Innovation and the Medieval Church

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Abstract

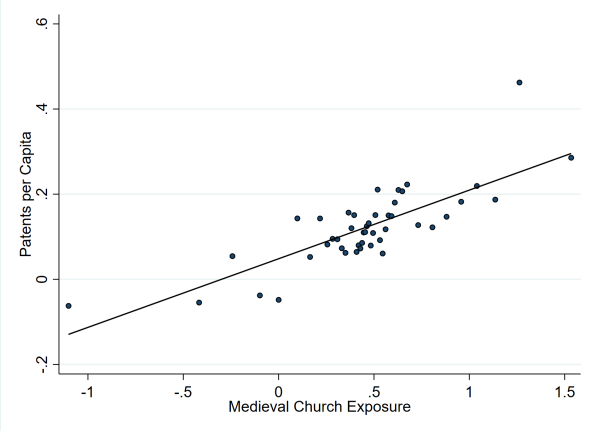
We investigate the long-run impact of the medieval Catholic Church on European innovation by testing the hypothesis that the Church fostered creativity by increasing regional connectivity and transforming social organization, beginning at the family level. Using event-study and triple-difference designs from 500 to 1500 CE, we show that the spread of the Western Church led to a sustained increase in the production of notable creatives relative to non-creatives. We provide evidence that the reconfiguration of social organization was a key mechanism underlying this historical effect. Church exposure increased regional connectivity, measured by the migration of notable individuals, while creative output and connectivity rose following the diffusion of Church policies targeting marriage and the family. Specifically, creative output increased after local bishops attended councils ratifying marriage and family legislation, whereas attendance at placebo councils' yielded no impact. We trace the persistence of these effects into the modern era (1980–2014), demonstrating that historical Church exposure robustly predicts contemporary innovation (measured by patents and modern creatives). Finally, exploring mechanisms of persistence, we link medieval Church exposure to contemporary variation in family structure, social networks and psychology (e.g., trust) and confirm links between these three measures to innovation.

Keywords: cultural evolution, innovation, medieval church

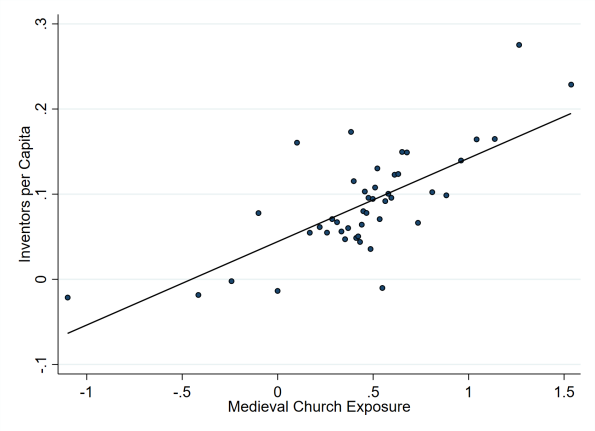
JEL Classification: Z12, O31, N33, Z13

1 Introduction

Here's a curious fact: Figure 1 shows the positive correlations between a European region's exposure to the medieval Western Church (500 to 1500 CE) and two measures of modern innovation (1980-2014 CE), one based on patents per capita (Panel A) and a second based on inventors per capita (Panel B). Using roughly $50km^2$ grid cells, regions that experienced more centuries under the medieval Church (500-1500 CE) produce more patents and inventors per capita today. An increase of one century of medieval Church exposure is associated with an increase of 22 patents and 7 inventors, with exposure varying from 0 to 10 centuries. This relationship is particularly eye-brow raising given recent research suggesting that religiosity inhibits innovation (Benabou et al., 2015; Bénabou et al., 2022; Andersen and Bentzen, 2024; Squicciarini, 2020) and the fact that our predictor variable–exposure to the medieval Western Church–reaches across some five centuries (from 1500 to 2000 CE) to account for variation in modern innovation. Could medieval religious institutions, practices and/or beliefs contribute to explaining contemporary patterns of innovation (Becker et al., 2024)?



(a) Patents per Capita



(b) Inventors per Capita

Figure 1: Relationship between exposure of the medieval Western Church (500-1500 CE) and contemporary patents and inventors per capita (binned scatter plot). See below details on data sources.

To investigate this puzzling pattern, we test the Church-Innovation Hypothesis using both historical and contemporary measures of creative production (Henrich, 2020; Mitterauer and Chapple, 2010; de la Croix et al., 2018; Greif, 2006b; Greif, Mokyr and Tabellini, 2025). This hypothesis proposes that the medieval Western Catholic Church fostered conditions conducive to creativity by both weakening kin-based organizations (e.g., clans) and establishing broader regional connections rooted in common cultural practices. These complementary changes opened the door to a freer flow of individuals and ideas through an expanding network across Western Europe. Specifically, the Church gradually rewired local social structures through its policies surrounding marriage and family (e.g., bans on consanguineous, polygamous and levirate marriage), slowly dissolved the intensive kin groups of pre-Christian Europe (e.g., kindreds) into monogamous nuclear families. These grass-roots changes in social structure combined with the diffusion of a shared language (Latin), customs (e.g., burial practices), weekly rituals

and supernatural beliefs (e.g., contingent afterlives) to increase people's geographic mobility and the fluidity of their social ties (i.e, relational mobility (Thomson et al., 2018)), thereby expanding their social networks and shifting their psychology towards greater impersonal trust, fairness, non-conformity, universal morality and individualism (Schulz et al., 2019; Enke, 2019; Bergeron, 2020; Greif and Tabellini, 2010, 2011). Such changes in both social networks and aspects of psychology expanded the flow of ideas, accelerating the rate of recombinative innovation (Andrews, 2019; Posch et al., 2025; El Ghoul et al., 2023; Algan and Cahuc, 2014; Lissoni and Miguelez, 2024; Nguyen, 2025; de la Croix et al., 2026a). Thus, the Church may have inadvertently produced fertile conditions for greater creativity and innovation.

Of course, the Church may have also stimulated innovation through other channels, including through its impact on political institutions (state capacity), universities, market scale, and economic growth (Grzymała-Busse, 2023; de la Croix et al., 2026b). These other channels are complementary to the mechanisms emphasized by the Church-Innovation Hypothesis (Mitterauer and Chapple, 2010; de la Croix et al., 2018; Greif, Mokyr and Tabellini, 2025) and, by some accounts, are quite important, but causally downstream from the grassroots transformations at the core of the Church-Innovation Hypothesis (Henrich, 2020). We explore the role of these complementary mechanisms empirically below.

Our exploration of the link between the medieval Church and innovation unfolds in two parts. In Part I, our historical analyses uses event study designs to assess the relationship between the arrival of the Church on regional trends in creativity from 1 to 2010 CE. In Part II, our contemporary analyses examines the relationship between medieval Church exposure and three contemporary measures of creativity. In both sections, we consider potential mechanisms, exploring the role of social networks, regional connectivity and the Church's policies surrounding marriage and the family. Our primary proxy for Church exposure derives from the historical diffusion of Latin bishoprics across Europe from 500 to 1500 (Schulz et al., 2019; Schulz, 2022).[1] We rely primarily on the diffusion of bishoprics because they are most suitble for events studies, but also consider the role of monasteries (Andersen et al., 2017) as another marker expansion of the Church.

To develop a proxy for creativity that can be used throughout the Middle Ages and into the modern world, we exploit a global database of notable historical figures (Laouenan et al., 2022). We focus on the roughly 850,000 individuals located in Europe between 1 and 2010 CE and allocate each to a 1.5° square grid cell. Based on their occupations or domains of contribution (developed by the database creators), we assigned them to the category 'creatives' (e.g., authors, inventors, artists, etc.) or 'non-creatives' (e.g., clergy, politicians, nobles and generals). Historically, we use the relative production of creatives vs. non-creatives as a measure of creativity; in the modern world, we place it alongside two standard patent-based measures of creativity.

[1] Bishoprics form the core of the Church's administrative organization and bishops were responsible for implementing the decisions and policies established by either the councils of bishops, who met periodically to govern the Church, or the Pope, to whom they eventually swore an oath of obedience (after 1075 CE). The term 'bishopric' refers to the institution, which includes the office of the bishop, the collection of clerical offices under his administration, and the territory governed by this organization. Thus, the diffusion of bishoprics during the medieval period offers a good proxy for the reach and influence of what eventually became the Roman Catholic Church (Grzymała-Busse, 2023).

In Part I, our historical analysis proceeds in three parts. First, to link Church exposure to creativity, we use an event study design that combines the data on notable individuals at the grid cell level in a triple difference estimation. Specifically, we interact three predictor variables: (1) ever-having-a-bishopric (ever treated), (2) when the bishopric arrived, and (3) classification as 'creative' vs. 'non-creatives.' We include fixed effects for periods, locations and, crucially, period X location. This approach isolates the impact of Church exposure by accounting for all time-varying effects in each 1.5 degree grid cell. These fixed effect should absorb variation due to local urbanization, ecology, conflict, plague and any other time-varying location-based conditions. By controlling for the production of non-creatives, we mitigate concerns about factors that might increase the likelihood of individuals entering the historical record, such as the presence of scribes, the survival of documents and the local population size (*ceteris paribus*, larger populations should produce more notables). The identifying assumption here requires that, absent Church exposure, the *ratio* of creatives to non-creatives would not have trended differently.

This triple difference analysis shows that the arrival of bishoprics resulted in an increase in the production of creatives relative to non-creatives that becomes significant at conventional levels after roughly two centuries. The size of the bishopric effect continues to increase for a millennium, achieving nearly an order of magnitude increase in the relative rate of production of creatives. No trends are are visible prior to the arrival of bishopric. Separate event analyses focused on creatives and non-creatives shows that the effects observed in the triple difference estimation arise from an increase in the production of creatives over time. Church exposure shows no effects on non-creatives.

To explore the mechanisms behind this relationship, we consider those emphasized by the Church-Innovation Hypothesis alongside several complementary mechanisms including those related to urban growth, rising state-capacity, universities and expanding markets. The Church-Innovation Hypothesis predicts that the Church's arrival would have fostered greater social fluidity, releasing people socially and psychologically from the bonds and responsibilities of their kin groups, untying them from their ancestral lands (pre-Christian rites often demanded propitiation rituals for ancestors) and encouraging them to seek more socially (and genetically) distant marriages with fellow Christians. Thus, the spread of the medieval Church opened the door to a freer flow of people and ideas through the Christianizing regions of Europe.

To assess whether Church exposure increased people's mobility, we present two analyses using the data on notables. First, to capture how the network of a location (a node) changes when a bishopric arrives, we use the birth and death locations of notables to calculate the network centrality for every grid cell in Europe for every half-century. Then, in an event study design that analyzes what happens in the wake of a bishopric's arrival, we demonstrate that roughly two centuries after the Church's arrival, there is a distinct uptick and acceleration in a region's network centrality. This rise continues for at least a millennium, resulting in roughly 25 additional links across Europe. Second, focusing on the connections (the links), we show that when two locations been exposed to the Church, the likelihood of a link between them (a notable migration) rises exponentially over time. Together, these results suggest that the spread of the Church increased the flow of notables through a network that together

episcopal hubs.

To more directly assess the role of the Church's marriage and family policies, we studied the historical influence of the attendance of bishops at early Church councils, termed synods, which were held periodically around Europe during the Middle Ages (mostly in the Frankish realms). These synods discussed and ratified new Church policies. Each such council addressed several issues, but sometimes included legislation related to marriage and the family. Due to the vagaries of travel in this era and because these councils were sometimes organized regionally, rather than administered by the Church (which wasn't fully centralized), the attendance of bishops at different synods generated within-Church variation in when and where marriage and family legislation was formulated, promulgated and implemented. Exploiting this variation, we use the same event study design to estimate the effect of a bishop first attending a council where marriage and family legislation was discussed ('MF synods') and compare this to attending those where such policies were not discussed ('non-MF synods'). The analysis suggests that roughly 150 to 300 years after a bishop first attends an MF synod, the production of creatives and network centrality. Crucially, we don't observe such take-offs for attendance at synods where such policies were not discussed.

The Church-Innovation Hypothesis also points to a role for the new monastic orders that emerged in Europe at the end of the Early Middle Ages (Henrich, 2020). Forged in the wake of the spread of bishoprics and the Church's dissolution of intensive kinship, members of the new monastic orders renounced their family ties (unlike earlier such orders) and pledged themselves as 'brothers' in a new self-governing community. These monastic franchise operations may represent one of the channels through which the Church instilled Christian practices, effectively strengthening the power of bishops and establishing connections among European regions (Andersen et al., 2017). In exploring this, we found two patterns. First, we confirm that the longer a region has hosted a bishopric, the more likely that region is to have a monastery. This holds individually for each of the five different monastic orders for which we have data and for all of them together. Second, the greater the number of monasteries (of any kind) in a region, the more creatives (relative to non-creatives) are produced in 1600 CE and the higher the region's network centrality (this holds in any later century as well). [2]. In the production of creatives, medieval Church exposure and the number of monasteries reveal similar effect sizes: a standard deviation increases in either is associated with an increase of roughly a quarter of a standard deviation in creatives.

In exploring complementary mechanisms that might explain the influence of bishoprics on creativity, we considered roles for (1) urban populations size, (2) state-capacity, (3) market expansion, (4) universities and (5) direct investment by the Church. Our data suggest that the founding of bishoprics may stimulate both the subsequent development of state capacity and urban population growth as well as the founding of universities. Crucially, however, our proxies for these mechanisms suggest that they lag the observed rise in creatives and, when controlled for, do not substantially alter our main results.

Building on these historical analyses, our contemporary analysis in Part II combines patent data with the

[2]We cannot conduct an event study because monastic houses (within orders) proliferated too rapidly and we often lack solid date

notables data to measure innovation and creativity from 1980 to 2014. First, we aim to establish a robust correlation between our Church exposure measure and three finely-grained measures of creativity: (1) patents per capita, (2) inventors per capita, and (3) the share of famous creatives relative to all notables. Using these as outcomes, we estimate a battery of OLS models using a grid cell's duration of Church exposure as our key predictor variable. The results confirm that the relationship shown in Figure 1 is robust across specifications that include a variety of geographic, demographic and climatic controls, subnational region fixed effects, and sundry historical variables, including the presence of Roman roads and distance to Wittenberg. Even in our most stringent specification, a standard deviation increase in medieval bishopric exposure is associated with an increase of 0.08 standard deviations in patents per capita.

While the triple difference analysis in Part I deals with potentially omitted variables, here we address endogeneity concerns by taking advantage of the fact that Europe's many wars unpredictably disconnected some bishoprics from the larger Papal community for long periods of time, often centuries. These disruptions included pagan uprisings on the Slavic fringes, Viking invasions in northern England and Islamic conquests in Spain and Italy (examples below). To exploit this quasi-randomness, we constructed two exposure measures, one capturing the years since the founding of the bishopric and a second capturing the length of any intervening disruptions. If the Church, for example, systematically targeted regions with high creative potential, our initial exposure measures should remain predictive but not the latter (where one would expect no effect). Empirically, we not only find large positive coefficients for the total time since founding but also negative coefficients for the length of the disruptions. This mitigates, but doesn't eliminate, concerns about omitted variables in this part of the analysis.

To explore the mechanisms underlying the relationship between Church exposure and innovation, we conduct three sets of analyses. First, to complement our historical analyses of the impact of the Church's marriage and family legislation, we analyzed the relationship between the attendance of medieval bishops at councils where marriage and family legislation was discussed and our three measures of contemporary innovation. The analyses show that European populations in places where medieval bishops happened to attend more such councils are more creative today. By contrast, the attendance of medieval bishops at synods that didn't address such issues reveals no relationship to creativity. In our most stringent specification, a standard deviation increase in the attendance of bishops at synods that discussed marriage and family legislation is associated with 0.12 of a standard deviation increase. Attendance at other synods reveals no relationship to our creativity measures.

Second, the Church-Innovation hypothesis suggests that the Church's influence on creativity persist due, at least in part, through its enduring impacts on family organization, social structure and key psychological traits like trust (Henrich, 2020). By comparing only subnational regions within countries in the modern world, we confirm that greater Church exposure predicts the (1) prevalence of nuclear families, (2) broader social networks (based on Facebook friends over 100km away) and (3) four aspects of psychology: individualism, non-conformity, impersonal trust and impersonal fairness (Schulz et al., 2019). We also link the attendance of early medieval bishop at synods

where marriage and family legislation was ratified to these social and psychological traits.

Closing the loop, we confirm that the prevalence of nuclear families, the breadth of social networks and all four aspects of psychology also predict patents per capita, inventors per capita and the share of famous creatives.

Our exploration unfolds over the next five sections. Section 2 lays out relevant theoretical background material, aiming to integrate research on religion, innovation and European economic history. Section 3 covers data and measurement, detailing our measures of medieval Church exposures and creativity. Section 4 presents Part I of our results, laying out our historical analysis. This section begins with a battery of event studies, including a triple difference analysis, that confirms the impact of an arriving Latin bishopric on subsequent creativity. We then explore a range of potential mechanisms. Section 5, shifting to contemporary world, presents Part II of our results. We first establish robust correlations between the duration of Church Exposure and our three measures of creativity and then explore mechanisms of persistence.

2 Theoretical Background and Relevant Literature

In this paper, we aim to contribute to an enduring question: how and why do religions influence innovation and creativity (Weber, 1958; Goody, 1983; Mitterauer and Chapple, 2010; Becker et al., 2024). Our efforts in this paper lie at the confluence of several different research streams, including research on the origins of innovation, the medieval Church's role in the 'Rise of the West,' and the connections between different religions and innovation across time and space.

At the core of our approach the empirical claim many if not most innovations involving recombining existing ideas, techniques or approaches (Weitzman, 1998; Jones, 2023a; Youn et al., 2015; Clancy, 2018; Jones, 2023b; Glaeser et al., 2004), often propelled by social interaction among individuals with different skills, expertise, perspectives, experiences and know-how (Akcigit et al., 2013, 2018; Page et al., 2019; Koschnick et al., 2022; de la Croix et al., 2018; Mokyr, 1995; Moser and San, 2020; Jacobs, 1985; Andrews and Lensing, 2022). This proposal suggests that any customs, institutions, practices, beliefs, psychological inclinations or organizations that increase the frequency of interactions among diverse minds can fuel greater innovation and creativity. For example, recent work on historical U.S. innovation (1850 to 1940) shows how rising cultural diversity, as captured by surnames, led to more interactions among strangers, higher patenting rates, and more breakthrough inventions (Posch et al., 2024). Similarly, Andrews (2019) shows how the closure of saloons during America's Prohibition Era resulted in less patenting among saloon-loving ethnic groups, who couldn't meet at the local water-holeto swap ideas. Lastly, this view contributes to understanding why immigrants–who bring diverse ideas and approaches with them–so powerfully stimulate innovation (Moser and San, 2020; Burchardi et al., 2019).

2.1 The medieval Church and the 'Rise of the 'West'

Within the context of European history, several scholars have argued that the spread of the medieval Catholic Church altered the pre-Christian institutions and customs of European populations in ways that fostered greater social interaction, intermarriage and residential mobility among families, regions, towns and tribes (Greif and Tabellini, 2010, 2011; Mitterauer and Chapple, 2010; Henrich, 2020; Goody, 1983; Greif, Mokyr and Tabellini, 2025). Indeed, the Church may have operated to stimulate diverse social interactions and creative recombinations by operating on both the supply and demand sides of European communities. On the supply side (Grzymała-Busse, 2023; Mitterauer and Chapple, 2010), the Church offered a common language, shared values, organizational infrastructure (monasteries, churches), funding and occupational opportunities (e.g., monks). On the demand side, the Church's promulgation of prohibitions and prescriptions related to marriage and the family—a process that began in Late Antiquity—may have slowly dissolved Europe's intensive kin-based institutions (e.g., clans) into monogamous nuclear families. These prohibitions and prescriptions included bans on polygamy, cousin marriage, concubinage, arranged marriage and levirate marriage as well as new rules favoring bilateral inheritance and neolocal residence.[3] Released from the responsibilities and obligations of of intensive (or 'tight') kinship, which included care for the infirmed, injured and elderly as well as arrangements for marriages, individuals would have had both greater freedom and greater needs to form ties with distant strangers (Greif, 2006a,b; Henrich, 2020). For example, in their comparison of the intergenerational transmission of craft skills in Europe vs. other Eurasian societies, de la Croix et al. (2018) show how interactions among diverse teachers and learners—masters, apprentices and journeymen–in Europe's non-kin-based guilds would have fueled more rapid technical improvements across many domains.[4]

In considering the impact of the medieval Church, including it's policies related to marriage and family, it's important to recognize that these may have influenced the subsequent construction of political, legal, economic and educational institutions. Schulz (2022), for example, shows how the Church, and specifically the Church legislation surrounding marriage and the family, may have spurred the rise of representative governments or participatory assembles. These self-governing towns, often merchant towns, favored more market-friendly legislation (Stasavage 2011, 2020) and were more likely to obtain seats in the national Parliament, strengthening its governing role (Angelucci, Meraglia & Voigtländer, 2023). As we'll show below, the arrival bishoprics is associated with the subsequent founding of universities, which facilitated the flows of academics and ideas around Europe (de la Croix et al., 2026b) and may have fostered the rise of markets through the creation of legal frameworks and the production of lawyers Cantoni and Yuchtman (2014). Of course, the first guilds emerged as religiously-based mutual

[3]Bilateral inheritance occurs when children inherit identity and/or property roughly equally from both parents. This is distinguished from traditionally more common forms of inheritance such as patrilineal or matrilineal inheritance. Neolocal residence refers to a form of post-marital residence in which new households are setup after marriage with neither the parents of the bride nor the groom (Murdock, 1949).

[4]Focusing on universities, de la Croix and Goñi (2021) argues for a decline in nepotism based on an analysis of father-son pairs from 1088 to 1800. In addition to demonstrating a general decline in nepotism, the data shows that nepotism was lower for position that had to be approved by the Church (theology) and at Protestant academic institutions.

aid organizations (offer social insurance, filling the role traditionall done by kin networks) and later evolved into occupation-based organizations.

At a macro-level, the rise of the Church as a pan-European institution offered a competing authority structure for secular political leaders. The medieval Church created a second power center—bishops with their own courts and tax rights—which forced monarchs to professionalize secular bureaucracies and clarify property rights (Grzymala-Busse 2023). At the same time, Europe's political fragmentation – particularly within the Holly Roman Empire – then supplied what Mokyr (1990, 2016), Jones (1981) and Landes (1998) call an "exit option": innovators could escape hostile princes by moving across nearby borders, a dynamic confirmed by spatial models of the Industrial Revolution (Desmet, Greif & Parente 2020).

