1 lists the principal early modern works on the devil and witchcraft, demonologist and skeptic alike. The list runs from Nider's *Formicarius*, written at the Council of Basel, to Cotton Mather's defense of the Salem trials, and it shows the debate this paper describes running in print for two and a half centuries. Physicians (Weyer), country gentlemen (Scot), and Jesuit insiders

(Spee) answered the prosecution manuals. By the late 17^{th} century the surviving defenders of the prosecutions were fellows of the Royal Society who argued their case by assembling collections of empirical evidence.

The chronology in the table matches the argument of the paper. The prosecution manuals cluster between 1487 and 1610, the period in which Aquinas's account of the devil spread through print, while the skeptical works appear within a generation of each manual and increasingly carry the day. Glanvill and Mather wrote the last major defenses of the prosecution framework, both in an openly empirical idiom and both from inside the Royal Society's orbit (Glanvill was a fellow, and Mather was elected in 1713). The skepticism the doctrine had created inside its own institutions turned on the doctrine itself.

C.5 Aristotle Over Time

Before the great wave of translations from Arabic that began in the 12^{th} century, the Latin West held only a tiny fraction of Aristotle's writings. What early medieval Europe knew of philosophy came almost entirely through Boethius (c. 477–524), who translated Aristotle's *Categories* and *On Interpretation* into Latin around 510–512. Those two texts, together with Porphyry's *Isagoge* and Boethius's own commentaries, made up the *logica vetus*, which was the whole of Aristotelian thought available to European Christians for roughly six centuries.

The fall of Toledo in 1085 changed that. Gerard of Cremona (c. 1114–1187) is credited by the memorial list of his students with seventy-one translations from Arabic into Latin, among them the *Posterior Analytics*, *Physics*, *On the Heavens*, *On Generation and Corruption*, and *Meteorology*. Michael Scot (c. 1175–1232) translated Averroes's great commentaries. William of Moerbeke (c. 1215–1286) worked directly from the Greek and completed the Latin Aristotelian corpus between roughly 1255 and 1278, including the first Latin translations of the *Politics* and the *Poetics*. Aquinas built his system largely on Moerbeke's translations. Van Steenberghen (1970) traces the arrival of the corpus in the Latin West, and Grant (1996) follows it into the university curriculum. Table C.2 gives the timeline.

Table C.1: Principal early modern works on the devil and witchcraft.

Work	Author	Year	Position	Argument
Formicarius	Johannes Nider, O.P.	c. 1437	Demonologist	Early compendium of witchcraft accounts. Among the first to portray witches as an organized sect and to emphasize female witches.
Malleus Maleficarum	Heinrich Kramer (Institoris), O.P.	1487	Demonologist	The most influential witch-hunting manual. Systematized the diabolism theory of witchcraft (pact, sabbat, *maleficium*). About sixteen editions by 1520 and some thirty by 1669.
De praestigiis daemonum	Johann Weyer	1563	Skeptic	Physician to the Duke of Cleves. The accused suffer from melancholy, not pacts. Demons are real but cannot grant magical powers.
De la démonomanie des sorciers	Jean Bodin	1580	Demonologist	The political philosopher's defense of witchcraft prosecution. It attacks Weyer directly.
The Discoverie of Witchcraft	Reginald Scot	1584	Skeptic	Witchcraft confessions and wonders are delusion or conjuring trickery. An early manual of stage magic.
Daemonolatreiae libri tres	Nicolas Rémy	1595	Demonologist	Casebook by the Lorraine judge who claimed to have condemned hundreds of witches.
Daemonologie	James VI of Scotland	1597	Demonologist	Royal treatise defending witch-hunting against Scot and Weyer.
Disquisitionum magicarum libri sex	Martín Del Río, S.J.	1599–1600	Demonologist	Encyclopedic synthesis. The standard reference on demons and witchcraft in the Counter-Reformation.
Compendium maleficarum	Francesco Maria Guazzo	1608	Demonologist	Illustrated compendium of witch lore for confessors and judges.
Cautio Criminalis	Friedrich Spee, S.J.	1631	Skeptic	Insider's attack on torture-driven trials, published anonymously: the procedure manufactures its own evidence.
Leviathan, Part IV	Thomas Hobbes	1651	Skeptic	"Of the Kingdom of Darkness": demonology is a pagan inheritance, and the possessed are the mentally ill.
Saducismus Triumphatus	Joseph Glanvill	1681	Demonologist	Royal Society fellow's empirical case collection for witchcraft and apparitions. To deny spirits is the first step to atheism.
De Betoverde Weereld	Balthasar Bekker	1691–93	Skeptic	Cartesian minister: spirits, being immaterial, cannot act on matter. Defrocked for the argument.
Wonders of the Invisible World	Cotton Mather	1693	Demonologist	Defense of the Salem trials by the Boston divine, elected FRS in 1713.