2.2 Religion and Innovation

This approach intersects with a growing body of work that examines the relationship between religion, innovation and other economic outcomes (Berkes et al., 2023; Benabou et al., 2015). Focusing on contemporary innovation across countries and US states, Bénabou et al. (2022) show that greater religiosity, measured with survey questions, is robustly associated with less innovation as captured by patents per capita.[5] Historically, several of studies of the pre-industrial world have considered the impact of religion on innovation (Squicciarini, 2020; Squicciarini et al., 2014). For example, focusing on Europe from 1300 to 1940, Andersen and Bentzen (2024) connects a family's religiosity, assessed primarily using first names, to the likelihood of children becoming scientists, engineers or scholars (holding advanced degrees) and link declining religiosity to rising patent rates across cities. The authors exploit the quasi-random occurrence of earthquakes, which increase religiosity, to identify a causal relationship between religiosity and engagement in innovative occupations.

More broadly, several studies have examined the influence of religion on factors thought to contribute to innovation, including schooling, literacy, impersonal trust, bribery, cheating, intertemporal discounting and economic growth (Barro and McCleary, 2003; Guiso et al., 2003; Andersen and Bentzen, 2024; Becker et al., 2016; Glaeser and Sacerdote, 2008; Botticini and Eckstein, 2012). Becker and Woessmann (2010) link the spread of Protestantism in historical Prussia, instrumented using distance from Wittenberg, to higher level of schooling in men and women in the 19th century (Becker and Woessmann, 2010). Focusing on France, Squicciarini and Voigtländer (2015) show that more religious regions grew less rapidly during and after the second industrial revolution, post-1870. Finally, research aimed at explaining psychological differences in traits like individualism, trust, fairness, non-conformity, normative tightness and analytic thinking have proposed links to intensive ('tight') kinship (Enke, 2019), strong family ties (Alesina and Giuliano, 2015) or to causal pathways running from Church exposure to kinship and psychology (Schulz et al., 2019; Bergeron, 2020). These traits have been linked to innovation and other economics outcomes (Algan and Cahuc, 2014; Gorodnichenko and Roland, 2016; El Ghoul et al., 2023; Nguyen, 2020)

[5]Converging with their patent results, the team also shows that less religiosity is positively associated with pro-innovation attitudes and child-rearing aims (Benabou et al., 2015)

3 Data and Measurement

This section describes the measurement of our two central variables: medieval Church exposure and famous creatives. The construction of synod exposure and monastery counts, as well as the measures used in the analysis of contemporary innovation, are provided in Appendix A. Summary statistics of all variables are reported in Table XX.

3.1 Medieval Church Exposure

We capture exposure to the Catholic Church using the locations and history of the see of medieval bishoprics. Bishops' sees functioned as regional administrative hubs from which the bishop and cathedral chapter governed their diocese—the ecclesiastical territory under their jurisdiction. The founding of a bishopric thus marks the moment a locality was fully drawn into the Church's institutional grid: it acquired a resident cathedral, a fiscal system for collecting tithes, and a consistory court that enforced canon law including on marriage, inheritance, and moral conduct across the diocese.

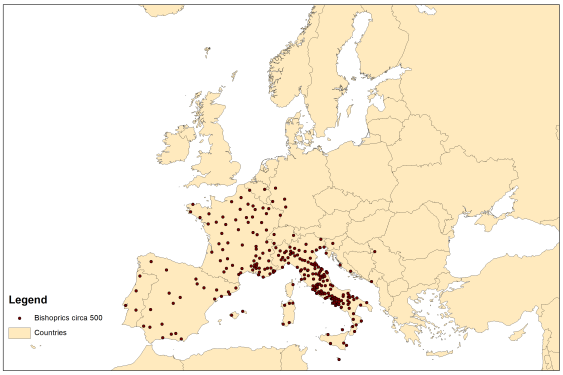
To construct our main independent variables for both the historical and contemporary analyses, we draw on Schulz et al. (2019), which provides a geo-coded dataset of Western Church bishoprics up to the year 1500. This dataset documents the periods during which each bishopric was active, measured in 50-year increments between the years 500 and 1500.[6] The locations of these bishoprics and their spread throughout the Middle Ages are mapped in Figure 2.

Our historical analyses will leverage the uneven diffusion of bishoprics across Europe between 500 and 1500. To this end, we aggregate the distribution of active bishoprics into half-century intervals (500–549, 550–599, ... , 1450–1500) and partition Europe into $1.5^\circ \times 1.5^\circ$ grid cells. We construct an indicator variable that equals one if an active bishopric was located within a 100 km radius from the center of a given cell. The resulting pixel-level measures are visualized in Figure A.1.

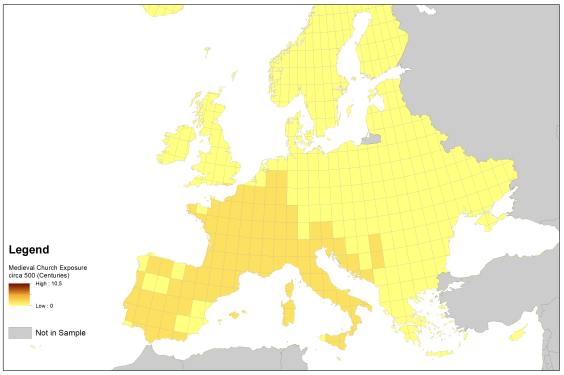
3.2 Famous Creatives

To capture creativity and innovation across Europe over the Middle Ages, we deploy a database of notable individuals created by Laouenan et al. (2022), based on data from multiple editions of Wikipedia and Wikidata. The dataset contains information on over 850 thousand people (0 to 2018 CE), which includes the locations of their births and deaths as well as both their primary and secondary fields of endeavor (e.g., science and discovery, culture, leadership). To measure a region's relative creativity, we focus on the production of those who achieved their fame through contributions to 'culture' and 'science' ('creatives') relative to individuals famous for non-creative pursuits ('non-creatives,' e.g., nobles, generals, clerics). The proposed measures are constructed by counting the number of

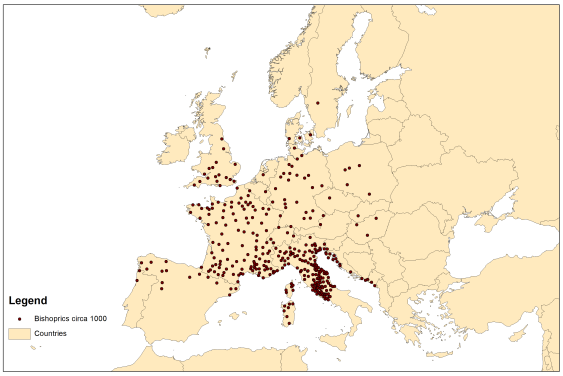
[6] Bishoprics may become inactive after their establishment. For example, bishoprics created in Spain during late antiquity became inactive following the Muslim conquest of the Iberian Peninsula.



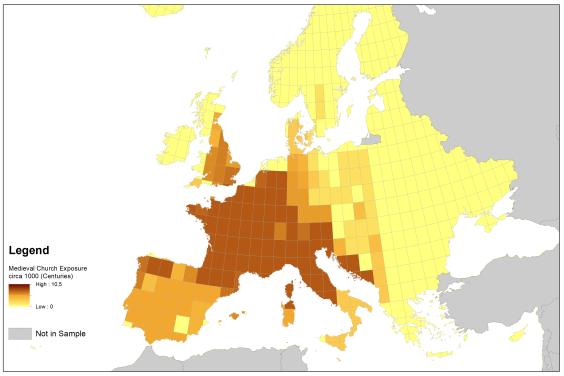
(a) 500 CE



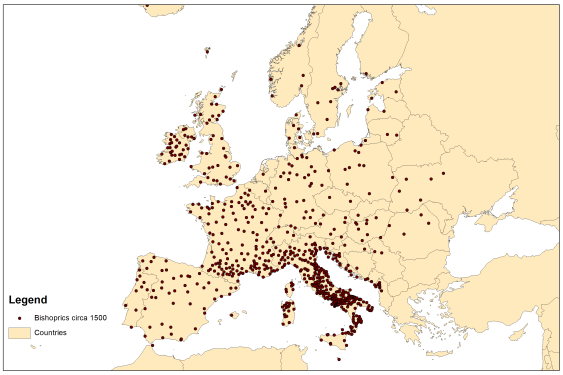
(b) 500 CE



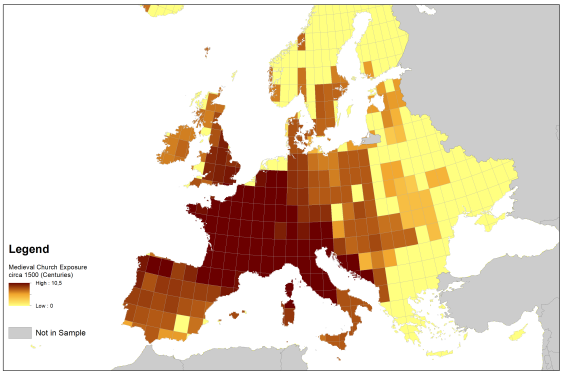
(c) 1000 CE



(d) 1000 CE



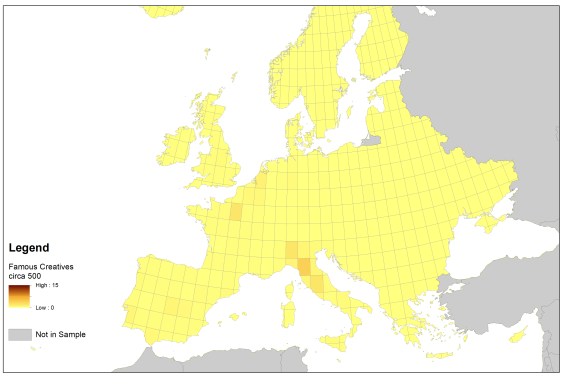
(e) 1500 CE



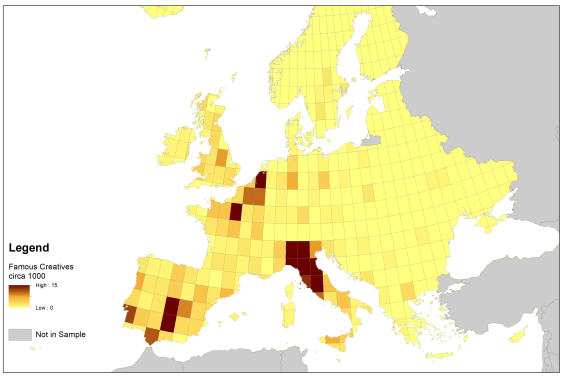
(f) 1500 CE

Figure 2: Bishoprics Locations and Medieval Church Exposure

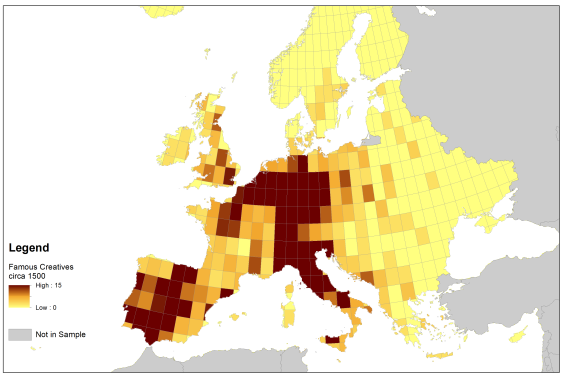
These maps display the spatial distribution of Western Church bishoprics and the corresponding measure of medieval Church exposure across Europe. Panels (a), (c), and (e) mark the locations of bishoprics active within the 50-year window following the indicated date. Panels (b), (d), and (f) depict the constructed exposure measure at the $1.5^\circ \times 1.5^\circ$ *grid-cell level for the same time periods. Color intensity denotes the number of 50-year periods in which at least one bishopric was active within a 100 km radius of the grid-cell center.*



(a) 500 CE



(b) 1000 CE



(c) 1500 CE

Notes: This Figure depicts the geographic distribution of notable artists and scientists (i.e., Famous Creatives) across Europe. Each panel reports the number of individuals born within a 50-year window following the indicated reference year. Counts are aggregated to $1.5^\circ \times 1.5^\circ$ *grid cells based on individuals' birth locations. Data on life spans and places of birth are drawn from Laouenan et al. (2022).*

Figure 3: Famous Creatives: 1.5 x 1.5 Degrees Grid Cells

famous creatives and non-creatives born in a given $1.5^\circ \times 1.5^\circ$ grid cell in Europe during a specific half-century period between 500 and 2000 CE. We use birthplace (birth cell) to anchor individuals to a pre-treatment location and avoid endogenous sorting into creative hubs, and results are robust to assigning creatives by death. The resulting panel dataset documents variation across time and space, where each observation reflects the number of notable individuals who contributed to the development of science and culture as well as the non-creatives (Serafinelli and Tabellini, 2022). Several temporal snapshots of the geographic distribution of famous creatives over the grid cells in Europe are mapped in Figure 3. We validate this measure against patents per capita; details in Appendix B.8.

4 Historical Creatives and the Medieval Church

This section reports our efforts to empirically link the spread of the Western Church to innovation. To start, capturing creativity with the production of creatives relative to non-creatives, we employ an event study design with a triple difference that focus on how the arrival of the Western Church influences the production of creatives relative

to non-creatives. This approach allows us to include period by location fixed effects, which theoretically accounts for all differences across geography and time, including variation in urbanization, population size, conflict, ecology and the total production of notables. To confirm these results using more transparent event study designs, we analyze the impact of the arriving Western Church on the production of creatives and non-creatives separately. Turning to the mechanisms proposed by the Church-Innovation Hypothesis, we consider the roles of social networks, the Church's legislation surrounding marriage, and the spread of monasteries. Considering complementary hypotheses, we explore several mechanisms, including urbanization, institutional capacity and the role of universities.

4.1 Triple-Difference Event Study Estimates

To examine the influence of the Church on innovation, we estimate the impact of local exposure to the medieval Church on the number of famous creatives born in a grid cell. Our aim is to assess whether the spread of the Church, captured by an arriving bishopric (within 100km), is followed by changes in creative production that are difficult to reconcile with pre-existing trends (we discuss threats to identification below). Here, we first pool the data on creatives and non-creatives and estimate a triple-difference event study model that includes grid cell-period fixed effects, absorbing all grid-cell-level, time-varying unobserved factors. Formally, we estimate the following equation:

$$y_{gti} = \sum_{\tau=1}^{T} \beta_{\tau}(Lag_{\tau})_{gt} \times \mathbb{1}(SC_i) + \sum_{\tau=1}^{T} \beta_{-\tau}(Lead_{\tau})_{gt} \times \mathbb{1}(SC_i) + \lambda_{t,g} + \lambda_i + \varepsilon_{gti}, \tag{1}$$

where y_{igt} is the log number of notable people in field i, measured in the grid cell g in period t, $\mathbb{1}(SC_i)$ indicates whether field i is Science or Culture (as opposed to nobility, military, political and other elites), $\lambda_{t,g}$ is the Period $\times$ Cell fixed effects, λ_i denotes science-culture fixed effects, and β_{τ} estimates the coefficients of interest. The lead and lag variables ($Lead_{\tau}$ and Lag_{τ}) enable us to estimate the treatment effect over time while accounting for all other local dynamic effects in the form of the Period $\times$ Cell fixed effects. This approach isolates the causal effect of a bishopric's arrival on the relative production of creative famous people.

You only need that, absent a bishopric, the ratio of creatives to non-creatives would not have trended differently across treated versus untreated cells.

The identifying assumption requires parallel trends within cells. That is, in the absence of a bishopric, the production of famous creatives and non-creatives within the same grid cell would not have exhibited systematically different trends. As before, although we cannot directly verify this assumption, we can examine pre-trends to assess whether this assumption likely holds.

Figure 4 summarizes the results. Approximately two centuries after the arrival of a bishopric, there is a significant uptick in the production of famous creatives relative to non-creatives. The magnitude of the effect stabilizes after about seven centuries. Relative to the production of non-creatives, the production of creatives rises by nearly an order of magnitude during the millennia after the arrival of a bishopric. Crucially, Figure 4 reveals no

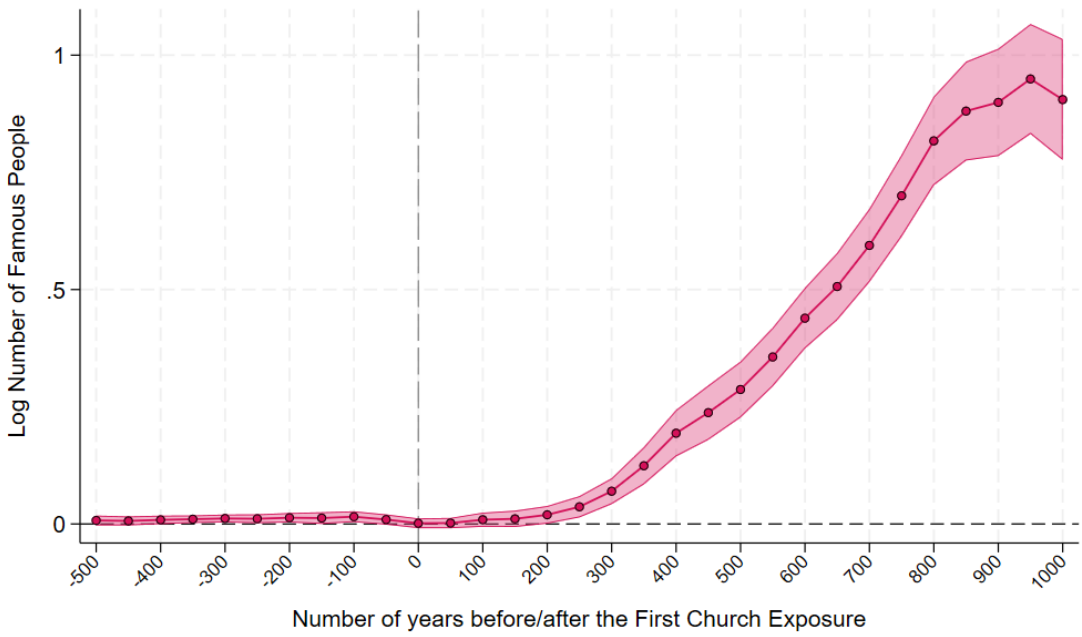


Figure 4: Triple-Difference Event-Study Estimates of the Effect of Church Exposure on Famous Creatives

Notes: The figure reports two way fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroscedasticity robust grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

evidence of pre-trends in the number of famous creatives relative to non-creatives prior to the arrival of bishoprics, bolstering our confidence in the identifying assumption for this analysis. In Appendix B.1, we estimate a simpler triple difference equation without the lag and lead temporal variables.

To probe the strength of these results, in Appendix B.1 we ran a battery of robustness checks.

1. **Geographic and Temporal Subsamples**: To assess heterogeneity and external validity, we re-estimate our model on two geographic subsamples on the Iberian Peninsula (Figure B.10 and Northern/Eastern Europe (Figure B.11), which offer distinct 'control groups' (Muslims vs. Pagans, respectively. To remove any influence of the industrial or scientific revolutions as well as the modern world, we also re-estimate our model using only medieval notables (500-1500 CE) in Figure B.9.

2. **Secular notables only**: To assess the role of religious notables in our results, we re-estimate our model using only secular notables in Figure B.23.

3. **Religious control group**: To account for the Church's promotion of religious figures, Figure B.1 re-estimated our model using religious, non-creative notables as a control group (instead of all non-creatives).

4. **Death locations**: To assess our choice of using the birth locations of famous notables, we re-estimate our baseline specification using death locations instead (Figure B.12).

5. **Estimate Procedure and Errors**: To explore the impact of differing estimation procedures, we re-estimated our model using three techniques, with the results summarized in Figures B.2 (Callaway and Sant'Anna, 2021), B.3 (De Chaisemartin and d'Haultfoeuille, 2020) and B.4 (Sun and Abraham, 2021).[7]. To assess the influence of how the error was modeled, Figures B.6 and B.7 re-estimate our triple differences analysis by modeling the error using Poisson and negative binomial error distributions.

Across all robustness checks, the results shown in Figure 4 hold.

To explore this more deeply, Appendix B.2 employs a similar on study designs separately on the production of creatives vs. non-creatives. Figure B.13 confirms that the arrival of a bishopric is associated with a rise in the production of creatives, not a decline in the production of non-creatives.

4.2 Mechanisms

The causal relationship suggested by the above findings may arise from a combination of mechanisms, including those associated with the Church-Innovation Hypothesis as well as two complementary mechanisms related to state capacity and market size. Here, we'll first focus on exploring the mechanisms related to the Church-Innovation Hypothesis and then consider the influence of the more traditional mechanisms.

The Church-Innovation Hypothesis proposes that the arrival of Latin Church initiated a cascading set of cultural evolutionary processes that stimulated creativity by opening up the flow of ideas and individuals across European regions, thus fueling recombinative innovation. This occurred because the Church first undermined the existing social organization through its policies related to marriage and the family and, second, offer a replacement, a new social, religious and institutional framework that integrated local and tribal communities into a single supra-regional organization. More specifically, the Church promoted a set of prohibitions and prescriptions related to family and marriage that gradually dissolved the intensive kin-based institutions, favoring the dominance of monogamous nuclear families. For example, as noted above, the Church prohibited non-consensual and polygamous marriages (concubines) as well as marriage to an expanding sphere of relative, including both affines and spiritual kin. This weakened the abilities of clans and kindreds to build strategic kin-based alliances, tighten existing kin networks (via endogamous marriage) and multiple its kin ties through plural marriages (only 1 wife can create legitimate heirs). At the same time, the Church opened the door to a large supra-tribal community via shared customs (e.g., marriage practices, rituals, inheritance), religious commitments and a written language, Latin (Grzymała-Busse, 2023; Rubin, 2017; Henrich, 2020). This 'push-pull' effect released people from dense network of kin bonds that tied them to their ancestral lands and communities, promoted more socially (and genetically) distance marriages, facilitated geographic movements (resulting in urbanization) and propelled the creation of and entry into new

[7] A dedicated triple-difference estimator analogous to the one proposed by Callaway and Sant'Anna (2021) does not yet exist. So, we approximate such estimates by reformulating our triple-difference strategy into a difference-in-differences framework. Specifically, we define the dependent variable as the difference between the log number of famous creatives and non-creatives. Figure B.2 demonstrates that our estimates broadly hold when adapting the Callaway and Sant'Anna (2021) approach to fit the triple-difference logic

voluntary institutions. These voluntary associations included new monastic institutions (the Cistercians), craft guilds, cathedral schools, charter towns and universities (Greif, Tabellini and Mokyr, 2025; Henrich et al., 2010; Schulz, 2022; Greif, 2006b). In absence of strong kin-based institutions, many of these associations took over the task of socialization and skill-training (building human capital [8]) becoming "corporations of learning" (Mokyr, 1990; de la Croix et al., 2018; Cantoni and Yuchtman, 2014) that archived texts, experimented with water-power, agricultural techniques and metallurgy (Andersen and Bentzen, 2024).

Below, we explore the potential relevance of this cascading set of mechanisms in three ways. First, using the birth and death locations of our notables, we study the impacts arriving bishop on the migration networks. The Church-Innovation Hypothesis predicts that the Church's arrival will induce rising flows of migrants, including notables. Second, we focus narrowing the impact of the Church marriage and family polices. Using the attendance of bishops from different regions at Church councils that either did or did not discuss and ratify marriage legislation (e.g., incest bans on cousin marriage), we study the impact of this legislation on creativity as captured by famous creatives (and later patents). The Church-Innovation Hypothesis predicts that attending councils that dealt with marriage legislation will result in arising creativity back in their bishoprics while attending councils that dealt with other issue will have no impact. Finally, we consider the roles of two other institutions or 'corporations of learning' within the Church: monasteries and universities. The Church-Innovation Hypothesis argues that the loosening of kinship ties and formation of supra-tribal communities opened the door to interaction among strangers and creation of both new monastic orders and universities. These institutions created learning hubs–often explicitly–that clustered people from around Europe to share insights, technique and ideas (REfs).

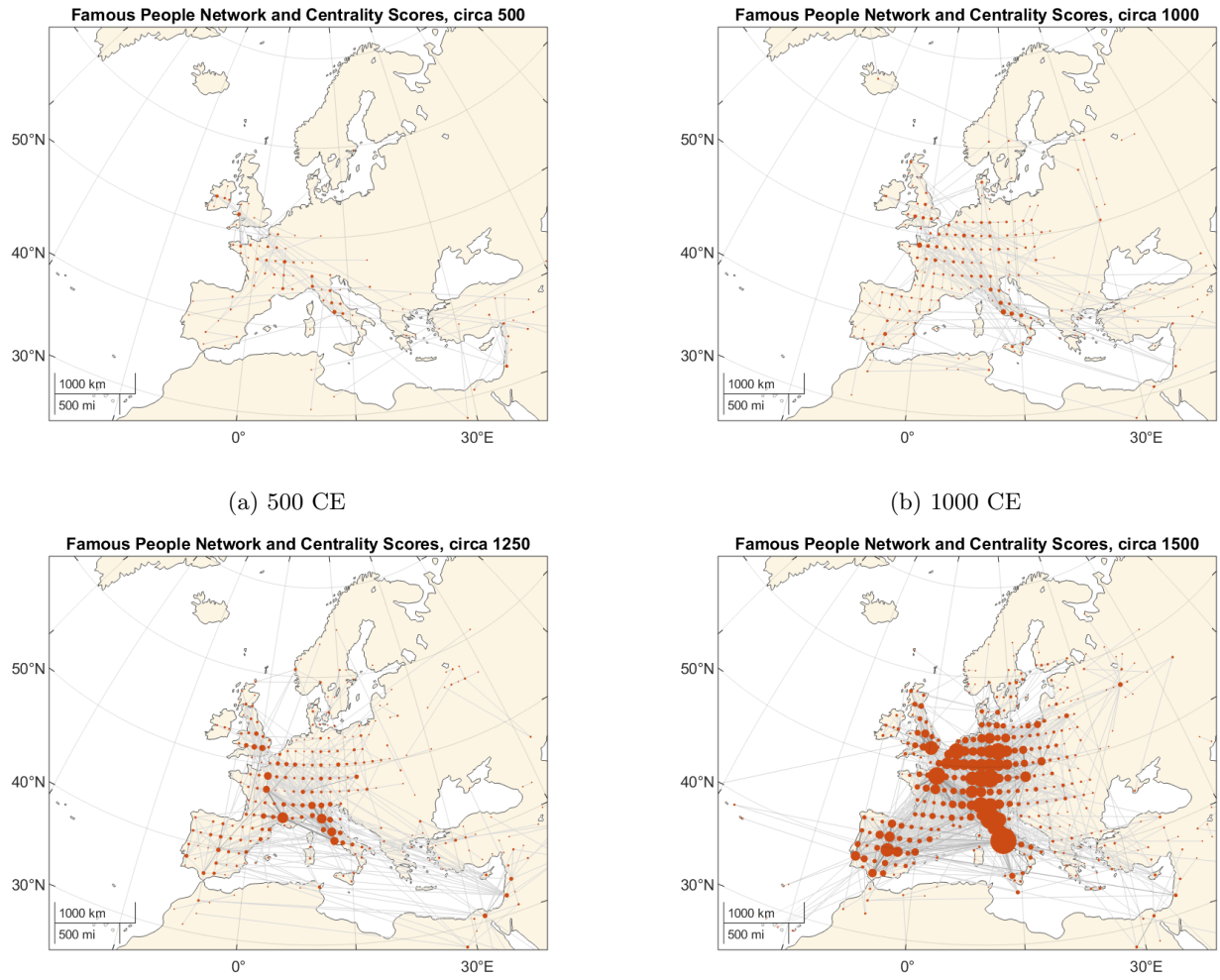
4.2.1 The Church broadens European social networks

To study the dynamics of medieval European regional networks, we developed a novel proxy. Using the same notables data Laouenan et al. (2022), we construct a measure of the flow of famous people among European communities using their birth and death locations. We then create migration networks that link our grid cells ($1.5° \times 1.5°$) across Europe for each half-century from 0 to 2000 CE. This approach results in a series of temporal snapshots, each depicting a spatial network formed by the migratory paths of famous individuals across these grid cells. Figure 5 depicts Europe's changing networks in four snapshots from 500 to 1500 CE. Our proxy measure shows a network that is both increasing in density and expanding in extent.

To assess the impact of the Church on this network, we again implement an event study that estimates the relationship between the arrival of a bishopric and network centrality of a grid cell at time t. Specifically, we estimate:

$$y_{gt} = \beta_0 + \sum_{\tau=1}^{T} \beta_\tau (Lag_\tau)_{gt} + \sum_{\tau=1}^{T} \beta_{-\tau} (Lead_\tau)_{gt} + \mu_t + \lambda_g + \varepsilon_{gt} \quad (2)$$

[8] Prior work focused on a later period of European history establishes how religion can increase human capital (Becker and Woessmann, 2010; Becker et al., 2016, 2024; Dittmar, 2011)



(a) 500 CE

(b) 1000 CE

(c) 1250 CE

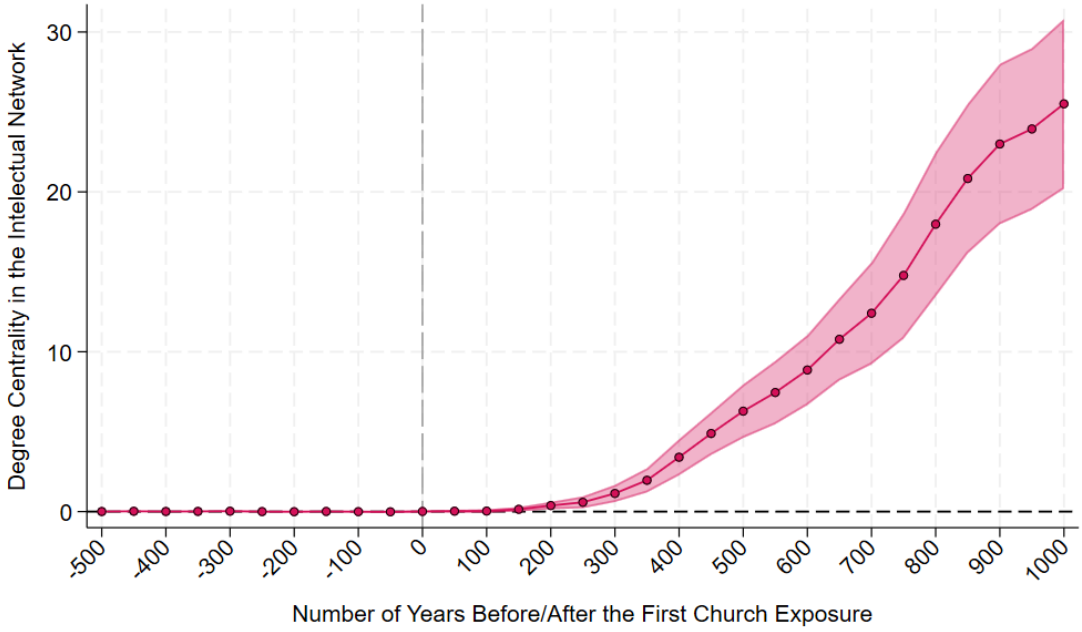
(d) 1500 CE

Figure 5: Famous Creatives Social Network

Notes: These figures present snapshots of the networks of notable creatives across Europe during the Middle Ages. Each node corresponds to the centroid of a $1.5^\circ \times 1.5^\circ$ *grid cell, and edges connect two nodes when at least one individual born in one grid cell and deceased in another was alive during the 50-year window following the indicated reference date, based on data from Laouenan et al. (2022). Edge darkness is proportional to the number of individuals linking two nodes (in panels (c) and (d), edges representing fewer than two individuals are omitted). Node size reflects degree centrality within the resulting network for the corresponding 50-year window, while isolated nodes with zero connections are excluded.*

To create our main network measure using these migratory flows, we compute the degree of centrality for each grid cell within the pan-European network for every 50-year interval. The degree centrality of a given grid cell i, within a specified period t, is quantified by counting the number of distinct grid cells, excluding cell i itself, that maintain a connection with cell i during period t. A connection between two cells, specifically between cell i and another cell j, is established if, within period t, there exists at least one famous individual who migrated either to or from cells i and j. This computation produces a panel dataset where each entry represents the centrality of a specific European location over multiple 50-year periods. The degree centrality measure thus reflects the connectivity of each location to others within a given time frame.Lags and leads are binary variables indicating the amount of time before/after the event date, $Event_g$, that establishes the first bishopric in grid cell g. These variables are thus

Figure 6: Degree Centrality and Church Exposure: Event Study



Notes: The figure reports the CSA estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

constructed as follows:

$$(Lag_\tau)_{gt} = \mathbb{1}[t = Event_g - \tau] \tag{3}$$

$$(Lead_\tau)_{gt} = \mathbb{1}[t = Event_g + \tau] \tag{4}$$

The results, summarized in Figure 6, show that a locale's network centrality begins to increase a few centuries after the arrival of a bishopric, hitting conventional levels of significance after 200 years. The peak impact observed is an increase of over 15 degrees in connection, signifying an additional 15 connections per grid cell to other cells.

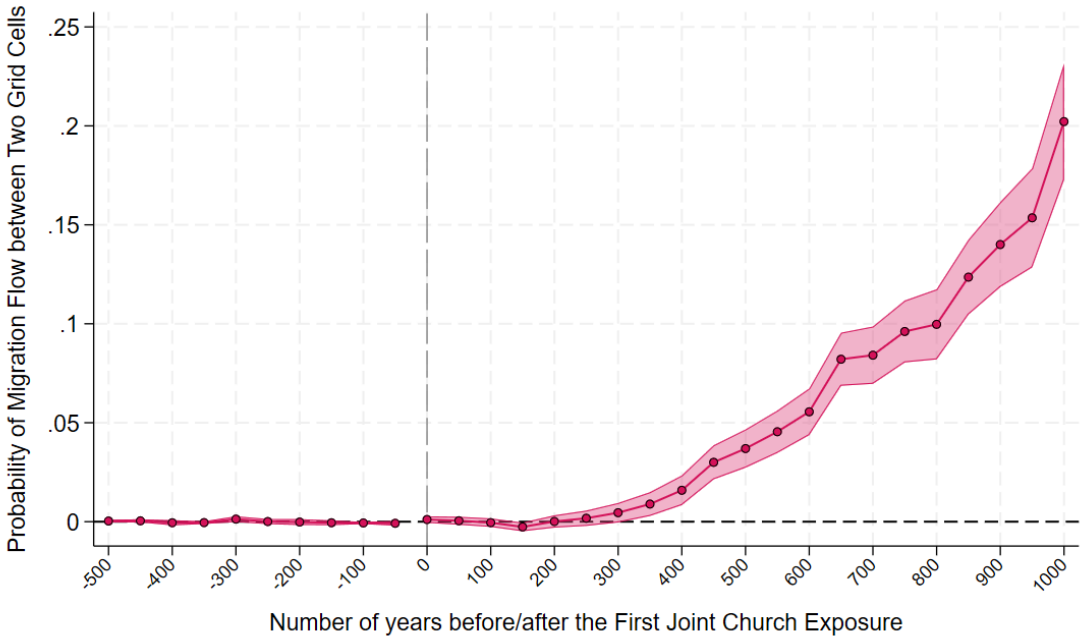
Crucially, Figure 6 reveals no pre-trends for network centrality, prior to the establishment of a bishopric. All lagged effects are small and statistically non-significant. The absence of pre-trends lends support to the causal interpretation of the positive correlation between the Church's influence and innovation. Importantly, as shown in Appendix B.4, the estimated relationship remains virtually unchanged when accounting for the heterogeneous dynamic effects of Roman roads (Figure B.26) or population size (Figure B.27) on the evolution of the Notable Network. The results are likewise robust to alternative estimation strategies, including (1) two-way fixed effects (Figure B.28), (2) the approaches of De Chaisemartin and d'Haultfoeuille (2020) and Sun and Abraham (2021) (Figures B.29 and B.30), (3) adjustments for spatial and temporal dependence (Figure B.31) and (4) restricting

the data used to the medieval period (500–1500 CE), see Figure B.32.

Complementing the baseline analysis of network centrality, we analyze the impact of joint exposure to the Church by investigating the changes in pairwise migration flows between all unique pairs of grid cells. Specifically, we estimate an event study model, similar to (8), across all unique pairs of grid cells in Europe, using the presence of migrating notables as a binary outcome measure. The event of interest is the onset of joint exposure to the Western Church. That is, the onset of joint exposure is defined as the first period when both grid cells have at least one western bishopric.

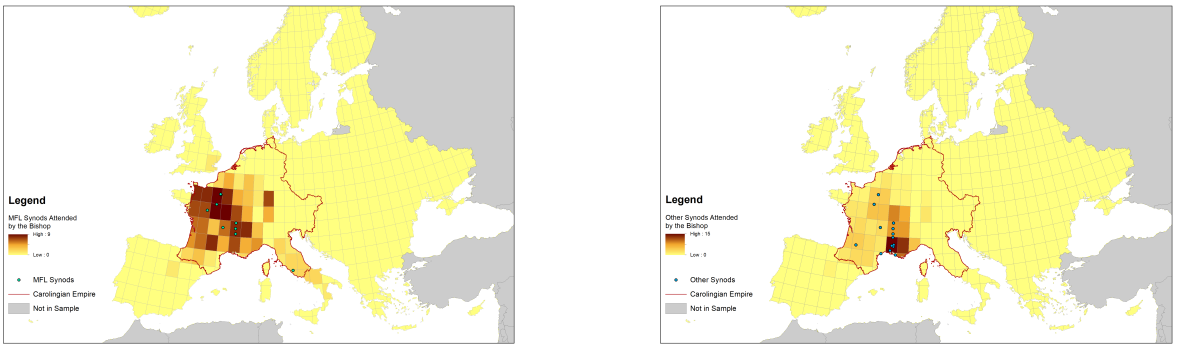
The results, presented in Figure 7, indicate that the probability of observing any migration between two locations significantly increases approximately two centuries after both are exposed to the Western Church. The increase in this probability peaks at 0.2. Importantly, this result is robust to the inclusion of dyadic fixed effects that hold constant everything about these two locations and accounts for non-parametric, grid-cell-specific time trends.

Figure 7: Notable Migration and Church Exposure: Event Study



Notes: The figure reports the CSA estimates and 95% confidence intervals for the effects of the establishment of bishoprics in both grid cells of a dyad on the probability of observing migration between those cells. The unit of observation is a dyad of 1.5 by 1.5-degree grid cells by half-century interval. The main independent variable is an indicator taking value one once a bishopric becomes active in both grid cells, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions (REF). The x-axis reports years to/from the first period when bishoprics were established in both grid cells in a dyad.

Qualitatively, Figures 5, 6 and 7 suggest that the diffusion of Latin Bishoprics, accompanied by the migratory flows they induced, contributed to establishing the ensemble of shared family structures, marriage customs, religious beliefs, alphabetic scripts, intellectual cultures (based on Latin texts) and ways of thinking that fostered a pan-European cultural identity despite the lack of political unification. In short, the Latin Church wired together the regions of western Eurasia that became Europe.



(a) Marriage and Family Synods

(b) Placebo Synods

Figure 8: Synod Locations and Exposure: 1.5 x 1.5 Degrees Grid Cells

Notes: These maps illustrate the geographic distribution of exposure to early medieval Church synods held between 500 and 712 CE across $1.5^\circ \times 1.5^\circ$ *grid cells in Europe. Panel (a) highlights exposure to synods where marriage and family legislation was debated, showing where local communities—through their bishops—were most directly exposed to these institutional reforms. Panel (b) provides a placebo comparison, mapping exposure to all other synods over the same period. The intensity of the color of each grid cell reflects the number of local bishops that attended corresponding synods. Dots reflect the locations of the synods.*

4.2.2 Linking the Church's Marriage and Family Legislation to Creativity and Network Centrality

The Church-Innovation Hypothesis proposes a key role for the Church's prohibitions and prescriptions surrounding marriage and the family. For example, the hypothesis suggests that the weakening of kinship ties and dissolution of Europe's clans and kindreds freed individuals from the obligations, responsibilities and security of kinship, contributing to the movement of people documented above. Here, we directly test for links between the Church's marriage and family legislation (hereafter 'MF legislation') and both network centrality (based on migratory flows) and innovation (based on the production of creatives). To accomplish this, we take advantage of variation in the attendance of early medieval bishops at Church councils where legislation related to marriage and family was either discussed or not. Keeping in mind that bishops were the administrative and religious leaders of their bishoprics, the Church-Innovation hypothesis straightforwardly predicts that greater attendance at councils, where the Church's marriage and family policies were discussed and ratified, will be associated with both higher network centrality and the production of more creatives. As a placebo, we compare this to the effects of bishops attending Church councils that didn't deal with MF legislation. This approach is distinct from those we used above in that we are only comparing regions that already have bishoprics in the early Middle Ages–thus, here we seek to explain variation among existing bishoprics rather than comparing the same place before and after a bishopric arrives.

Before diving into the econometrics, let's set the historical scene. During the Early Middle Ages, especially in the Merovingian Kingdoms, important policy decisions in the Western Church were debated and ratified at councils of bishops known as synods. Each synod dealt with a variety of topics, ranging from the doctrine of original sin (turns out, everyone carries the guilt of Adam's sin in Paradise) to whether clerics can enter taverns (decision:

only on long journeys). But, from the 6^{th} to the 8^{th} century, one set of recurrent policy issues revolved around marriage and the family. For example, during this period, the Church affirmed and often re-affirmed prohibitions on marriage to additional wives, spiritual kin (e.g., God-daughters), step relatives (e.g., step mothers), affines (e.g., sisters-in-law) and cousins, with the taboos on the latter expanding from first to the sixth degree between the 6^{th} and 11^{th} centuries. Attending bishops were charged with enacting, within their own bishoprics, any legislation ratified during these meetings. Of course, during the era, travel was difficult and health precarious, so not all bishops attended every synod. This variation, in the attendance of bishops at different synods, may capture variation in the promulgation and implementation of MF policies in different regions.

To analyze the heterogeneity in exposure to the Church's marriage and family legislation due to variation in bishop's attendance, we construct a measure of exposure to the Church's MF legislation by counting the number of synods devoted to issues of marriage and family attended by each bishop and then aggregating this data on the $1.5^\circ \times 1.5^\circ$ grid cell level.[9] Figure 8 (a) maps the locations of synods dedicated to MF legislation held from 500 to 712 within the realm of what would latter become the Carolingian empire, while Figure 8 (b) maps the locations of all other Synods (i.e., not dealing with marriage and family issues) held during that time.[10]

Using our event study design (with the CSA estimator), Figure 9 visualizes the effect of exposure to marriage and family (MF) synods on the production of famous creatives and their social network centrality. Panel (a) shows that regions with greater exposure to MF synods experience a significant increase in the number of famous creatives over time. The effect becomes visible a few centuries after the first synod exposure and grows steadily over the subsequent millennium. Panel (b) provides complementary evidence by examining creative network degree centrality. Here too, exposure to MF synods is associated with a clear and rising effect, suggesting that marriage and family oriented legislation of the Church translated not only into more individual creatives but also into more connected creative networks. As expected, the data even hint that migratory flows (of notables) may have lagged the rise in creatives by about a century or so. The hypothesis suggests that as people's kin ties loosened, they were both freer and in greater need to move and form new relationships with non-kin, often joining voluntary associations. The greater freedom of movement and relationships, capture by our migration measure, fueled creativity via the interaction of diverse minds.

As a placebo contrast, Panels (c) and (d) illustrate the impact of attending synods that didn't address MF legislation. These analyses reveal no systematic or significant effects on either outcome. The contrast between Panels (a-b) and (c-d) suggest addresses the concerns that the pattern observed in Panel (a-b) may result from having energetic bishops (with good attendance records) or overall synodal activity rather MF legislation itself. Overall, these findings reinforce the view that exposure to MF synods played a central role in shaping the migratory networks and creative production of medieval Europe.

[9]The grid cell is considered exposed to the policies of a particular Synod if at least one bishop who's bishopric falls within the grid cell attended the Synod. See Table B.2 for summary statistics of the Synod attendance by the bishops.

[10]The data stops at 712

Importantly, as reported in Section B.5, the results are likewise robust to alternative estimation strategies, including (1) two-way fixed effects (Figure B.33), (2) the approaches of De Chaisemartin and d'Haultfoeuille (2020) and Sun and Abraham (2021) (Figures B.34 and B.35), (3) estimating the effect with respect to the number of famous creatives using Poisson and negative binomial regressions (Figure B.36), (4) adjustments for spatial and temporal dependence (Figure B.37), (5) restricting the data used to the medieval period (500–1500 CE), see Figure B.38, (6) estimating the effect for secular famous creatives exclusively (Figure B.39), (7) geolocating the famous people via the death place rather than the birth place (Figure **??**).

4.2.3 The role of monasteries in innovation

The Church-Innovation proposes that the Church, through its dissolution of the intensive ('tight') kinship organizations and creation of supra-regional connections, fostered the creation of new voluntary associations built around impersonal institutions. These new voluntary associations include both new monastic orders and universities, both 'corporations of learning.' New monastic organizations and orders, such as the Cistercians Andersen and Bentzen (2024), began to appear first in the 10th and 11th centuries. These sprawling transnational organizations incorporated new impersonal institutional elements. For example, among the Cistercians, new abbots were elected from among the rank-and-file monks (previously abbots were hereditary), monastic rules required monks to cut their own kin ties in favor of their fellow monks (termed 'brothers'), and they stationed in monasteries distant from their kin and ancestral lands.