Notes: "Demonologist" marks works that defend the reality of witchcraft or the legitimacy of prosecuting it. "Skeptic" marks works that attack the prosecutions, the rules of evidence they used, or the doctrine about demons behind them. Years are those of first publication. Sections 3.1 and 3.4 discuss several of these works.

Table C.2: Availability of Aristotelian texts in Latin translation

Period	Texts Available	Translator(s)
c. 510–512	*Categories*, *On Interpretation*	Boethius
c. 510–512	*Isagoge* (Porphyry)	Boethius
c. 1120–1150	*Posterior Analytics*, parts of *Metaphysics*	James of Venice
c. 1150–1187	*Physics*, *On the Heavens*, *On Generation and Corruption*, *Meteorology*, *Posterior Analytics*	Gerard of Cremona
c. 1150–1160s	*De Anima*, *Metaphysics* (via Avicenna)	Gundissalinus
c. 1220–1230	Averroes's commentaries on Aristotle	Michael Scot
c. 1255–1278	*Politics*, *Poetics*, revised corpus	William of Moerbeke

C.6 From Condemnation to Canon

The earliest sign of Thomistic demonology in institutional practice comes long after the *Summa Theologica* (1265–1274), and the delay reflects how contested Aquinas's thought was at first. His synthesis spent roughly fifty years under attack before it had the authority to reshape practice. Within three years of Aquinas's death, the Paris and Oxford condemnations of 1277 placed some Thomistic theses under censure and threatened excommunication (Wippel, 1995; Bianchi, 1998). The *Correctoria* controversy filled the years 1278–1285: William de la Mare's *Correctorium Fratris Thomae* (1278) censured 118 Thomistic theses (Glorieux, 1927), and the Franciscan General Chapter of 1282 forbade study of the *Summa* without critical annotations (Fussenegger, 1933). Even inside the Dominican order, general chapters had to legislate adherence again and again (1278, 1279, 1286, 1309, 1313) (Burbach, 1942). Iribarren (2020) dates a second stage of Thomism to 1300–1323, in which the general chapter of Metz (1313) declared that the doctrine of Thomas "is reputed the sounder and the more common" (*sanior et communior reputetur*) and strictly forbade friars to hold the contrary in lecturing, determining, or responding (Reichert, 1899, vol. II, p. 64).

Full rehabilitation came with Aquinas's canonization on July 18, 1323, and with the 1325 revocation of the Paris condemnation insofar as it touched his teachings (Foster, 1959; Maier, 1968; Denifle and Chatelain, 1891). Only then did Thomist doctrine carry genuine authority

beyond the Dominican order (Iribarren, 2020). The *Summa* did not replace Peter Lombard's *Sentences* as the standard theology textbook until the 16^{th} century (Rosemann, 2007), and before that it spread through commentaries derived from it and through the Dominican *studia*, the order's own schools.

The late-14^{th}-century evidence from the Cathedral of Murcia fits this chronology: *rogativas* are documented there in 1376 and *conjuros* from 1406, one to two generations after Thomism won institutional dominance in the 1320s. By then the clerical infrastructure trained in Thomistic demonology was in place across Catholic Europe. Figure 13 in Subsection 4.5 maps that infrastructure, plotting the 782 Dominican houses founded by 1500 by foundation cohort. Appendix A.7 describes the inventory.

C.7 Monasteries and Economic Growth

Recent work examines the economic consequences of medieval monasteries. The closest result to this paper is Cantoni et al. (2018), who show that the Reformation moved resources out of the religious sector and into the secular one by expropriating monasteries, shifting human capital from theological to secular training. That is a later instance of the curriculum shift I document: where the Thomistic revolution changed the *content* of theological education (from Platonic to Aristotelian), the Reformation changed its *destination* (from religious to secular institutions).