The supra-regional spread of these franchise monastic organizations may have provided one mechanism through which the Church stimulated creativity through the flow of people and ideas its pan-European network. The Cisterians, for example, maintained a sprawling network of monasteries that effectively circulated novel arts and 'best practices' through their network, in part through the attendance of Abbotts at annual meetings (Donkin, 1978a; Andersen and Bentzen, 2024; Henrich, 2020). Ideas, practices and the monks themselves flowed among different monasteries, potentially bringing fertile ideas for recombination and forging new social connections among different parts of Europe.

To explore the potential role of monasteries in fueling historical creativity, we conducted three regression batteries. First, we regressed the number of famous in the century prior to 1600 (post-Middle Ages) on both our measure of Church exposure and our monastic data. Second, we repeated this analysis but substituted network centrality in 1600 CE in place of the number of creatives. Second, to consider whether the arrival of bishoprics encouraged the founding of monasteries, we regress the presence of monasteries within a grid cell on the duration of Church exposure based on the founding of bishoprics. Here, event studies or other time series analyses are not appropriate because monasteries often diffused too quickly for us to capture the process effectively (because our temporal granularity is limited to half century cells) and we often don't have founding dates. To further complicate matters, most of our bishoprics diffused before 1100 CE while most monastic orders diffused after this date.

Panel (a) of Table 1 shows that both the presence of monasteries and bishoprics predict the number of famous creatives from 1500 to 1600 CE. These analyses control for the number of non-creatives (mitigating concerns about population size) and include period fixed effects. The estimates indicates that impact of monasteries is large, with a standard deviation increase in the total number of all monasteries in a grid cell predicting about one-third of standard deviation increase the log number of creatives produced in 1600 CE (column 6). The effect sizes are similar across five different monastic orders, ranging from 0.14 to 0.30 of a standard deviation. Notably, these effect sizes are generally similar to or larger than those of Church Exposure: e.g., the effect size for all monasteries together is about 50% larger (0.31) than that for Church exposure (0.22). Of course, exposure to both monasteries and bishoprics represent types of Church exposure

Table 1: Famous Creatives, Church Exposure and Monasteries

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	Log Number of Famous Creatives					
Medieval Church Exposure	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of Monasteries	0.18***	0.30***	0.26***	0.14***	0.27***	0.31***
	(0.02)	(0.02)	(0.06)	(0.03)	(0.02)	(0.02)
Between-R^2	0.48	0.66	0.59	0.47	0.61	0.70
Panel B:	Creative Network Degree Centrality					
Medieval Church Exposure	0.37***	0.37***	0.38***	0.38***	0.37***	0.37***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Number of Monasteries	0.16***	0.15***	0.13***	0.11***	0.16***	0.19***
	(0.03)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Between-R^2	0.35	0.33	0.29	0.25	0.35	0.40
Observations	59286	59286	59286	59286	59286	59286
Monastic Order	Cist	Clun	Fran	Domi	Prea	All

Note: Using OLS panel regressions, this table establishes a positive and significant relationship between medieval church exposure and two outcomes: the log number of famous creatives (i.e., scientists and artists) (Panel A), and the degree centrality of the creative network (Panel B). The analysis is conducted at the level of $1.5^\circ \times 1.5^\circ$ grid cells across Europe over 50-year intervals between years 0 and 2000. All specifications include period fixed effects and control for the number of monasteries of various orders: Cistercian (column 1), Cluniac (column 2), Franciscan (column 3), Dominican (column 4), Premonstratensian (column 5), total number of monasteries of all 5 orders (column 6). The results indicate that while the presence of monasteries is an important determinant of both outcomes, the measure of medieval church exposure explains a substantial share of the variation. Models in Panel A additionally control for the number of prominent non-creatives (e.g., political leaders, nobility, military figures). All variables are standardized by subtracting their mean and dividing by their standard deviation, such that coefficients represent the effect of a one-standard-deviation change in the independent variable on the dependent variable in standard deviation units. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Using the same regression approach, Panel (b) of Table 1 demonstrates that both the number of monasteries and the length of bishopric exposure predict greater creative network centrality. A standard deviation increase in

the number of all monasteries in a grid cell is associated with an increase of about one-fifth of a standard deviation in network centrality. Across our five monastic orders separately, this effect ranges in size from 0.11 to 0.16. Unlike in the analysis of creatives in Panel (a), the estimates for the influence of bishoprics are consistently 2-3 times larger, at 0.37.

Finally, Table B.3 shows that the presence of a bishopric predicts the founding of a larger number of monastic houses. Across all monastic orders, a standard deviation increase in the duration of bishopric exposure is associated with 12% rise in the number of monasteries. This holds across all five monastic orders separately, with effect sizes ranging from 0.04 (Franciscans) to 0.19 (Cluny).

The results presented in this section suggest that the Church's influence on creativity likely operated through multipl mechanisms. Here, we've focused on how the implementation of the Church's Marriage and Family Program via the bishops and the founding of new monasteries influence, partly through an expansion of regional migratory flows, the rise in creativity initiated by the spread of Western Christianity.

4.2.4 Complementary Mechanisms: State Capacity, Market Size, Universities and Urbanization

Shifting to more traditional economic mechanisms, we explore the possibility that the arrival of bishoprics may have stimulated creative production by raising state capacity, expanding the scale of markets, employing people directly within the Church, fueling urbanization and/or attracting universities.[11]

To assess the potential roles of state capacity, market expansion and direct Church employment, we used our Notables database to create proxies that parallel our measure of creativity. For state capacity, we calculated the production of famous people engaged in four occupations: we refer to lawyers/adminstrators, nobles, politicians and military figures as 'state actors.' Any expansion of the state should require more personnel in at least some of these occupations–though whether they'd make it into the Notable data is an open question. To assess market size, we studied the production of merchants or 'business people.' Presumably, larger markets entail more people engaged in buying and selling. Lastly, to address the notion that these effects might be linked to direct employment, we calculated the production of people engaged in religious occupations.

Figures 10 and 11 summarize our efforts, with each row addressing one of these three mechanisms. The first column displays an event study for each occupational category, thus exploring the dynamics before and after the arrival of a bishopric. Columns 2 and 3 rerun our event analyses for the production of creatives and for the region's degree centrality (based on migratory flows) while holding each proxy constant (see Section B.7 for a detailed description of the estimation strategy). Complementing these analyses, Figure 11 reruns these analyses using the share of occupational categories and creatives (as a fraction of all notables) rather than absolute numbers.

[11]The role factors such as state capacity, urbanization, market expansion has been presented as an alternative to the Church-Innovation Hypothesis, with its emphasis the dissolution of kin-based institutions and relational mobility. However, Henrich and Schulz (Henrich, 2020; Schulz et al., 2019; Schulz, 2022) have argued that these explanations are elements in a causal network: the social and psychological shifts induced by the Church's policies surrounding family and marriage paved the way for the creation, spread and effectiveness of new organizational forms, including representative governments, impersonal markets, charter towns and universities. Each of these factors may then have its own downstream effects.

Using the share of total notables offers one way to account for expanding populations and greater urbanization. Finally, figure B.40 reruns our analysis of state actors separate using lawyers/administrators, politicians, nobles and military figures.

Overall, our analysis offers some support for the role of state capacity and direct employment by the Church but none for market size. For state capacity, Column 1 of Row 1 in Figure 11 suggests that, at least initially, state actors (as a share of all notables) rise in the wake of creatives, with a lag of only a century or so. However, while creatives continue to rise, state actors level off as a share of the population after about 5 centuries. Focusing on absolute numbers, Column 1 of Row 1 in Figure 10 does not reveal a similar rise in state actors. Figure B.41 reruns these analyses disaggregating the production of Lawyers/Administrators, Politicians, Nobles and Military Figures. For market size, Column 1 of Row 2 in Figures 10 and 11 do not suggest a link between the arrival of bishoprics and an expansion of market size, at least as captured by notable merchants. For employment by the Church, Column 1 of Row 3 in Figures 10 and 11 do suggest a bump in religious employment after the arrival of a bishopric, although the relative share of religious notables begins declining after about 500 years while the production of creatives continues to rise.

Crucially, Columns 2 and 3 in Figures 10 and Column 2 in Figure 11 show that our results linking the spread of bishoprics to increases in the production of creatives hold after controlling these other mechanisms (at least as captured by our proxies). Further, as noted, neither the dynamics of state actors nor religious figures match creatives.

While we do find some support for state capacity and direct employment as playing a role, we emphasize that the proxies we propose here may not capture what we hope or maybe less sensitive than our measures of creatives. Thus, we are agnostic on the importance of these channels.

Turning now to a potential role of urban population size, Column 1 of Figure 12 suggests that urban population size does increase after the arrival of a bishopric, though the effect size is poorly estimated and never significant at conventional levels. Controlling for urban population size in Columns 2 and 3 reveals little impact on our main results.

Finally, the development of medieval universities, which began during the High Middle Ages, may influence the production of creatives. In panel A of Row 1 in Figure 13, we can see that the arrival of bishoprics is associated with the subsequent appearance of a medieval universities. However, Columns 2 and 3 confirm that, holding constant the presence of universities, does not alter our main results for either the production of creatives or region's network centrality. In Row 2, because medieval universities always arrive after bishoprics in particular locations, we consider a dual event study model that includes coefficients for both bishoprics and universities (an interaction term). Panel A shows that our basic result remains little changed when universities are in the equation. Panel B, however, shows that adding a university to locales that already possess bishoprics generates little extra creativity.

Overall, we find some evidence supporting a link between arriving bishoprics and (1) expanding state capacity,

(2) greater direct employment by the Church, (3) rising urbanization and (4) the subsequent arrival of universities. However, our analyses also indicate that none of these mechanisms can account for our main results.

5 Results II: Contemporary Innovation

Here, we explore whether the impact of the Medieval Church on creativity and innovation can still be observed today in Europe. Below, returning to the relationship between a region's Church exposure and its production of patents and inventors, we begin by testing the robustness of this relationship and then explore potential mechanisms.

5.1 Data: Measuring innovation using patents and notables

To capture the contemporary level of innovation on a fine geographic scale, we use a novel global geocoded dataset of patents compiled by De Rassenfosse et al. (2019) alongside the same notables dataset we deploy in our historical analyses above. The patent dataset provides geographic coordinates for inventors of 18.8 million patents filed over more than 30 years. The dataset covers more than 99% of all patents in the Worldwide Patent Statistical Database (PATSTAT) that were filed between 1980 and 2014, and only takes into account the first filings for each patent to avoid multiple counts of the same patents across several locations. The geographic coordinates of each patent filling are identified as the location (i.e., address) of the patent's inventor. As a result, each patent made in the 34-year period enters the dataset only once corresponding to the geographic location of its inventor. Naturally, several patents can be attributed to a single inventor, each of them representing a separate observation in the dataset.

Using these data, we construct two patent-based measures of innovation and creativity. First, following field standards (Berkes and Gaetani, 2021), we construct a measure of patents per capita by aggregating the number of patents over a given geographic region (e.g., country, sub-national region, arbitrary grid-cell) and normalizing by the total population of the region in the year 2010, based on the Gridded Population of the World (GPW version 4) data. As a result, the proposed measure captures the number of unique patents made by inventors living in a given geographic region over the last 34 years per capita of the region's population in 2010. Second, to parallel our use of famous creatives in our historical analysis above, we also count the number of unique inventors who were active (i.e., filed a patent) while residing in a given geographic region. This measure is also normalized by the total population of the region in the year 2010, yielding the measure of Inventors per capita.

Based on the geographic resolution of explanatory variables of our baseline empirical analysis, we constructed these contemporary measures of innovation at two levels of geographic granularity: (1) NUTS 3 regions in Europe and (2) $0.125° \times 0.125°$ grid cells. Figure A.2 (a) shows the number of patents per capita aggregated at the grid-cell level and Figure A.2 (b) shows the aggregation to the level of NUTS 3 regions in Europe. Whenever possible, we will use the more finely-grained grid cell level analysis

To complement these patent data, we also use the Notables dataset to calculate the production of modern

creatives and non-creatives at a fine geographic scale from 1984 and 2010 (to match the patent data).

5.2 Empirical Strategy

In our baseline analysis linking exposure to the medieval Church and innovation analysis, our observational unit is the $0.125° \times 0.125°$ grid cell. Using the more finely-grained grid-cell analysis allows us to exploit regional (subnational) variation while accounting for observable geographic characteristics and for time-invariant unobserved characteristics at the country or administrative regional levels using fixed effects. We estimate the association between Medieval Church Exposure and the number of patents per capita by the following Ordinary Least Squares (OLS) specification:

$$y_{gic}^{pc} = \beta_0 + \beta Church_Exp_g + \sum_c \gamma_c \delta_{pc} + \sum_i \gamma_i \sigma_{pi} + \sum_j \xi_j Z_{pj} + p(lat_g, lon_g) + \epsilon_g \tag{5}$$

where y_{gic}^{pc} captures the number of patents, inventors or notables per capita made in grid cell g, located in sub-national region i of country c between the year 1980 and 2014. $Church_Exp_g$ is grid cell g's exposure to the Medieval Catholic Church (in centuries) based on the diffusion of bishoprics, δ_{gc} and σ_{gi} are the fixed effects for countries and sub-national regions, respectively, Z_{gj} is an observable characteristic j of grid cell g (e.g., region area, population, and geographic attributes), $p(lat_g, lon_g)$ is the second order polynomial of the latitude and longitude of grid cell g's geographic center, and ϵ_g is the error term. Again, we report spatially robust standard errors to account for spatial auto-correlation (i.e., following the approaches of Conley, 1999; Müller and Watson, 2022). Our coefficient of interest is $\beta > 0$. The Church-Innovation Hypothesis predicts a positive association (i.e., $\beta > 0$).

As we'll show, the β coefficients are stable, robust and significant across all specifications. Nevertheless, while simple reverse causality is not a concern, omitted variables may bias our results. To mitigate—though not eliminate—these concerns, we'll take advantage of the fact that the total duration of Church exposure after 500 CE was influenced by the highly stochastic and unpredictable nature of medieval conflict. During periods that often lasted centuries, bishoprics were disrupted due to pagan uprisings in the eastern part of the Holy Roman Empire (Germany), Viking conquests imposing the Daneland in England, and Islamic conquest in Italy and on the Iberian Peninsula.

5.3 Main Contemporary Results

Here, we begin by presenting our baseline OLS regression results focusing the link between medieval Church exposure and innovation, and then consider the potential contributions of the total time since a bishopric's first founding and the role of subsequent impression. Next, explore potential mechanisms, we show...

5.3.1 Baseline Results

Table 2 reports the *beta* estimates from equation 5. Across all specifications, we find a positive and significant relationship between Church exposure (i.e., the number of centuries spent under the influence of the Catholic Church during the Middle Ages) and the number of modern-day patents (Panel A) or inventors (Panel B) per capita in the corresponding grid cell. Both estimates are highly significant in the simple regression (Column 1) and when accounting for country fixed effects (Column 2), geographic coordinates polynomial (Column 3), geographic controls such as elevation, ruggedness, agricultural suitability, and climate (Column 4), sundry potentially confounding characteristics such as population size, proximity to Roman roads or distance to Wittenberg (Column 5), and administrative region fixed effects (Column 6). These estimates are stable across specifications and vary from 0.07 to 0.2 standard deviations. Figure 1 previewed the results in Column 1 and now Figure 14 displays the residualized binned scatter plots corresponding to Column 6, our most demanding specification.

To supplement this analysis, we took advantage of the historical fact that many bishoprics in different parts of Europe were suppressed by non-Christian powers for periods lasting from a few decades to centuries. The effectively 'disconnected' the conquered bishopric from the Church's network and limited, or sometimes eliminated, the influence of local bishops. These suppressions include pagan uprisings in Germany and England as well as Muslim conquests in Spain and Italy. The extent to which Christians were suppressed varied across cases. For example, the Saxons in northern Germany rebelled in 772 against Charlemagne's Christian Empire after his forces destroyed a sacred pagan. It took the Empire roughly three decades to end this uprising. Over in the Elbe-Baltic region, Wendish pagans seized control for nearly two centuries, effectively eliminating the power of local bishops. In Sicily, Muslim conquests in 827 CE left the Catholic bishoprics intact. But, without the support of the political leadership, their ability to implement Church policies was weaker. After the Norman conquest of 1061, Sicily's bishoprics entered the Catholic hierarchy, headed by the Pope in Rome. Eventually, by 1500 CE, all suspended bishoprics had been restored to the Catholic fold.

These suppressive events offer a degree of pseudo-random variation. Clearly, from the point of view of those who founded particular bishoprics, successful uprisings and conquests were not planned and the vagaries of battle add a stochastic element—many pagan uprisings and Muslim efforts at conquests failed. For example, in 732 CE a large Muslim force crossed the Pyrenees, established control of Septimania (in Narbonne) and sent a raid into Bordeaux. In a battle near Tours, the Muslim commander was killed in the melee, resulting in chaos in the Mulsim ranks and a rapid withdrawal. This chance death effectively ended a promising campaign into the heart of Frankish territory. The victory boosted the prestige of the Frankish leader, Charles Martel and his lineage. Martel's grandson, Charlemagne, was crowned Emperor in 800 CE by Pope Leo III.

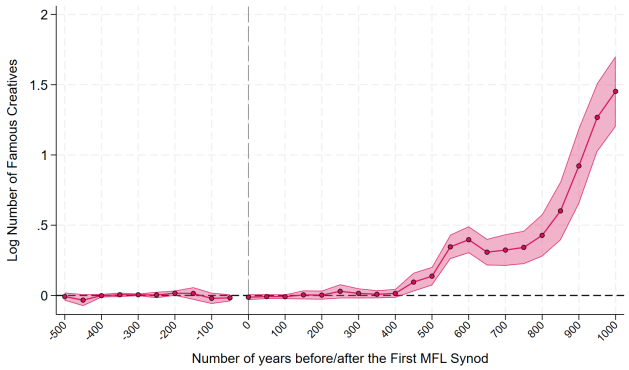
Analyzing this, Table C.1 shows that the total duration of Church Exposure and period of suppression influence all three of our measures of innovation in the expected manner. Longer Church exposure is associated with more patents, inventors and notable creatives per capita while longer suppressions results in fewer. The stochastic nature

of these suppressions partially addresses concerns that the Church may have been strategically targeting regions that would experience rising creativity a few centuries after its arrival. The smaller effect size for the duraction of suppression is consistent with the fact that many bishoprics were merely weakened rather than eliminated and the pre-existence of a bishopric meant they could rapidly re-enter the Catholic fold.

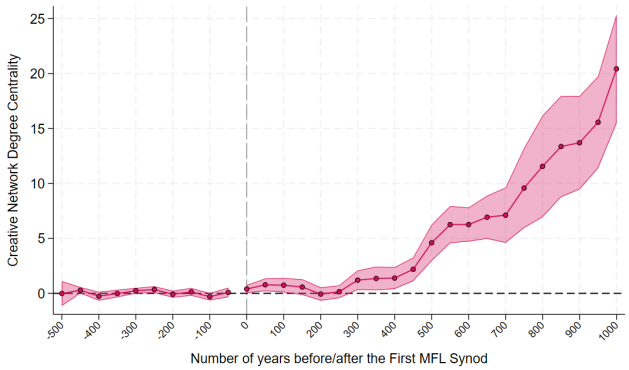
Table 2: Innovation and Church Exposure: Grid-Cells in Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A:	Patents per capita						
Medieval Church Exposure	0.14***	0.18***	0.15***	0.09***	0.08***	0.08***	
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	
MFL Synods Attended by the Bishop					0.10***	0.11***	0.12***
					(0.03)	(0.03)	(0.03)
Placebo Synods Attended by the Bishop						-0.02	-0.02
						(0.02)	(0.02)
Adjusted-R^2	0.02	0.09	0.09	0.12	0.12	0.12	0.12
Observations	78315	78315	78315	78308	78308	78308	78308
Panel B:	Inventors per capita						
Medieval Church Exposure	0.07***	0.13***	0.12***	0.07***	0.06***	0.06***	
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	
MFL Synods Attended by the Bishop					0.07***	0.07***	0.08***
					(0.02)	(0.02)	(0.02)
Placebo Synods Attended by the Bishop						-0.01	-0.01
						(0.01)	(0.01)
Adjusted-R^2	0.01	0.06	0.06	0.07	0.07	0.07	0.07
Observations	78315	78315	78315	78308	78308	78308	78308
Panel C:	Share of Famous Creatives						
Medieval Church Exposure	0.06***	0.06***	0.09***	0.04*	0.04*	0.04*	
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	
MFL Synods Attended by the Bishop					0.02	0.02	0.02
					(0.00)	(0.00)	(0.00)
Placebo Synods Attended by the Bishop						0.01	0.01
						(0.00)	(0.00)
Country FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	No	No	Yes	Yes	Yes	Yes	Yes
Geographic Controls	No	No	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	Yes	Yes	Yes	Yes	Yes
Administrative Regions FE	No	No	No	Yes	Yes	Yes	Yes
Adjusted-R^2	0.00	0.06	0.07	0.09	0.09	0.09	0.09
Observations	23168	23168	23168	23165	23165	23165	23165

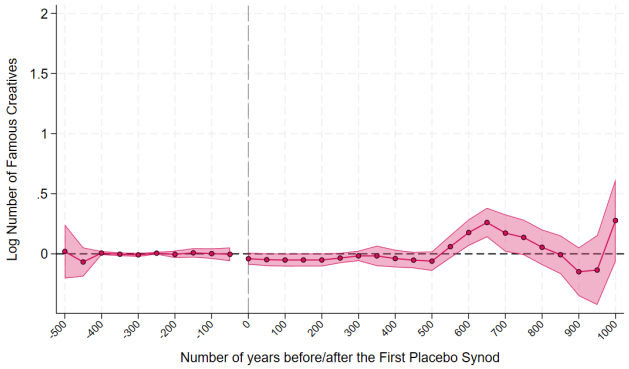
Notes: Using OLS regression, this table establishes a positive significant relation between the number of inventors per capita and the number of centuries spent under the exposure to Catholic church from year 500 to 1500, across the 0,125 by 0,125 degree cells in Europe. Latitude and longitude polynomial is of a second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.



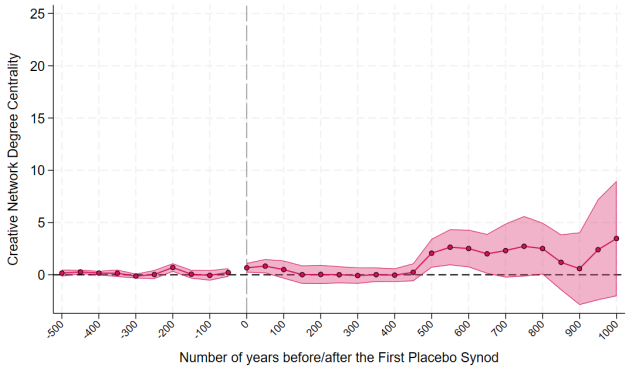
(a) Famous Creatives and MFL Synods



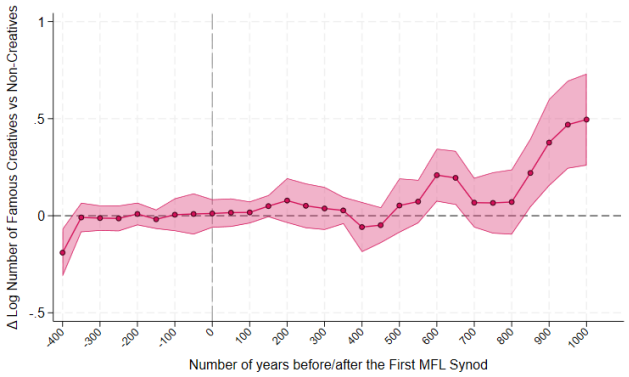
(b) Creative Network Degree Centrality and MFL Synods



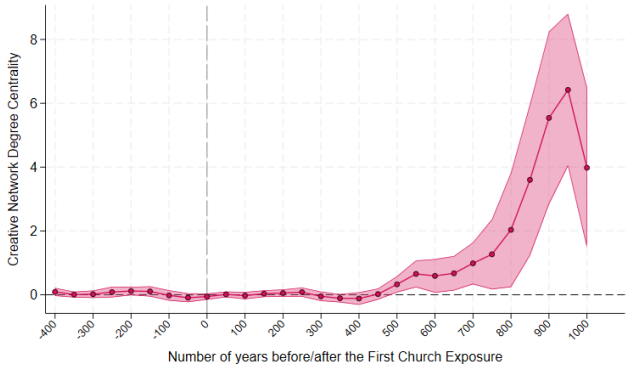
(c) Famous Creatives and Placebo Synods



(d) Creative Network Degree Centrality and Placebo Synods



(e) Famous Creatives and Synods: Triple Diff



(f) Creative Network Degree Centrality and Synods: Triple Diff

Figure 9: Even-study Estimates of the Effect of Marriage and Family Synods on Famous Creatives and their Social Network Degree Centrality

Notes: The figure reports CSA estimates and 95% confidence intervals for the effects of exposure to marriage and family legislation (MFL) synods on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and the creative network degree centrality in Panel (b), as well as the effects of exposure to all other (placebo) synods on these outcomes in Panels (c) and (d). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one after the local bishop attended the first synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

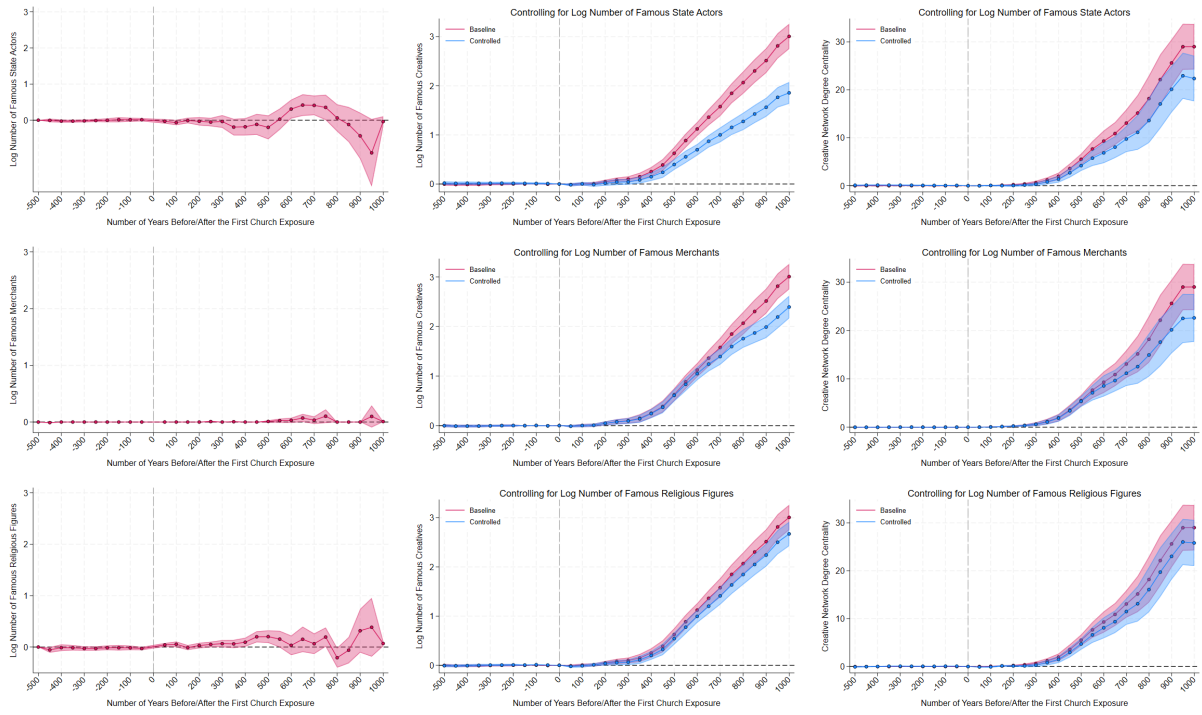


Figure 10: Robustness to Alternative Mechanisms

Note: Seeking to account for alternative mechanism, we explore the role of three different proxy measures derived for the Notable dataset. We consider a role for state capacity by studying the dynamics of lawyers/administrators, politicians, nobles, and military leaders (Row 1). To consider the role of market scale, Row 2 studies the production of notable business people. To assess the direct employment of notables, Row 3 studies the production of famous religious figures. Column 1 provide an event analysis, paralleling our approach above for creatives and network centrality. Columns 2 and 3 re-run our main event analysis controlling for these proxies to assess their influence on main results.

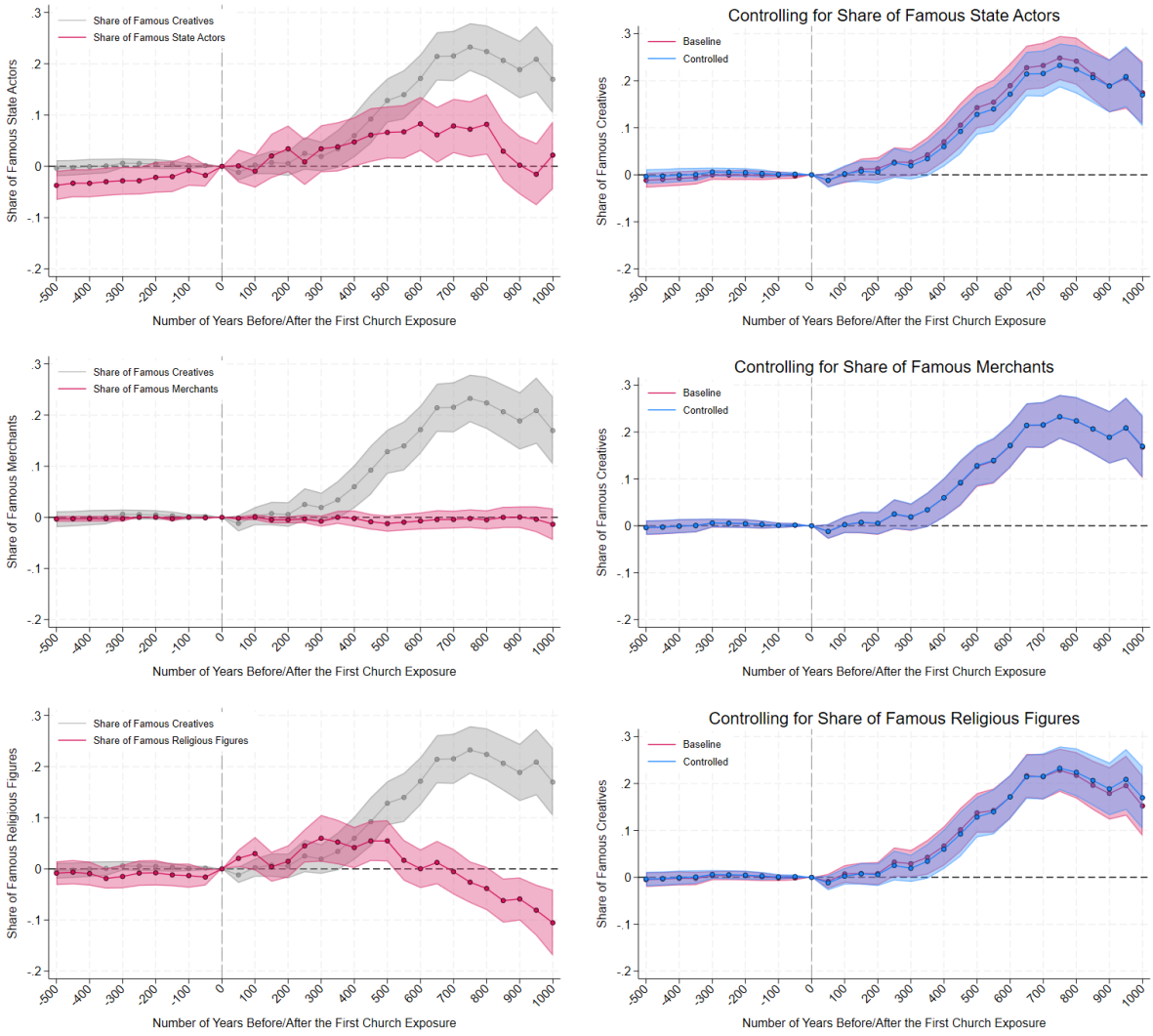


Figure 11: Shares of Different Categories of Famous People out of all Famous People

Note: Seeking to account for alternative mechanisms, we explore the role of three different proxy measures derived from the Notable dataset using shares of specific types of famous people out of all famous people. We consider a role for state capacity by studying the share of lawyers/administrators, politicians, nobles, and military leaders (Row 1). To capture market scale, Row 2 examines the share of notable business people. To assess direct employment by the Church, Row 3 focuses on the share of famous religious figures. Column 1 presents event-study estimates, paralleling our baseline approach but using shares rather than log counts. Column 2 re-estimates our main specification while controlling for these proxies to assess their influence on the core results.

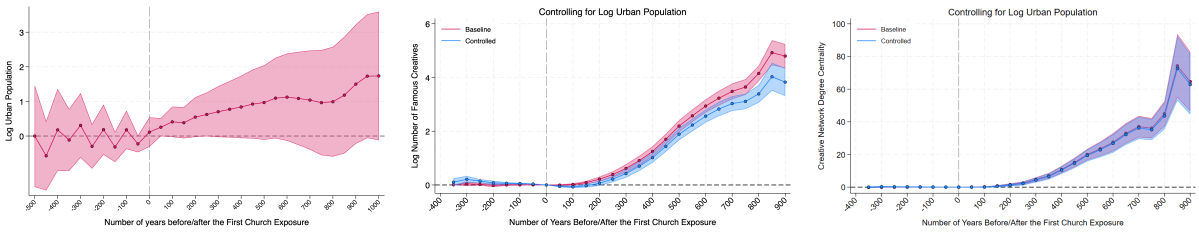


Figure 12: Urban Population as a potential mechanism

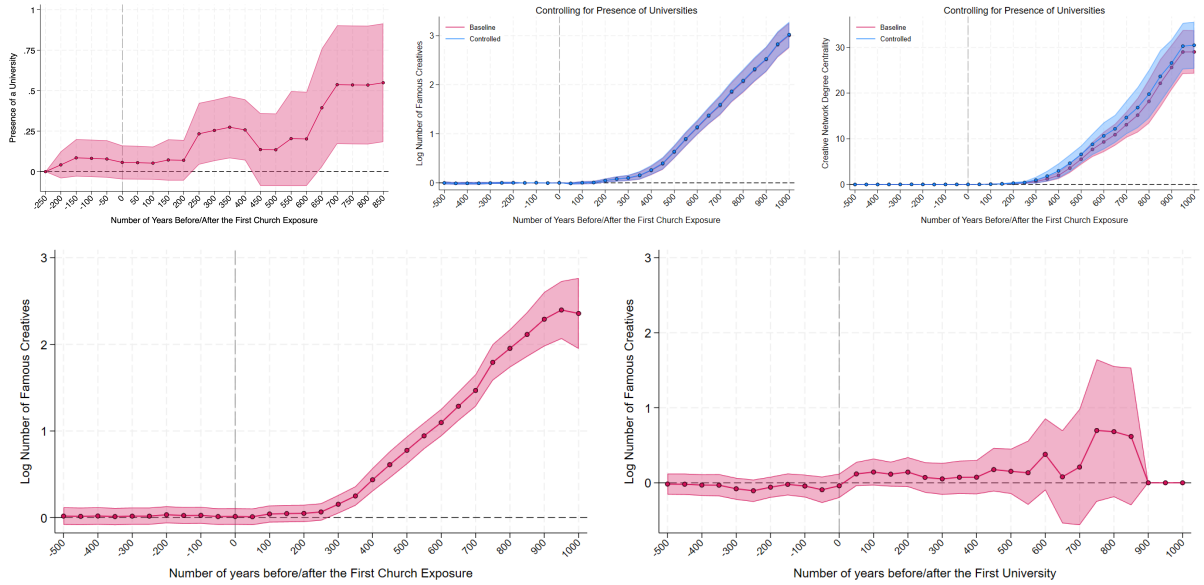
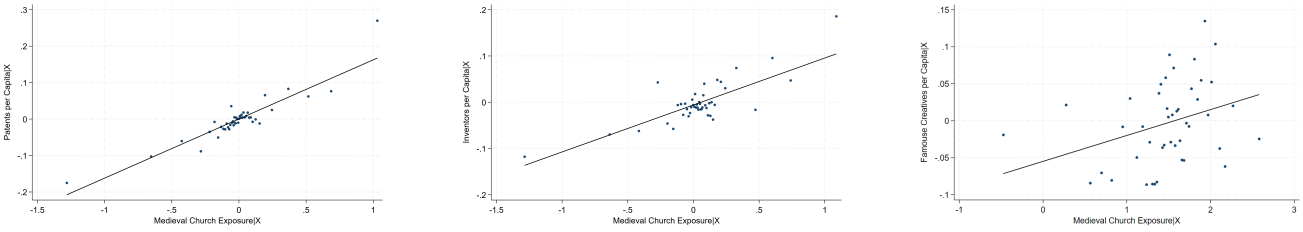


Figure 13: A potential role for medieval universities. Lower row: Church and University Interaction Effects: Sun and Abraham (2021) Estimator



(a) Patents per Capita (b) Inventors per Capita (c) Share of Famous Creatives

Figure 14: Contemporary Innovation and Church: Residualized Binned Scatter Plots based on Column 6 (Table 2)

5.4 Contemporary Mechanisms: Synods, Social Structure and Psychology

The Church-Innovation Hypothesis proposes that the medieval Church inadvertently propelled innovation in Europe in two interrelated ways. First, by creating a pan-European organization based on shared religious beliefs, kinship practices and marriage customs, the Church opened the door to richer social interactions, inter-ethnic exchanges and inter-tribal marriages. Second, by gradually transforming the intensive kinship groups and clans of Europe into monogamous nuclear households, the Church initiated a set of social and psychological changes that freed people to build more distant social ties, opening the door to greater individualism, less conformity, more trust and fairness with strangers and fewer constraints on residential mobility. That is, with fewer kin ties, fewer family responsibilities and no ancestral rites, more people could move as individuals to new places, where they'd find fellow Christians and like-minded others. These changes would have fueled the flow of individuals across space and the exchange of ideas among diverse minds, resulting in greater creativity and innovation in local populations.

If the latter element of the Church-Innovation Hypothesis—the dissolution of intensive kinship—plays an important role in this process, we may observe some lingering influence of the frequency with which a region's bishops attended Church councils at which legislation related to marriage and the family was discussed and ratified. In the historical analysis above, we used an event study design to examine the long-term effects of bishops attendance at Church councils where marriage legislation was addressed. Here, we study the cumulative effect of bishops' attendance over the early Middle Ages (500 to 743 CE). Differences the rates of attendance of Church councils offers variation on the intensive margin, allowing us to compare regions at the core of the Carolingian Empire (in France, western Germany and northern Italy), where little variation exists in Church exposure based on the founding of bishoprics.

To test the Church-Innovation Hypothesis, we add the attendance records for early medieval bishops, partitioning the record based on whether the council meeting involved discussing and ratifying legislation related to marriage and the family (MFL synods) or not (Placebo synods). On-average, bishops attended 3 MFL synods out of 14 and attend 2 placebo synods out of 16. For patents and inventors per capita, in Panels A and B of Table 2, columns 5 and 6 show that more attendance at MFL synods is associated with both more patents and inventors per capita. As standard deviation increase in attendance at MFL synods is associated with an 11 and 7% of standard deviation increase in patents and inventors per capita, respectively. As expected, attendance at placebo synods is not associated with either measure of innovation–the coefficients are near zero and poorly estimated. Using the share of famous creatives as a measure of innovation, shown in Panel C, our estimates reveal a positive coefficient, though the coefficient is imprecisely estimated with a 95% confidence interval that includes zero. The coefficient for placebo synods is half that of the MFL synods includes its 95% CI includes zero. Here, we can think of Church exposure (bishoprics) and attendance at MFL councils as offering extensive and intensive margins.

One concern with this analysis is that a region's bishop can't attend a Church council unless a bishopric has first been founded. To address this, Table 3 zooms in on the region of the Carolingian Empire, where the all

Table 3: Innovation and Church Exposure: Effect of Incest Prohibition

	Patents per Capita		Inventors per Capita		Share of Fam Creatives	
	(1)	(2)	(3)	(4)	(5)	(6)
MFL Synods Attended by the Bishop	0.19***	0.21***	0.16***	0.16***	0.06**	0.05*
	(0.03)	(0.03)	(0.01)	(0.02)	(0.00)	(0.00)
Placebo Synods Attended by the Bishop		-0.03		-0.01		0.00
		(0.01)		(0.01)		(0.00)
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.33	0.33	0.32	0.32	0.05	0.05
Observations	9442	9442	9442	9442	7337	7337

Notes: Using OLS regression, this table establishes a positive significant relation between the number of patents per capita, inventors per capita, share of famous creatives, and the number of MFL Church synods attended by the local Bishop between 500 and 743 CE, across the 0,125 by 0,125 degree cells in Europe, while establishing no significant relationship between these outcomes an the number of other (placebo) Church synods attended by the local Bishop during the same period. Latitude and longitude polynomial is of a second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

councils were held and within which nearly all territories possess at least one bishopric before the relevant MFL synods began at 500 CE. Across all specification, we estimate significant coefficients ranging from O.05 (famous creatives) to 0.21 (patents per capita) for the relationship between bishop's attendance of MFL synods and our three innovation measures. By contrast, estimated coefficients for attendance at placebo synod are close to zero, fluctuated between negative and positive, and poorly estimated.

In both Tables 2 and 3, the relationships between our three innovation measures and both Medieval Church Exposure and Bishops' Attendance at MFL Synods remains robust (save for the single exception noted above) when we only comparing regions within the same countries or even within subnational administrative regions and while holding constant population size, regional area, latitude/longitude (using second degree polynomials) and a number of geographic controls, including elevation, terrain ruggedness, agricultural suitability, temperature, precipitation (mean and standard deviation) and distance to the nearest coast or river.

5.4.1 Why does the influence of the Medieval Church persist into the modern world?

The Medieval Church, through the office of the bishop, played an important role in social life throughout the Middle Ages. However, today there's little reason to suspect that bishops or the Church's administration directly influence patenting or the production of famous creatives in the largely secular countries of modern Europe. Thus, a key question is how has the influence of the Medieval Church persist into the modern world? Many of the mechanisms that could plausibly explain creativity before 1800 CE have disappeared or been taken over by secular institutions. For example, the Church promoted the use of Latin as a *lingua franca* but today Latin is largely gone except

from within the Church itself. Likewise, formal schooling, once provided by Cathedral schools, is now universal througout Europe and supplied by the secular state. The supernatural beliefs promoted by the Church have largely declined and play much less of a role in people's lives.

The Church-Innovation Hypothesis proposes that the medieval Church shaped people's social norms and practices related to families and social networks along with certain aspects of their psychology. This mutually-reenforcing package of kinship and psychology has persisted. Specifically, we test three sets of predictions derived from this hypothesis:

1. Greater medieval Church exposure should positively predict both the prevalence of nuclear family households and broader social networks in the modern world (Section 5.4.3). Many of the medieval Church's marriage and family policies favored the emergence of monogamous nuclear families (Henrich, 2020; Greif, Mokyr and Tabellini, 2025). Without strong kin groups, the survival and prosperity of individuals required them to establish their own portfolios of relationships with strangers to find mates, friends and mutual support (creating safety nets). These strategies became embedded in culturally transmitted social norms, beliefs and practices.

2. Greater medieval Church exposure should also positively predict key aspects of psychology, specifically impersonal trust, impersonal fairness, non-conformity and independence (Section C.3). Consistent with research in the field of cultural evolution, aspects of psychology like trust will coevolve culturally with informal social norms about family structure and the breath of people's social networks. (Schulz et al., 2019; Henrich et al., 2010).

3. These intermediate variables–nuclear family prevalence, social network breadth and WEIRD psychology—should predict our contemporary measures of innovation (Section 5.4.4). Social structures and psychological inclinations that encourage rich interaction among diverse minds will foster more rapid innovation and greater creativity through the recombination of ideas.

Here, we test for the existence of the expected empirical correlations but do not endeavor to confirm causal relationships. We could find, for example, that the expected correlations do not appear, which would shift the exploration in favor other other potential mechanism.

5.4.2 Data: Contemporary Social Structure and Psychology

To analyze these predictions, we have assembled six contemporary variables. First, to capture the impact of the Church on family organization, we created a measure of the prevalence of single-nuclear households. The measure is constructed from the data of the 2001 European Population and Housing Census provided by Eurostat. The data covers 759 NUTS 3 regions in Europe and reflects the structure of local households by composition. These data enable us to capture the share of households that consist of a single nuclear family, as opposed to those comprised

of several nuclei (e.g., several generations or siblings/cousins residing together). The geographic coverage and distribution of the resulting measure are reflected in Figure A.3.