Heldring et al. (2021) show that the Dissolution of the English Monasteries under Henry VIII created land markets that accelerated agricultural innovation and industrialization, evidence that removing monastic institutions had lasting economic effects, though through property rights rather than through the human capital channel I emphasize. Andersen et al. (2017) argue that Cistercian monasteries spread values of hard work and thrift centuries before the Reformation, though Sonntag (2023) raises concerns about the robustness of the causal estimates. Rossignoli and Trombetta (2024), using Domesday Book data, show that Benedictine-governed holdings had higher productivity growth after the Norman Conquest, which suggests that how a monastery was governed mattered for economic outcomes. Doucette and Møller (2021) find that towns near

Cluniac monasteries were more likely to set up autonomous town councils, which provided an institutional template for lay political organization.

C.8 ...of Wealth and Taste

Explanations of the Industrial Revolution fall into two broad families: those that ground the break in economic and institutional conditions (wealth), and those that ground it in culture, ideas, and preferences (taste). The division is rough, and the most persuasive recent accounts draw on both, but it organizes the debate and shows where this paper fits.

The wealth family explains the timing and location of industrialization by material incentives and institutional constraints. Allen (2009) argues that Britain went first because high wages and cheap coal made labor-saving, energy-using technology profitable there and nowhere else. The spinning jenny and the steam engine were worth inventing only at British factor prices. Wrigley (2010) locates the break in the move from an organic economy, bounded by what the land yielded each year, to a mineral-energy economy drawing on accumulated stocks of coal. From a comparative direction, Pomeranz (2000) reaches a similar conclusion: the most advanced regions of China and Europe were on comparable paths until 1750, and Europe escaped the ecological constraint they shared through coal and the windfall resources of the Americas. The institutional branch of the family looks at limits on expropriation rather than at prices: North and Weingast (1989) argue that the constitutional settlement of 1688 made the English state's promises credible and lowered the cost of capital, and Acemoglu et al. (2005) put secure property rights and limits on executive power at the foundation of long-run growth. North (1990) gives the general framework in which institutions set the incentives that make innovation worth undertaking.

The taste family holds that prices and property rights, necessary as they are, cannot explain why the useful knowledge being applied had accumulated in the first place. Mokyr (2002, 2016) argues that the Industrial Revolution required an "Industrial Enlightenment": a culture that valued producing and spreading propositional knowledge about nature in a systematic way, embodied in a Republic of Letters that crossed borders and in cultural entrepreneurs like Francis

Bacon, who persuaded Europeans that such knowledge was the proper measure of progress. McCloskey (2010) pushes the cultural argument further: neither trade, nor coal, nor institutions can account for the scale of the enrichment. What changed was the rhetoric of bourgeois life: innovation and commerce became honored activities rather than despised ones. Squicciarini and Voigtländer (2015) provide the quantitative bridge between the two families. French regions with denser upper-tail knowledge elites, measured by *Encyclopédie* subscriptions, grew faster exactly when industrial technology arrived, while average literacy mattered little. Growth came from knowledge elites (taste) meeting new production opportunities (wealth). Becker and Woessmann (2009) make the parallel move for the Protestant human capital channel, and Rosenberger (2024) shows that access to useful knowledge, measured by how far Enlightenment encyclopedias spread, contributed directly to the acceleration of growth during the Industrial Revolution.

This paper enters on the taste side of the ledger, but it pushes the origin of the relevant preferences back five centuries and names the institution that taught them. The Thomistic settlement described in Sections 2 and 3 changed what educated Europeans wanted to know: it made the investigation of natural causes a religious duty, wrote that duty into the standard university curriculum, and spread it through the mendicant network mapped in Subsection 4.5. On this reading, the high wages and cheap energy of the wealth family explain why the accumulated knowledge was applied in 18^{th}-century Britain rather than somewhere else, while the curriculum shift documented here helps explain why a continent-sized stock of empirically trained minds was there to be applied at all. The two families are complements: taste set the direction of European curiosity, and wealth set where that curiosity paid.

C.9 Disproving Aristotle

Across medieval Europe, what Aristotle said about motion, matter, the elements, the heavens, and the nature of life was treated as authoritative. Aristotelian physics came apart slowly from the 16^{th} century on, and that dismantling was one of the defining features of the Scientific Revolution. In several cases the overthrow of one Aristotelian doctrine led directly to a major

practical invention.

C.9.1 The Vacuum, Atmospheric Pressure, and the Steam Engine

No Aristotelian doctrine was held more firmly than *horror vacui*: "nature abhors a vacuum." In the *Physics* Aristotle argued that a void was logically impossible: motion in a vacuum would meet no resistance and would therefore be instantaneous, which he took to be absurd (Aristotle, 1984, IV.8, 215a–216a). For two millennia almost nobody questioned the principle, Galileo included (Grant, 1981).