Second, to capture the shift in social network structure linked theoretically to the Church, we employ the Facebook Social Connectedness data (Bailey et al., 2018). Indicators provided in the dataset, among other things, reflect an average share of Facebook friends individuals have outside a 100-mile radius from their location. We believe that a high relative number of friends outside the immediate geographic neighborhood of an individual indicates a predisposition toward forming wide networks with diverse counterparts outside of one's close social network, the resulting measure is constructed for 1476 NUTS 3 regions (Mapped in Figure A.4).

Third, to capture heterogeneity in the psychological traits that are associated with the Church's influence on kinship and social networks, we use four psychological measures from Schulz et al. (2019) based on questions in the European Social Survey. These capture: (i) Impersonal Trust (i.e., generalized trust towards other people); (ii) Impersonal Fairness (i.e., generalized fairness towards other people); (iii) Individualism (i.e., the importance of independence and original thinking); (iv) Non-Conformity (i.e., a lack of emphasis on conformity, tradition and obedience). The exact ESS questions used to construct each dimension are summarized in Section A.7. The psychological outcomes are captured across all survey waves and are aggregated at the smallest geographical level (i.e., NUTS 2 or 3 regions).[12]

For exposition purposes, we conducted a principal component analysis on our four psychological measures and found a single dominant component that captures 80% of the variation (Table A.2). We've dubbed this first component 'WEIRD Psychology,' where WEIRD is a backronym that stands for Western, Educated, Industrialized, Rich and Democratic (Henrich et al., 2010). We'll use WEIRD Psychology in the main text (mapped in Figure A.5) and supplement a full battery of analyses in the appendix using each psychological measure separately.

5.4.3 Church Exposure, Social Structure and Psychology

Focusing on the first prediction, Table 4 establish a link between Church Exposure based on bishoprics and both the prevalence of nuclear family house (Panel A), distant social network connections on Facebook (using NUTS 3 regions in Panel B) and WEIRD psychology (based on ESS questions in Panel C). In our most conservative specification (columns 4-5), a one standard deviation increase in Medieval Church exposure corresponds to increases of 0.12, 0.20 and 0.09 in the prevalence of nuclear families, distance FB friends and WEIRD psychology, respectively. These specifications only compare regions within the same country and hold constant religiosity (from the ESS, see Section C.5), population size, regional area, longitude/latitude (using second degree polynomials) and a broad range of geographic variables. For WEIRD Psychology, Table C.2 analyses each of our four psychological outcomes separately. Since one might suspect a link between Church exposure and modern religiosity, columns 3-6 add a

[12] Enke (2019) links kinship to a similar battery of psychological traits.

control for religiosity based on the European Social Survey.[13]

Overall, these correlations support the hypothesis that extended exposure to the Western Church led to fundamental alterations in social structure, diminishing the importance of familial ties and expanding individuals' social networks beyond the local level.

Next, we assess whether links can be established between the attendance of bishops at early medieval Church councils and our three social structural and psychological variables. For distance Facebook friends and WEIRD Psychology in Panels B and C (Table 4), we find that a standard deviation increase in a bishops attendance at synods where marriage and family legislation (MFL synods) was discussed is associated with an increase of 0.09 and 0.05 of a standard deviation, respectively. These correlation hold even when we only compare regions within the same country and control for religiosity, population size, regional area, longitude/latitude (using second degree polynomials) and a broad range of geographic variables.

However, in Panel A where we have substantially fewer observations, we do not observe positive association between the attendance of bishops at MFL synods and the prevalence of single-nuclear family household.

[13]In contrast to these linkages with medieval Church exposure, Table C.4 shows that medieval Church exposure doesn't reliably predict religiosity. Indeed, the most effects are non-significant and the coefficient flips sign across some specifications.

Table 4: Social Structure, WEIRD Psychology, and Church Exposure: NUTS 3 Regions in Europe (OLS)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	Share of Single-Nuclear Households					
Medieval Church Exposure	0.08	0.11*	0.12**	0.12**	0.12**	
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	
MFL Synods Attended by the Bishop				0.00	-0.00	0.01
				(0.02)	(0.03)	(0.03)
Placebo Synods Attended by the Bishop					0.01	-0.00
					(0.03)	(0.03)
Adjusted-R^2	0.83	0.86	0.86	0.86	0.86	0.86
Observations	851	851	849	849	849	849
Panel B:	Share of FB friends outside 100 miles					
Medieval Church Exposure	0.23***	0.34***	0.24***	0.20***	0.21***	
	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)	
MFL Synods Attended by the Bishop				0.12***	0.09**	0.12***
				(0.03)	(0.04)	(0.04)
Placebo Synods Attended by the Bishop					0.07	0.05
					(0.09)	(0.09)
Adjusted-R^2	0.25	0.35	0.59	0.60	0.60	0.59
Observations	1151	1151	1149	1149	1149	1149
Panel C:	WEIRD Psychology					
Medieval Church Exposure	0.19***	0.13**	0.10**	0.09***	0.09***	
	(0.06)	(0.05)	(0.04)	(0.03)	(0.03)	
MFL Synods Attended by the Bishop				0.03**	0.05***	0.06***
				(0.01)	(0.02)	(0.02)
Placebo Synods Attended by the Bishop					-0.04*	-0.05**
					(0.02)	(0.02)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	No	Yes	Yes	Yes	Yes	Yes
Geographic Controls	No	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	Yes	Yes	Yes	Yes
Religiosity	No	No	Yes	Yes	Yes	Yes
Adjusted-R^2	0.94	0.94	0.94	0.94	0.94	0.94
Observations	1149	1149	1149	1149	1149	1149

Notes: Using OLS regression, this table establishes a positive significant relationship between the Church Exposure and: (Panel A) share of non-multinuclear families, (Panle B) share of Facebook friends living outside the 100 mile radius, (Panel C) WIERD Psychology measured as the first principal component of four psychological traits (universal trust, universal fairness, individualism and non-conformity), across the NUTS 3 region in Europe. Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area and population. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

5.4.4 Innovation, Family Organization, Social Networks and WEIRD Psychology

In this subsection, we assess the predicted relationships between our three measures of innovation and (1) family structure (prevalence of nuclear families), (2) distant FB friends and (3) WEIRD Psychology. Panels A, B and

C of Table 5 demonstrate a positive statistically and economically significant effect of these features of social structure and psychology on our three measures of innovation: patents (logged), inventors (logged), and the share of famous creatives across Europe's NUTS 3 regions. These effects hold not only after controlling for population size (logged) but when we only compare regions within the same country and hold constant longitude, latitude and a range of geographical controls (mean elevation, terrain ruggedness, agricultural suitability, distance to the coast, temperature and other variables). The magnitude ranges from 0.12 to 0.6 for our richest specifications (columns 2,4 and 6). Table C.3 provides parallel analyses for each of our four psychological outcomes separately.

Table 5: Innovation, Social Structure, and WEIRD Psychology: NUTS 3 Regions in Europe (OLS)

	Patents per Capita		Inventors per Capita		Share of Fam Creatives	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:						
Share of Single-Nuclear Households	0.23***	0.16***	0.26***	0.20***	0.41***	0.23***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Adjusted-R^2	0.07	0.47	0.08	0.50	0.19	0.61
Observations	1110	1108	1110	1108	1109	1107
Panel B:						
Share of FB friends outside 100 miles	0.41***	0.30***	0.42***	0.35***	0.48***	0.37***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Adjusted-R^2	0.10	0.50	0.10	0.54	0.11	0.50
Observations	1476	1474	1476	1474	1455	1453
Panel C:						
WEIRD Psychology	0.46***	0.53***	0.54***	0.54***	0.32***	0.33***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes	No	Yes
Lon/Lat Polynomial	No	Yes	No	Yes	No	Yes
Geographic Controls	No	Yes	No	Yes	No	Yes
Religiosity	No	Yes	No	Yes	No	Yes
Adjusted-R^2	0.23	0.50	0.29	0.53	0.10	0.47
Observations	1474	1474	1474	1474	1453	1453

Notes: Using OLS regression, this table establishes a positive significant relationship between the number of patents per capita and: (Panel A) share of non-multinuclear families, (Panle B) share of Facebook friends living outside the 100 mile radius, (Panel C) WIERD Psychology measured as the first principal component of four psychological traits (universal trust, universal fairness, individualism and non-conformity). Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

5.4.5 Church Exposure and Persistence of Creative Networks

The mechanisms of persistence described above for the Church-Innovation Hypothesis propose that people in regions in which the social networks are more open, with more distant connections, and where people are less conformist and more trusting and fair-minded towards strangers are more likely to interact, share ideas and devise novel recombinations (creative products including patentable inventions). To further test the mechanism, Table 6 analyzes the patterns of co-invention (joint patenting) across European regions. Specifically, we study the influence of both the length of time two regions $1.5° \times 1.5°$ grid-cells) were jointly under the Church's administration (i.e., both had bishoprics) and the flows of famous people during reach century from 1200 to 2000 CE. We estimate the following model:

$$copat_{ij} = \beta Church_Exp_{ij} + \sum_k \beta^k X_{ij}^k + \mu_i + \lambda_j + \varepsilon_{ij}, \tag{6}$$

where the outcome variable, $copat_{ij}$, represents the number of co-patents for a pair of grid-cells i and j (i.e., patents co-authored by a team where at least one author is from cell i and another from cell j) written between 1980 and 2010. The explanatory variable, $Church_Exp_{ij}$, captures the number of years both grid-cells i and j were under the influence of the Western Church together. X_{ij}^k are the dyad-level controls, including the distance between the grid cells, an indicator for being within the same country, and being connected by Roman roads. μ_i and λ_j are grid-cell fixed effects.

Table 6 reports the results. Column 1 shows just the impact of centuries jointly under the Church's administration. The β coefficient is estimated to be positive and highly significant, with a magnitude of 0.12 in standardized form, confirming the importance of the medieval Church in forming long-lasting creative networks among inventors up to the present. Columns 2–10 of Table 6 report estimates from models similar to (6), but with an additional explanatory variable—the number of famous migrants in the past. According to the results in Section 4.2, the Church created conditions for establishing social links between places in the past, which we capture via the flow of famous historical migrants. This analysis demonstrates that these links, established as far back as the 1400s, continue to have a significant positive effect on the number of creative connections between inventors today, as measured by the number of co-patents, further confirming our theory.

These findings are consistent with the Church-Innovation Hypothesis in linking the production of joint patents to both shared medieval Church exposure and historical flows between regions. The idea is that the arrival of the Church in a region both opens up people's social networks and shifts their psychology, reducing conformity and distrust while increasing individualism and fairness-mindedness towards strangers. Historically, this opened up the flow of migrants between regions exposed to the Church and these flows further established connections between these places.

Table 6: Famous People Networks and Contemporary Co-Patents : Cells in Europe (OLS)

	Number of Joint Patents (1980-2010)									
		1200	1300	1400	1500	1600	1700	1800	1900	2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Famous People Migration Volume (circa)		0.05	0.00	0.06**	0.30***	0.20**	0.12**	0.25*	0.40***	0.32***
		(0.04)	(0.01)	(0.02)	(0.10)	(0.09)	(0.06)	(0.13)	(0.13)	(0.12)
Joint Number of Years under the Church	0.12***	0.11***	0.12***	0.11***	0.09***	0.10***	0.11***	0.10***	0.09***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)
Grid Cells FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dyadic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.13	0.13	0.13	0.13	0.21	0.16	0.14	0.18	0.26	0.22
Observations	15891	15891	15891	15891	15891	15891	15891	15891	15891	15891

Notes: Using dyadic OLS regression, this table establishes a positive significant relation between the number of co-patents in a pair of grid-cells and the number of years jointly spent under the influence of the Church, as well as the volume of famous migrants in years 1200 – 2000, across the unique pairs of 1,5 by 1,5 degree cells in Europe. Dyadic controls include distance and binary indicators of being in the same country and being connected via Roman roads. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

6 Conclusion

Economists and other social scientists have long considered both the origins of innovation and the role of religion in economic growth (Weber, 1958; Benabou et al., 2015). Operating at the nexus of these enduring questions, this paper explores the impact of the medieval Western Church on both contemporary and historical creativity and innovation in Europe. We motivate this inquiry with the surprisingly strong correlation between the number of centuries a regional population spent under the Western medieval Church and both the production of patents and inventors per capita (Figures 1 and 14).

To assess the nature and robustness of the relationship between the medieval Church and innovation both historically and today, we develop a measure of creativity based on the production of famous creative people relative to non-creatives using a database of over 850K individuals between 1 and 2010 CE (Laouenan et al., 2022). We confirm that this new measure is correlated with traditional economic measures of innovation based on patents and inventors in the modern world.

In our historical analysis, we use event-study designs based on the founding of Latin bishopics across Europe from 500 to 1500 CE. Our battery of analyses, which includes a triple difference analysis, indicates that the arrival of the medieval Church sparks a long-term rise in the production of creatives relative to non-creatives. The results indicate that by roughly two centuries after the arrival of a bishopric, the production of famous creatives begins to rise relative to the production of famous non-creatives. The specification includes period-by-location fixed effects, absorbing all time-varying factors common to creatives and non-creatives within a grid cell. Identification therefore

requires that, absent bishopric establishment, the relative production of creatives versus non-creatives would not have changed systematically around the timing of establishment. We observe no pre-trends that might jeopardize our inference. Across all of our historical analyses, our results remain robust to different analytical approaches, estimation methods, corrections for spatial autocorrelation, use of different subsets of the data and controls for urbanization and population size in various ways.

Our historical analyses point to a common process through which the Church may have fostered creativity: reconfiguring local social organization while increasing connectivity across communities. We examine this in three ways. First, the arrival of the Church is followed by greater regional connectivity, measured using the migration of notable individuals. Migration between two locations increases after both become exposed to the Western Church. Second, the production of creatives and network centrality rise after local bishops attend synods at which marriage and family legislation that undermined clan cohesion was passed, whereas we do not observe comparable patterns following attendance at other synods. Third, greater Church exposure predicts the subsequent presence of monasteries, while monasteries are themselves associated with both greater creative production and greater network centrality. Together, these results are consistent with the idea that the Church weakened intensive kin-based organization while simultaneously creating broader institutions and networks through which people, practices, and ideas could circulate.

We also consider several complementary mechanisms, including state capacity, market expansion, urbanization or the founding of medieval universities. Our proxies provide some evidence that several of these factors—particularly state capacity, urbanization, Church employment, and universities—also respond to the arrival of bishoprics. Importantly, however, accounting for these complementary channels leaves the relationships between Church exposure, regional connectivity, and creative production largely unchanged. Thus, while our measures are not designed to rule out important roles for these mechanisms, the patterns emphasized by the Church-Innovation Hypothesis cannot be readily explained by the observable proxies for these alternative channels.

The historical influence of the medieval Church appears to have cast a long shadow. We find a robust relationship between the duration of medieval Church exposure and three contemporary measures of innovation: patents and inventors per capita and the share of famous creatives. These relationships hold when comparing regions within the same country or administrative region and controlling for a broad range of geographic and historical characteristics. Consistent with the channel emphasizing the reconfiguration of social organization, we find that greater medieval Church exposure predicts a higher prevalence of nuclear-family households, broader and more geographically dispersed social networks, and psychological traits including generalized trust and fairness, individualism, and non-conformity. Bishops' historical attendance at synods dealing with marriage and family legislation also predicts broader contemporary networks and several of these psychological outcomes. These features of contemporary social structure and psychology are themselves positively associated with patents, inventors, and the production of famous creatives. Historical migration links between European regions also predict contemporary

co-patenting. Although these contemporary relationships are correlational, they are consistent with persistence through changes in family organization, social networks, and psychology.

Taken together, our findings suggest that the medieval Western Church may have fostered European innovation by reshaping social organization and increasing connectivity across communities. These changes appear to have facilitated the movement of people and ideas and may have left persistent effects on the social structures and networks associated with innovation today. More broadly, the results illustrate how religious institutions can have economic consequences that persist long after their direct authority has diminished.

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A Data Sources and Construction

A.1 Medieval Western Church Exposure

Panel Our historical analysis will leverage the uneven diffusion of bishoprics across Europe between 500 and 1500. To this end, we aggregate the distribution of active bishoprics into half-century intervals (500–549, 550–599, ... , 1450–1500) and partition Europe into $1.5° \times 1.5°$ grid cells. We construct an indicator variable that equals one if an active bishopric was located within a 100 km radius from the center of a given cell. The resulting pixel-level measures circa 500, 1000 and 1500 CE are visualized in Figure 2 (b), (d), and (f).

Cross-section Our analysis of contemporary outcomes will draw on dependent variables measured at varying levels of geographic granularity, ranging from fine-grained patent data to coarser survey data. Accordingly, we construct measures of Church exposure at different levels of aggregation. For the finest level, we replicate our earlier approach but divide Europe into smaller grid cells of $0.125° \times 0.125°$. For coarser aggregation, we map bishoprics onto modern NUTS 3 regions and construct an indicator variable equal to one if an active bishopric was located within a given region during a particular half-century interval. In both cases, we aggregate the data cross-sectionally by summing these indicators across all half-centuries and dividing by two, thus deriving an approximate measure of each grid cell's or region's duration of Church exposure, expressed in centuries. These measures are shown in Figure A.1.

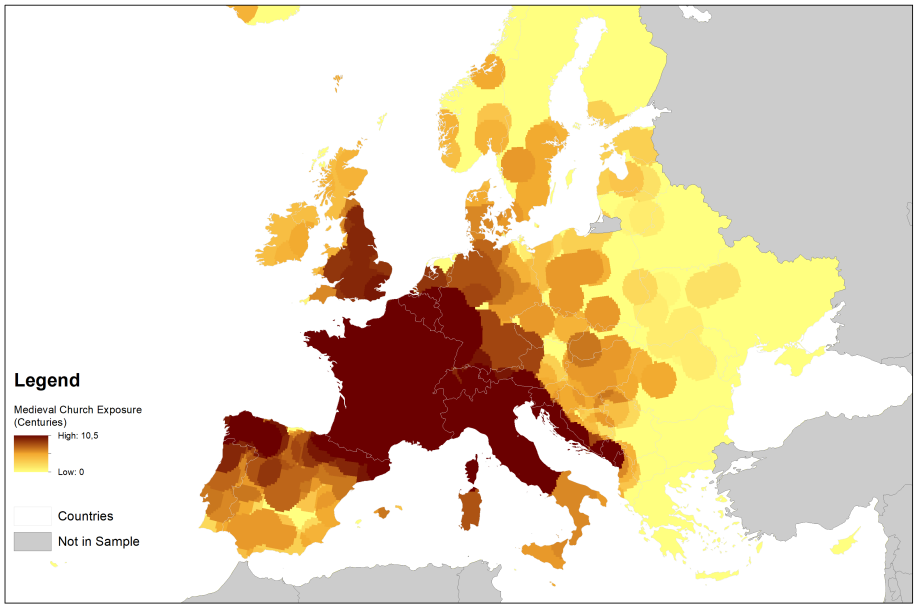


Figure A.1: Medieval Church Exposure: 0.125 x 0.125 Degrees Grid Cells

A.2 Panel of historical networks

We construct a panel dataset capturing the evolution of regional network embeddedness across Europe by combining the migration-based network described above with a time-varying measure of node centrality. For each half-century between 1 and 2000 CE, we treat the set of $1.5^\circ \times 1.5^\circ$ grid cells as nodes in a pan-European network, and define edges based on observed migration links of notable individuals (i.e., cases where an individual is born in one grid cell and dies in another within the relevant 50-year window). This procedure yields a sequence of temporally indexed network snapshots.

Within each snapshot, we compute degree centrality for every grid cell. Formally, for a given cell i in period t, degree centrality is defined as the number of distinct grid cells $j \neq i$ that are connected to i via at least one migration link during period t. This measure captures the extent to which a location is integrated into the broader network of intellectual and cultural exchange.

Aggregating these measures across all grid cells and time periods produces a balanced panel at the grid cell $\times$ half-century level. Each observation records the centrality of a specific location at a given point in time, allowing us to track the dynamic evolution of connectivity across space. The snapshots of the network as well as degree centrality measures of its nodes at years 500, 1000, 1250, and 1500 CE are depicted in the Figure 5.

A.3 Church's Marriage and Family Legislation

To capture regional variation in exposure to the Church's marriage and family (MF) legislation, we exploit differences in the attendance of bishops at early medieval synods. We begin by compiling a dataset of Church councils held between 500 and 743 CE and classifying each synod according to whether it addressed MF-related issues (e.g., prohibitions on consanguineous marriage, affinal unions, and polygyny). Locations, dates, and the classification of each council with respect to marriage and family (MF) legislation are summarized in Table A.1. We then match individual bishops to the synods they attended, based on historical records of council participation.

Our baseline measure of exposure is constructed at the bishopric level by counting the number of MF-related synods attended by each bishop. Intuitively, greater attendance reflects more direct exposure to the formulation and ratification of MF legislation, as well as a higher likelihood of its subsequent implementation within the bishop's jurisdiction. We then aggregate this information to the $1.5^\circ \times 1.5^\circ$ grid-cell level used throughout the analysis. A grid cell is considered exposed to a given synod if at least one bishop whose bishopric lies within that cell attended the synod. The resulting measure captures the cumulative intensity of local exposure to MF legislation through ecclesiastical networks.

Figure 8 visualizes the spatial distribution of this exposure aggregated over time (i.e., the number of synods each grid cell was exposed to between years 500 and 743). Panel (a) maps exposure to MF-related synods, while Panel (b) presents a placebo measure based on attendance at synods that did not address marriage and family issues. The contrast between these two measures allows us to isolate the specific role of MF legislation from broader

patterns of ecclesiastical activity.

Table A.1: Early Medieval Church Councils and Marriage & Family (MF) Legislation

Council	**Year**	**MFL Related**
Agde	507	
Orléans	511	✓
Épaone	517	✓
Épaone	517	
Lyon	518–519	
Arles	524	
Carpentras	527	
Vaison	529	
Marseille	529	
Orange	529	
Orléans	533	✓
Clermont	535	✓
Orléans	538	✓
Orléans	541	✓
Orléans	549	
Paris	551	
Paris	551–552	
Arles	554	
Paris	561–562	✓
Tours	567	✓
Lyon	567–570	
Paris	573	
Clermont	580	
Mâcon	581–583	
Lyon	583	✓
Mâcon	585	✓
Valence	585	
Paris	614	✓
Clichy	626	✓
Rome	721	✓
Rome	743	✓

A.4 Monasteries

To examine the role of monastic organizations in shaping regional connectivity and creativity, we construct measures of exposure to different monastic orders across European grid cells. We compile historical data on the locations of monasteries and classify each establishment by its religious order (e.g., Cistercian, Cluniac, Franciscan, Dominican, Premonstratensian), using the data compiled by Schulz et al. (2019). The original geo-located data on monastic houses are compiled from the Atlas zur Kirchengeschichte (Andersen et al., 2017) and the Digital Atlas of Roman

and Medieval Civilization (for Cluniac, Dominican, Franciscan, and Premonstratensian orders) (McCormick et al., 2013), as well as from Donkin's work (Donkin, 1978b) as digitized in Andersen et al. (2017). These data capture the spatial diffusion of monastic institutions that emerged and expanded across Europe beginning in the 10^{th} century, forming dense, supra-regional networks.

We aggregate monastery-level information to the $1.5° \times 1.5°$ grid-cell level used throughout the analysis. For each grid cell, we construct a cross-section measure of monastic exposure based on the number of monasteries located within the cell. Our baseline specification includes separate counts for the major monastic orders—Cistercian, Cluniac, Franciscan, Dominican, and Premonstratensian—as well as a composite measure capturing the total number of monasteries across all five orders. These measures reflect the intensity of local exposure to monastic networks and allow for heterogeneity across different organizational forms.

A.5 Patents and Inventors

To capture contemporary innovation at a fine geographic scale, we draw on a global geocoded dataset of patents compiled by De Rassenfosse et al. (2019). This dataset provides precise geographic coordinates for the inventors of approximately 18.8 million patents filed between 1980 and 2014, covering more than 99% of all patents recorded in the Worldwide Patent Statistical Database (PATSTAT). Importantly, the data include only first filings for each patent, thereby avoiding multiple counting of the same invention across jurisdictions.

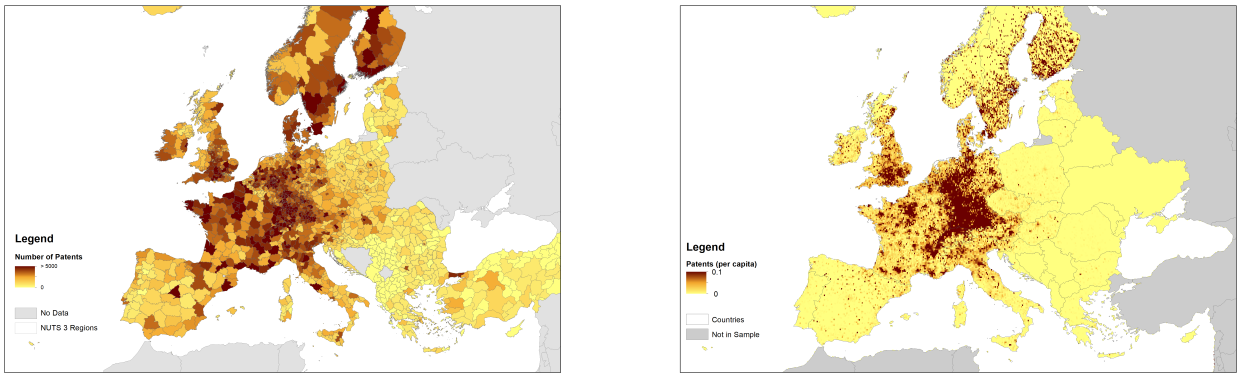
Each patent is assigned to a geographic location based on the address of its inventor, allowing us to spatially map innovative activity. We aggregate patent counts to our units of analysis—both NUTS 3 regions and $0.125° \times 0.125°$ grid cells—by summing the total number of patents associated with inventors residing in each location. To ensure comparability across regions of different sizes, we normalize these counts by population using data from the Gridded Population of the World (GPW v4) for the year 2010. The resulting measures capture the number of patents per capita produced by inventors in a given region over the 1980–2014 period and are depicted in Figure A.2.

In addition to patent counts, we construct a complementary measure of the number of inventors using the same methodology. Specifically, we identify unique inventors based on their geocoded locations and aggregate them to the same spatial units, again normalizing by population.

A.6 Contemporary Social Structure

We construct indicators capturing key features of contemporary social structure associated with WEIRD societies, namely weak kinship ties and open, geographically dispersed social networks. These dimensions reflect the extent to which individuals are embedded in narrow family-based systems versus broader, impersonal networks.

Single-Nuclear Households. We measure the looseness of kinship ties using data from the 2001 European Population and Housing Census provided by Eurostat. Specifically, we construct the share of single-nuclear households



(a) NUTS 3 (b) $0.125° \times 0.125°$ Grid Cells

Figure A.2: Geographic Distribution of Patents

using data from the European Population and Housing Census provided by Eurostat (dataset: Private households by household composition, size, and NUTS 3 region), which reports harmonized measures of household structure across European regions. A nuclear household is defined as a household composed of a single conjugal unit (e.g., parents and their children), in contrast to multi-nuclear households that include extended family members such as grandparents, siblings, or other relatives. We calculate the share of single-nuclear households in NUTS 3 region r as:

$$Single\ Nuclear\ Share_r = \frac{Single\ Nuclear\ Household\ Number_r}{Single\ Nuclear\ Household\ Number_r + Multi\ Nuclear\ Household\ Number_r}$$

This measure captures the extent to which individuals live in independent family units rather than within extended kin-based structures. A higher share of single-nuclear households indicates weaker kinship intensity, greater residential independence, and reduced reliance on extended family networks—features that are closely associated with WEIRD social organization. The geographic distribution of this measure is shown in Figure A.3.

Social Network Openness: Facebook Connectedness. To capture the openness and geographic breadth of social networks, we use data from the Facebook Social Connectedness Index (SCI) constructed by Bailey et al. (2018). The SCI measures the intensity of social ties between locations based on friendship links on Facebook.

Using these data, we construct a measure of network openness defined as the average share of Facebook friends located outside a 100-mile radius for individuals in each NUTS 3 region. This measure reflects the extent to which individuals maintain connections beyond their immediate geographic and social environment.

A higher value indicates more geographically dispersed and potentially more diverse social networks, suggesting greater engagement in impersonal, non-local interactions. Such network structures are characteristic of WEIRD societies, where social ties extend beyond kin and local communities. The geographic distribution of this measure

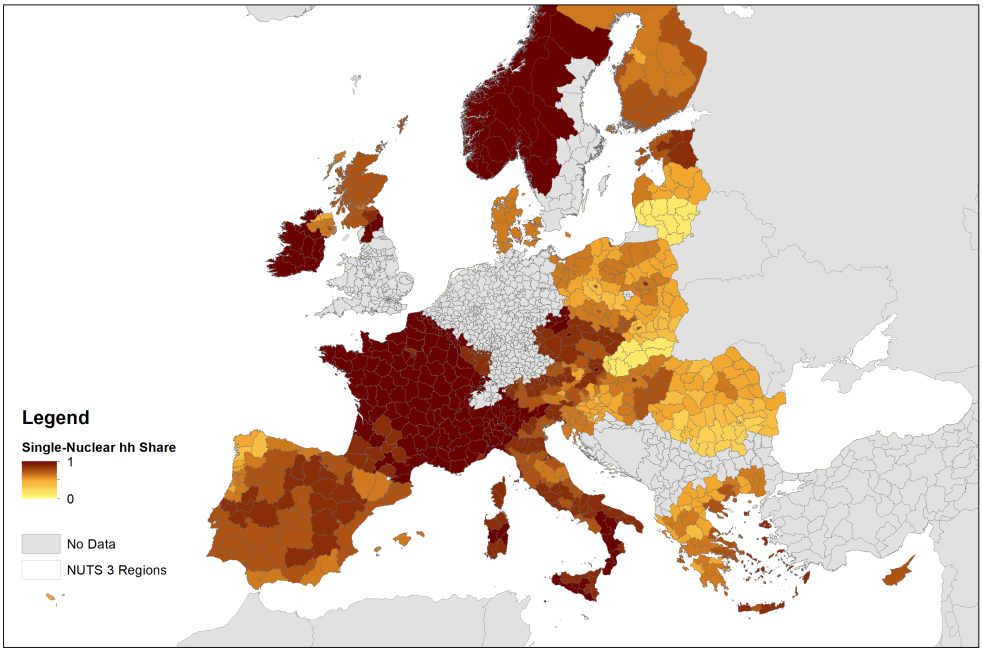


Figure A.3: Share of Single-Nuclear Households: NUTS 3 Regions in Europe

is presented in Figure A.4.

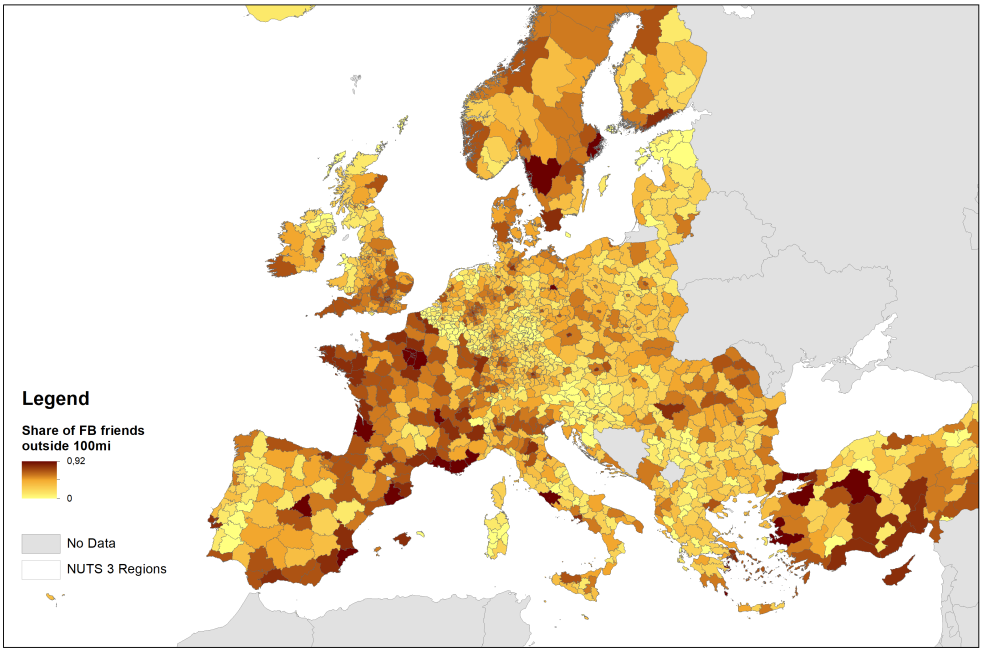


Figure A.4: Average Share of Facebook Friends Outside of the 100-mile Radius: NUTS 3 Regions in Europe

A.7 Measures of WEIRD Psychology

To capture cross-regional variation in psychological traits associated with WEIRD societies, we draw on individual-level data from the European Social Survey (ESS). Guided by Schulz et al. (2019), we focus on four key dimensions: universal trust, universal fairness, independence, and non-conformity. These dimensions capture both how individuals relate to strangers (impersonal prosociality) and how they relate to social norms and autonomy.

Universal Trust. Universal trust captures the extent to which individuals extend trust beyond close kin and familiar social circles. We measure this dimension using the ESS question: "Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?" (ESS variable: `ppltrst`). Responses are recorded on an 11-point scale ranging from 0 ("you can't be too careful") to 10 ("most people can be trusted"). Higher values indicate greater generalized trust toward others.

Universal Fairness. Universal fairness reflects expectations about how others behave in impersonal interactions. We use the ESS question: "Do you think that most people would try to take advantage of you if they got the chance, or would they try to be fair?" (ESS variable: `pplfair`). Responses are recorded on an 11-point scale from 0 ("people would try to take advantage") to 10 ("people would try to be fair"). Higher values indicate stronger expectations of fairness in interactions with strangers.

Independence. Independence captures the importance individuals place on autonomy and self-direction. Following Schulz et al. (2019), we construct an index based on ESS human values items derived from Schwartz's value framework. Specifically, we use: "Thinking up new ideas and being creative is important; doing things in one's own original way" (`ipcrtiv`) and "It is important to make one's own decisions and be free" (`impfree`). Each item is measured on a 6-point scale ranging from 1 ("very much like me") to 6 ("not like me at all"). We recode these variables so that higher values correspond to greater independence and then standardize and average them to form a composite independence measure.

Non-Conformity. Non-conformity captures the extent to which individuals deviate from social norms and traditions. In line with Schulz et al. (2019), we construct this measure as the inverse of conformity and obedience. We use two ESS items: "It is important to follow traditions and customs" (`imptrad`) and "It is important to behave properly and avoid doing anything people would say is wrong" (`ipbhprp`). These variables are measured on a 6-point scale from 1 ("very much like me") to 6 ("not like me at all"). We recode them so that higher values indicate weaker adherence to tradition and proper behavior (i.e., greater non-conformity), and then standardize and average them to form a composite non-conformity index.

Aggregation and Composite Measure. All variables are standardized at the individual level and aggregated to the regional level (NUTS 2/3) across all ESS waves. Each dimension is used separately in the supplementary empirical analysis and jointly combined into a first principal component, which captures the common variation across universal trust, universal fairness, independence, and non-conformity for the baseline analysis. This composite index provides a summary measure of WEIRD psychology, reflecting a coherent package of traits characterized by greater independence, lower conformity, and stronger trust and fairness toward strangers. Regional-level correlations between all psychological dimensions and the corresponding composition of the first principal component are reported in Table A.2. The geographic distribution of the resulting single measure is depicted on Figure A.5.

Table A.2: WEIRD Psychology: Correlation and Principal Component Weights

	Correlation			
	U. Trust	U. Fair	Ind	Non-Conf
Universal Trust	1.00			
Universal Fairness	0.88***	1.00		
Individualism	0.52***	0.68***	1.00	
Non-Conformism	0.68***	0.80***	0.84***	1.00
	Principal Component Weights			
WEIRD Psychology *(First Principal Component)*	0.24	0.26	0.24	0.26

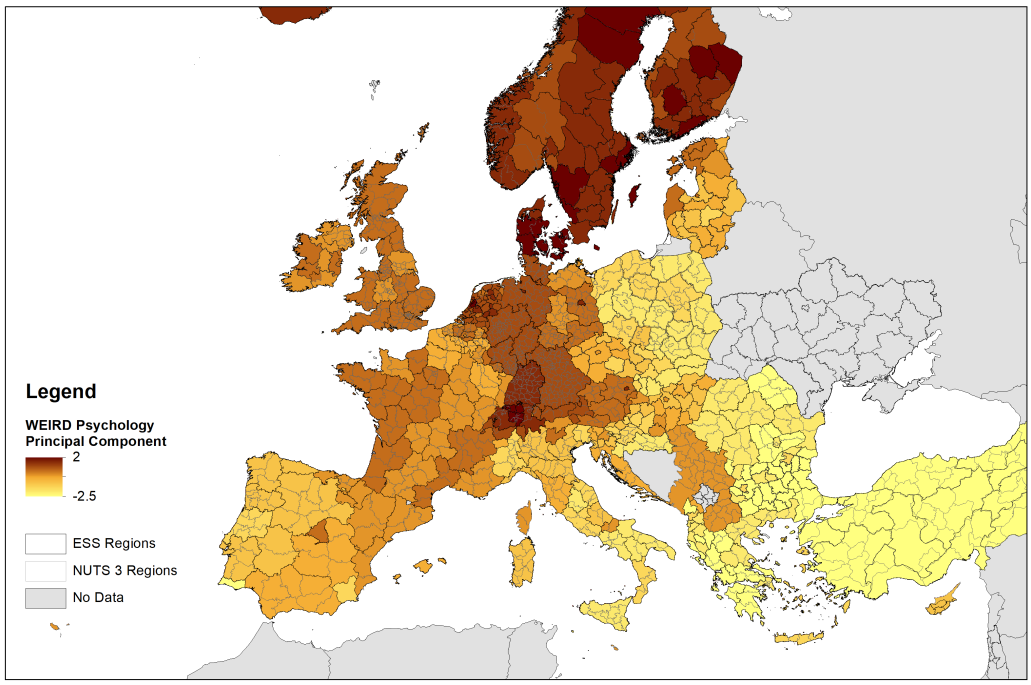


Figure A.5: WEIRD Psychology (First Principal Component): Sub-National Regions in Europe

B Supplementary Historical Results

B.1 Famous Creatives and Church Exposure: Triple Difference

B.1.1 Famous Creatives and Church Exposure: Simple Triple Difference

This section reports the results of estimating the standard triple difference model to study the effects of Church exposure on the number of famous creatives in Europe, according to the following equation:

$$y_{igt} = \beta_1(Bishop_g \times Post_{gt} \times SC_i) + \beta_2 Bishop_g \times SC_i + \beta_3 SC_i + \lambda_{t,g} + \varepsilon_{igt}, \tag{7}$$

Although this approach allows to account for all time-varying characteristics specific to each grid cell, employing Period × Location Fixed Effects, it does not allow to estimate the intertemporal structure of the effect, contrary to the baseline model (1).

Table B.1 summarizes the results. In particular, we establish that following the arrival of a bishopric, the affected grid cell gets around 10 extra famous scientists and artists. The effect is well-estimated and stable across specifications. The specification in column 1 includes only our key predict variable, columns 2-4 add Period and Cell fixed effects. Column 5 further accounts for linear trends separately in each cell. Column 6, our main result here, includes fixed effects for every Period-Cell. Holding constant Importantly, the effect is positive and significant when accounting for all time-varying characteristics of each grid cell in the form of Period × Cell fixed effects in column (6).

Table B.1: Famous People in Culture and Science and Church Exposure: Cells in Europe (FE)

	Number of Famous People : Science and Culture					
	(1)	(2)	(3)	(4)	(5)	(6)
Treated X Post X SC	11.82***	9.80***	11.79***	9.76***	6.40***	8.85***
	(1.49)	(1.41)	(1.49)	(1.41)	(0.90)	(0.67)
Period FE	No	Yes	No	Yes	Yes	No
Cell FE	No	No	Yes	Yes	Yes	No
Cell × Linear Trend	No	No	No	No	Yes	No
Period × Cell FE	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.01	0.01	0.03	0.10	0.01
Observations	534435	534435	534435	534435	534435	534435

Notes: Notes: Using Triple-Difference OLS regression, this table establishes a positive significant relation between the number of famous historic figures in the realms of Science and Culture and the exposure to the bishopric of Medieval Catholic Church, across the 1.5 by 1.5-degree cells in Europe. The outcome variables have not been normalized. Heteroscedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B.1.2 Famous People and Church Exposure: Triple Difference with Religious Notables as Control Group

This figure implements a triple-difference event-study design that compares the evolution of the number of famous creatives to that of non-creative religious notables around the establishment of a bishopric. By using religious notables as a control group, the specification accounts for general changes in the production or recording of prominent individuals that may be driven by Church expansion itself, such as increased documentation, education, or institutional capacity. The estimates therefore isolate whether Church exposure is associated with a differential increase in creative individuals beyond these broader effects. The absence of significant pre-trends supports the identifying assumption, while the positive post-treatment dynamics indicate that bishopric establishment is followed by a relative rise in famous creatives compared to religious figures.

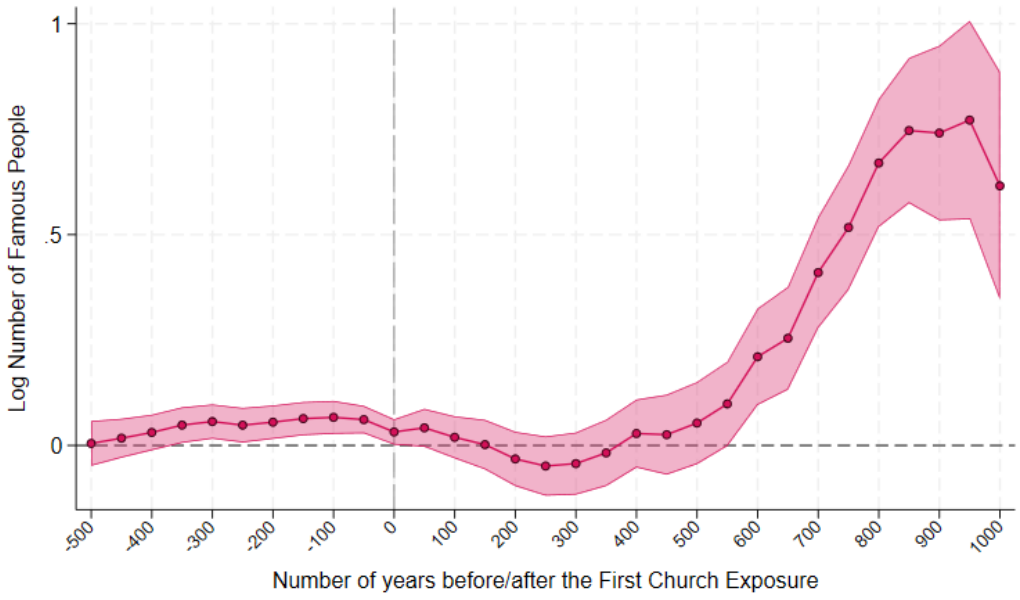


Figure B.1: Famous People and Church Exposure: Triple Difference with Religious Notables as Control Group

Notes: The figure reports TWFE estimates and 95% confidence intervals for the effects of bishopric establishment on the difference between the log number of famous creatives relative and non-creative religious notables. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.1.3 Famous People and Church Exposure: Triple Difference with Callaway and Sant'Anna (2021)

This section re-estimates the Triple Difference event study model explored in Section 4.1 using a modification of Callaway and Sant'Anna (2021) methodology that is suited for the Triple Difference model. In particular, we are estimating a standard Callaway and Sant'Anna (2021) model for a difference between the log of the number of famous creatives and famous non-creatives. The results of the estimation are reported in Figure B.2 and once again establish a positive significant effect of the Church arrival on innovation.