The break came in 1643, when Evangelista Torricelli ran his mercury experiment in Florence. He took a glass tube sealed at one end, filled it with mercury, inverted it over a dish of mercury, and watched the column fall and settle at about 76 centimeters above the surface. The space above the column was a vacuum, the first ever created in a laboratory. Torricelli wrote to Michelangelo Ricci on June 11, 1644, "We live submerged at the bottom of an ocean of the element air" (Middleton, 1964).

What these experiments taught about atmospheric pressure was the direct foundation of the steam engine (Cardwell, 1971). Once it was clear that the atmosphere pushes with a force of roughly 14.7 pounds per square inch, it became conceivable to put that force to work by creating a vacuum mechanically. Thomas Newcomen built the first practical atmospheric engine at Dudley Castle in 1712: steam entered a cylinder and was condensed by a spray of cold water, leaving a partial vacuum into which the atmosphere drove a piston. James Watt's later improvements refined the technology without altering that principle. Nobody could have conceived the steam engine before Aristotle's denial of the vacuum was overthrown.

C.9.2 The Microscope and the Germ Theory of Disease

Aristotle's biology assumed that everything alive was large enough to see with the naked eye. His theory of disease, like that of Galen and Hippocrates, ran on the four humors rather than on outside agents (Nutton, 2004). The compound microscope, invented in the late 16^{th} century,

opened a world Aristotle could not have imagined (Ruestow, 1996). Antony van Leeuwenhoek, working with single-lens microscopes he built himself, was the first to see bacteria and protozoa in the 1670s (Dobell, 1932). Robert Hooke's *Micrographia* (1665) showed the cellular structure of plant tissue (Hooke, 1665). These discoveries gave Pasteur and Koch the observations on which they built the germ theory of disease in the 1860s and 1870s. Without the microscope, the Aristotelian and Galenic medicine of the humors could not have been challenged.

C.9.3 The Evil Eye and Optics

Work on the evil eye (*mal de ojo*, *fascinatio*) was one of the longest-running programs of optical research in medieval and early modern Europe, and the demonological framework this paper describes drove it directly. The evil eye put the Thomistic three-way question in sharp form: was it a natural phenomenon, a demonic illusion, or a genuine supernatural power?

The theory behind it was Aristotelian. Aristotle's account of perception in *De Anima* and *De Sensu* held that vision works through a medium (air or water) that passes the form of the object to the eye. A competing tradition, rooted in Plato's *Timaeus* and worked out by Euclid and Ptolemy, held instead that the eye sends out visual rays that reach the object. Medieval writers took something from each, and many scholastics accepted that the eye both receives and, in the right conditions, emits. The principle underneath was Aristotelian reciprocity: a faculty that can receive a quality can also produce it. If light can act on the eye, the eye can also send something out. Reciprocity made the evil eye physically conceivable within Aristotle's own physics: a person of corrupt disposition could send harm out through the eyes, just as the eyes of a menstruating woman were widely believed to tarnish mirrors (Aristotle, BCE, ch. 2, 459b–460a).

Aquinas addressed the evil eye directly in *Summa Theologica* (I, q.117, a.3, ad 2), where he argued that the eyes can indeed alter nearby objects by giving off something physical, not by supernatural power but by natural processes working through the medium. On this account, intense emotion in the soul (anger, envy, desire) could alter the body's humors, and the humors

in turn altered what the eyes gave off. The effect was natural, not demonic. But if it was natural, it was open to empirical investigation: one could ask how strong the effect was, at what distance it operated, through what medium, and whether it could be blocked or deflected.

That question drove some of the most important optical research of the medieval period. Roger Bacon gave the problem substantial attention in his *Opus Majus* (1267), drawing heavily on the Arabic optical tradition that came through the same translation pipeline described in Subsection 2.3. The decisive figure was Ibn al-Haytham (Alhazen, c. 965–1040), whose *Kitab al-Manazir* (*De Aspectibus* in Latin) established the intromission theory of vision on experimental grounds: light enters the eye, and the eye emits nothing. Alhazen's work reached Europe in Latin translation in the early 13^{th} century and was studied by Bacon, John Pecham, and Witelo, who together were the *perspectivisti*, the medieval school of optics. Their research steadily undermined the extramission theory, the view that the eye sends rays out. With it went the physical basis for the evil eye.

Claims of harm by the eye also reached the tribunals, and there the doctrine supplied the categories rather than the optics. An inquisitor had to ask whether a reported effect had a natural cause, whether it was a demonic illusion, or whether anything genuinely supernatural had occurred. Alonso de Salazar Frías, the inquisitor discussed in Subsection 4.3, put questions of that kind to the Basque accusations and found nothing he could substantiate. The optical work itself belongs to the universities and to the *perspectivisti* described above, and the tribunals were the users of what that work established.

The chain from the evil eye to optical instruments runs through four links. The *perspectivisti* (Bacon, Pecham, Witelo) studied Alhazen's intromission theory to settle how vision works, and worked out the mathematics of refraction and magnification along the way (Lindberg, 1976). Bacon set out the principles of magnifying lenses in Part V of his *Opus Majus*: "we can so shape transparent bodies, and arrange them in such a way with respect to our sight and objects of vision, that the rays will be refracted and bent in any direction we desire, and under any angle we wish we shall see the object near or at a distance" (Bacon, 1928, Part V, vol. II, pp. 581–

582). That knowledge was put to practical use when the first spectacles were manufactured in northern Italy around 1286, creating a lens-grinding industry in Florence and Venice that lasted for centuries (Ilardi, 2007). Dutch spectacle-makers, heirs to that trade, produced the first telescope in 1608, which Galileo turned on the heavens in 1609, overturning Aristotelian cosmology. The same craft produced the compound microscope that Leeuwenhoek and Hooke used to lay the observational foundations for germ theory. The evil eye was never disproved the way *horror vacui* was. What made it implausible was the optical knowledge that investigating evil eye claims had helped produce.

C.9.4 The Patio Process: New World Metallurgy Beyond Aristotle

The Age of Discovery brought Europeans up against practical problems on which Aristotelian natural philosophy offered no guidance. Aristotle's theory of metals, set out at the end of *Meteorology* III (378a), held that metals form from two "exhalations" trapped underground, one dry and smoky and one moist and vaporous, and that their proportions fix the metal's properties. Gold differs from lead because the balance of exhalations differs. On this account the character of a metal was settled when it formed and could not be altered by human art. The theory also said nothing about the chemistry of processing an ore.

The patio process (*beneficio de patio*), invented by Bartolomé de Medina at Pachuca, Mexico, in 1554, violated these Aristotelian assumptions at every step. Workers mixed crushed ore with salt, water, copper sulfate (*magistral*), and mercury, then spread it across an open courtyard. Over six to eight weeks a series of chemical reactions turned the silver in the ore into native metal, which combined with the mercury into an amalgam. Heating the amalgam to approximately 350–400°C drove off the mercury for reuse and left pure silver behind.

The process contradicted Aristotelian metallurgy in three ways. First, the exhalation theory predicted nothing about how mercury could selectively dissolve silver from a complex ore, a chemical specificity that Aristotle's framework could not accommodate. Second, Medina's key innovation was an empirical finding. He discovered that copper sulfate was needed in the Ameri-

cas because Mexican ores lacked the natural pyrites present in Spanish ones. No theory predicted it. It came out of the systematic trial and error that Thomistic theology had encouraged. Third, the process showed that human art could extract silver from ores too poor for natural smelting, a direct challenge to the Aristotelian principle that art imitates nature but cannot surpass it. That is the question at the center of the scholastic art-nature debate that Newman (2004) documents: if human technique can accomplish what natural processes cannot, then the line between the natural and the artificial, a line central to Aristotle's metaphysics, is not where he drew it.

The knowledge behind Medina's invention had European roots. A German metallurgist known as "Maestro Lorenzo" told Medina, while he was still in Spain, that silver could be extracted using mercury and brine (Bakewell, 1971; Bargalló, 1955). Medina took this knowledge to New Spain and adapted it by experiment. The economic consequences were large: the patio process made it possible to extract silver from ores containing as little as 0.04 percent silver (Brading and Cross, 1972), and Spanish American silver production quadrupled in the 1570s once the method spread (Garner, 1988). From the mid-16^{th} century to the end of the colonial era, the mines of Spanish America produced between 3 and 3.5 billion ounces of silver, roughly 100,000 metric tons, and the region was the world's leading supplier throughout (Garner, 1988, p. 898). TePaske (2010) assembles the registration data that place this output in its global context. Viceroy Francisco de Toledo called the pairing of the Potosí silver mines with the mercury mines at Huancavelica "the most important marriage in the world" (Zimmerman, 1938).