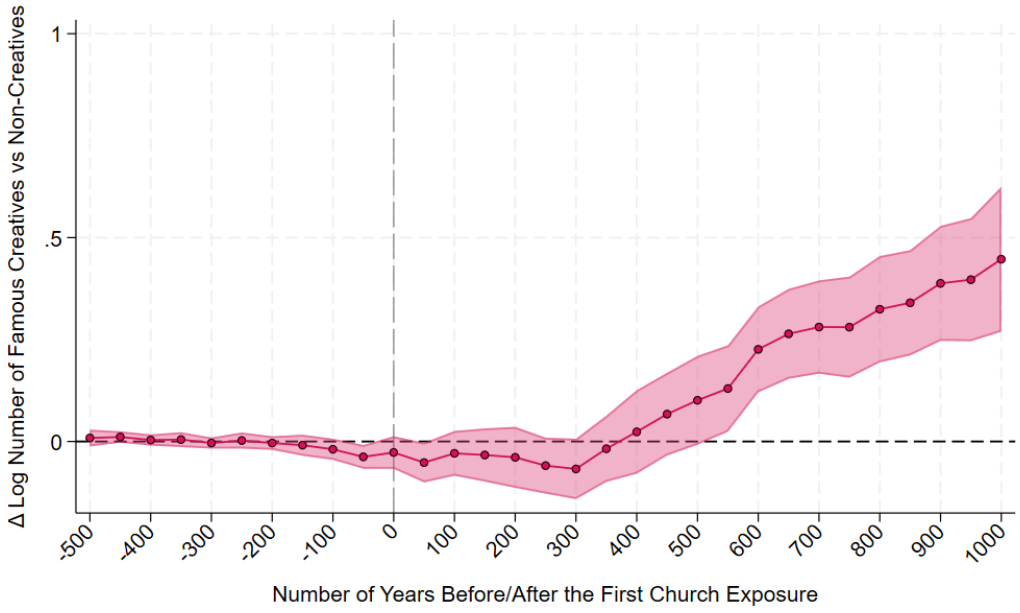


Figure B.2: Famous People and Church Exposure: Triple Difference (Callaway and Sant'Anna, 2021)

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the difference between the log number of famous creatives relative and non-creatives. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.1.4 Famous People and Church Exposure: Triple Difference with De Chaisemartin and d'Haultfoeuille (2020)

This section re-estimates the Triple Difference event study model introduced in Section 4.1, now applying the estimator of De Chaisemartin and d'Haultfoeuille (2020), which is designed for difference-in-differences settings with staggered treatment adoption and treatment effect heterogeneity. In particular, we estimate the difference between the log number of famous creatives and famous non-creatives using their two-way fixed effects–robust approach. The results, presented in Figure B.2, closely mirror our baseline findings: Church arrival is associated with a positive and statistically significant effect on innovation, confirming the robustness of the main results to this alternative estimation strategy.

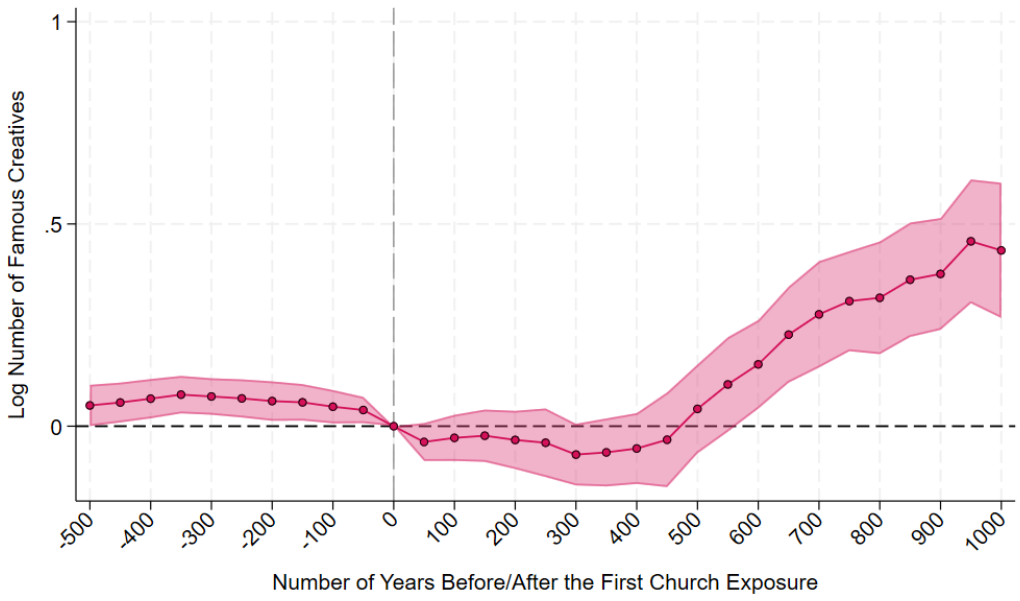


Figure B.3: Famous People and Church Exposure: Triple Difference (De Chaisemartin and d'Haultfoeuille, 2020)

Notes: The figure reports De Chaisemartin and d'Haultfoeuille (2020) estimates and 95% confidence intervals for the effects of bishopric establishment on the difference between the log number of famous creatives relative and non-creatives. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.1.5 Famous People and Church Exposure: Triple Difference with Sun and Abraham (2021)

This section re-estimates the baseline Triple Difference event study model from Section 4.1, now employing the estimator proposed by Sun and Abraham (2021), which provides consistent inference in staggered treatment settings with heterogeneous treatment effects. The specification and identifying variation remain the same as in the baseline analysis. As reported in Figure B.4, the results align closely with our earlier findings: Church arrival continues to exert a positive and statistically significant effect on innovation, confirming that the baseline results are robust to this estimation approach.

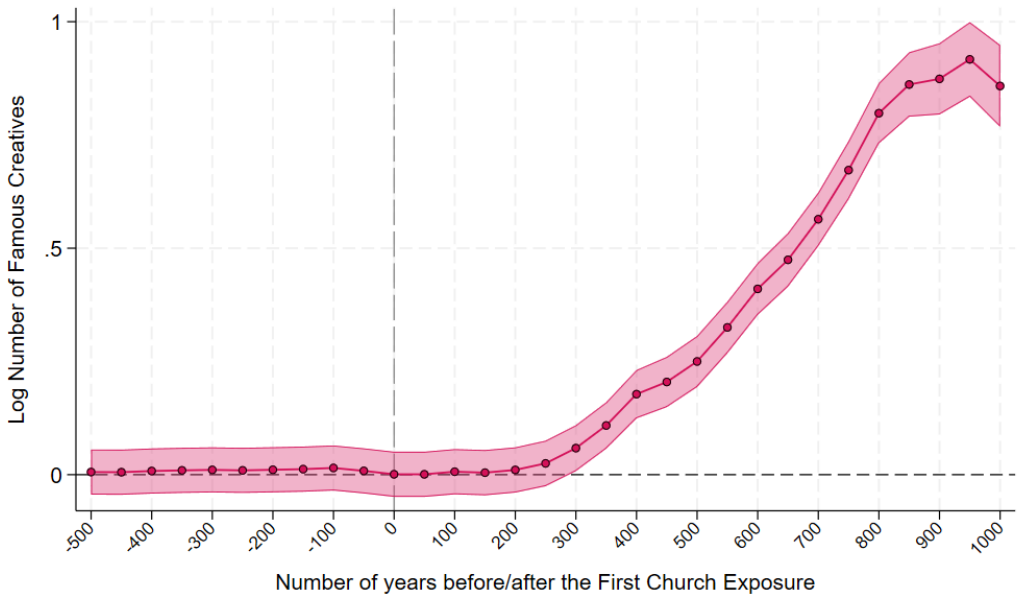


Figure B.4: Famous People and Church Exposure: Triple Difference with Sun and Abraham (2021)

Notes: The figure reports Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on on the log number of famous creatives relative to non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.1.6 Famous People and Church Exposure: Triple Difference, Additional Robustness

This section presents a series of additional robustness exercises for the triple-differences specification. Figure B.5 examines the sensitivity of statistical inference to spatial autocorrelation by applying the spatial correlation–robust standard errors proposed by Conley (1999). Figures B.6 and B.7 assess robustness to alternative distributional assumptions by re-estimating the model using Poisson and negative binomial specifications.

To evaluate the stability of the results across alternative sample definitions and subsamples, Figures B.8 and B.9 restrict the analysis to secular creatives and to medieval notables observed between 500 and 1500 CE, respectively. Figures B.10 and B.11 further explore geographic heterogeneity by estimating the model separately for the Iberian Peninsula and Northeastern Europe.

Finally, Figure B.12 assesses the sensitivity of the results to the spatial assignment of famous individuals by using death locations rather than birth locations, while also controlling for local urban population size. Across all robustness checks, the estimated effects remain qualitatively similar to those obtained in the baseline specification.

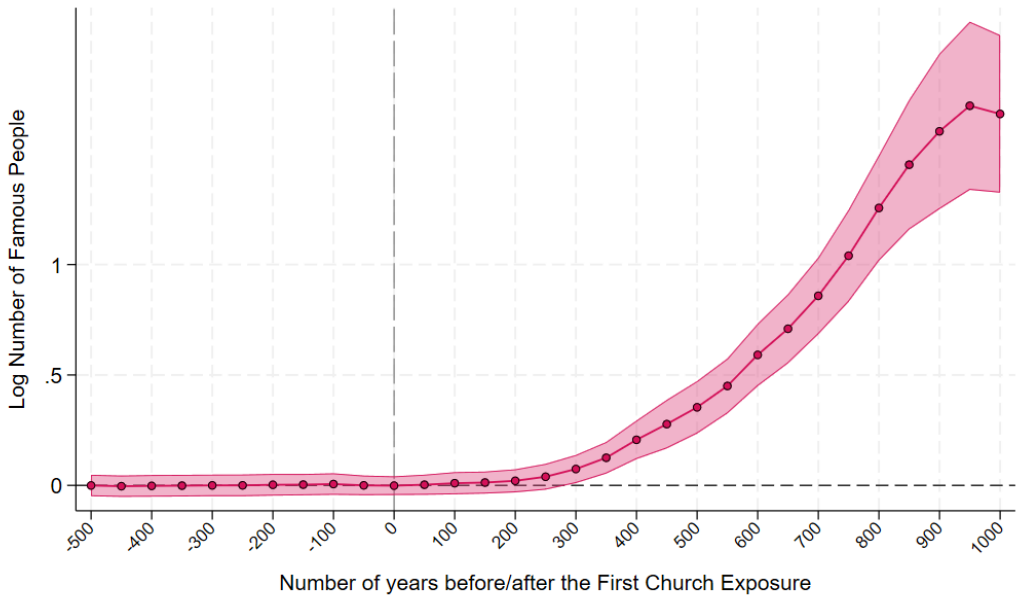


Figure B.5: Famous People and Church Exposure: Triple Difference with Conley (1999) Inference

Notes: The figure reports two way fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on Conley (1999) spatial correlation-robust grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

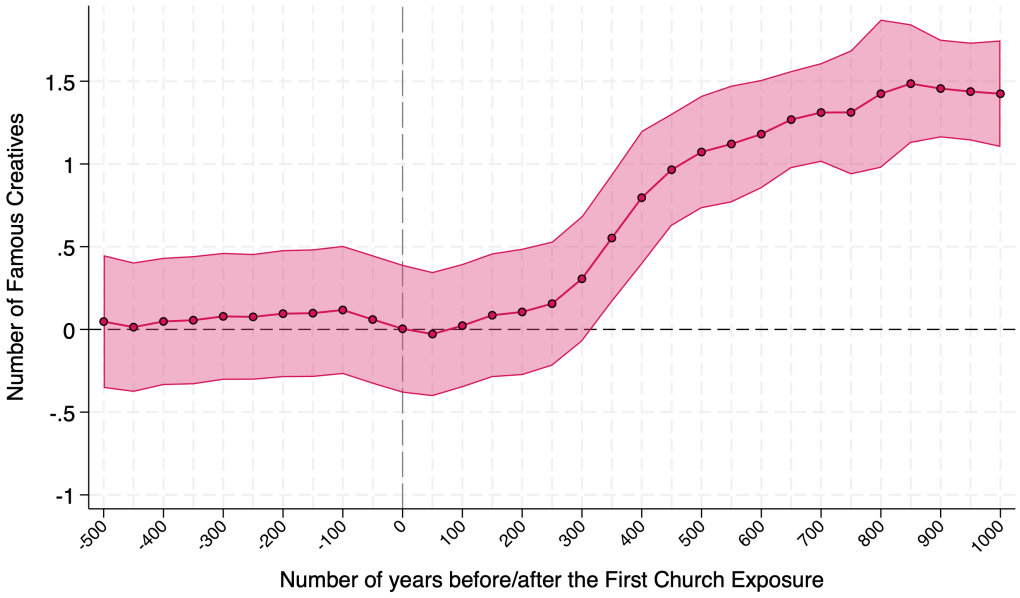


Figure B.6: Famous People and Church Exposure: Triple Difference with Poisson Regression

Notes: The figure reports Poisson regression estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

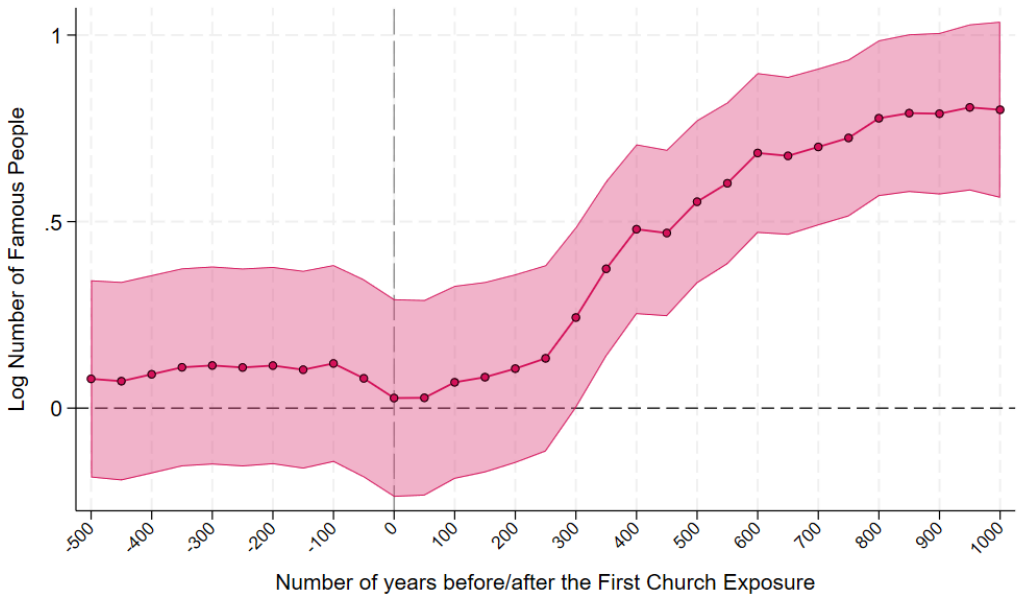


Figure B.7: Famous People and Church Exposure: Triple Difference with Negative Binomial Regression

Notes: The figure reports negative binomial regression estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

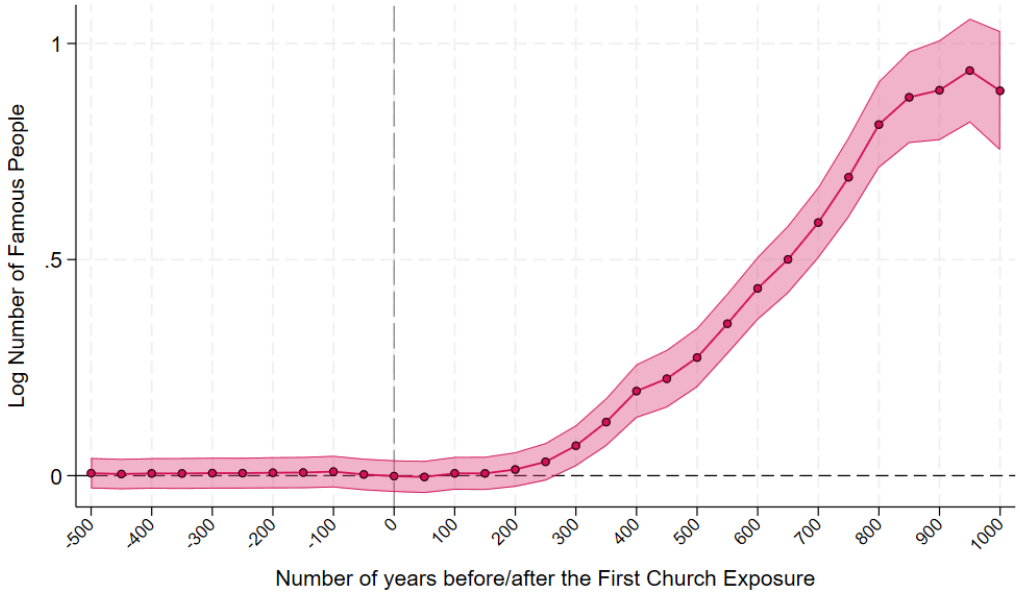


Figure B.8: Secular Famous People and Church Exposure: Triple Difference

Notes: The figure reports two way fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous secular creatives relative to secular non-creatives based on equation (1). The unit of observation is grid cell by half-century interval by secular creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

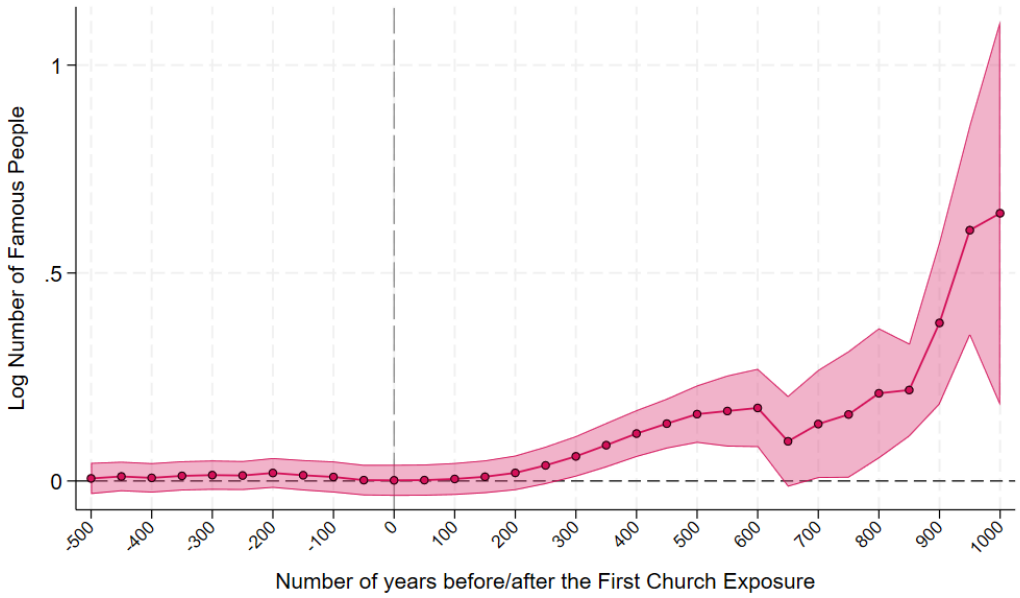


Figure B.9: Famous People and Church Exposure: Triple Difference (500 – 1500)

Notes: The figure reports two-way fixed-effect estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1) between 500 and 1500 CE. The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

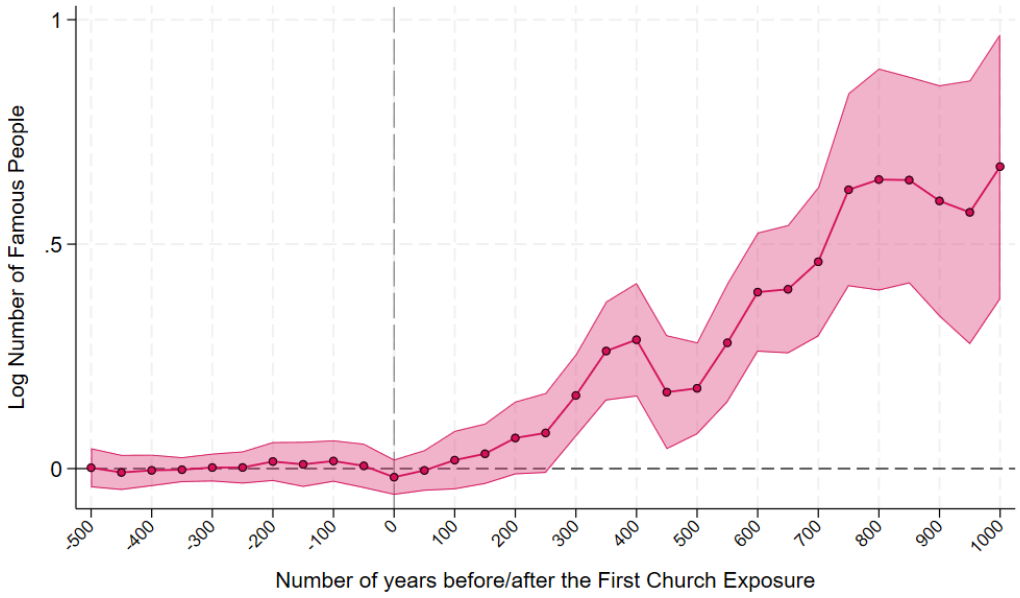


Figure B.10: Famous People and Church Exposure: Triple Difference (Iberian Peninsula)

Notes: The figure reports two-way fixed-effect estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1) across Iberian peninsula (i.e., modern day Spain and Portugal). The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

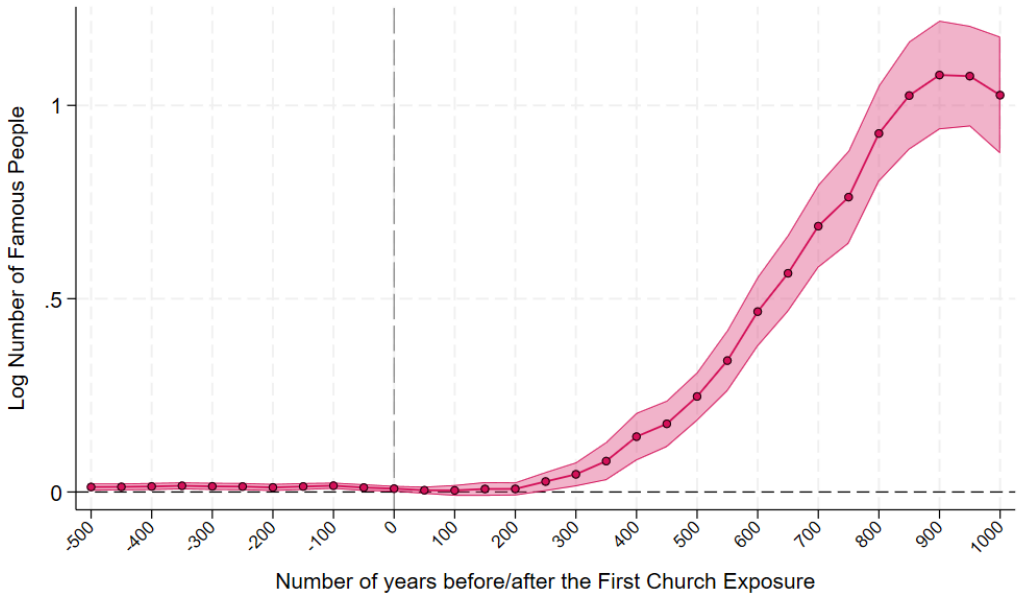


Figure B.11: Famous People and Church Exposure: Triple Difference (Northern and Eastern Europe)

Notes: The figure reports two-way fixed-effect estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1) across Northern and Eastern Europe. The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

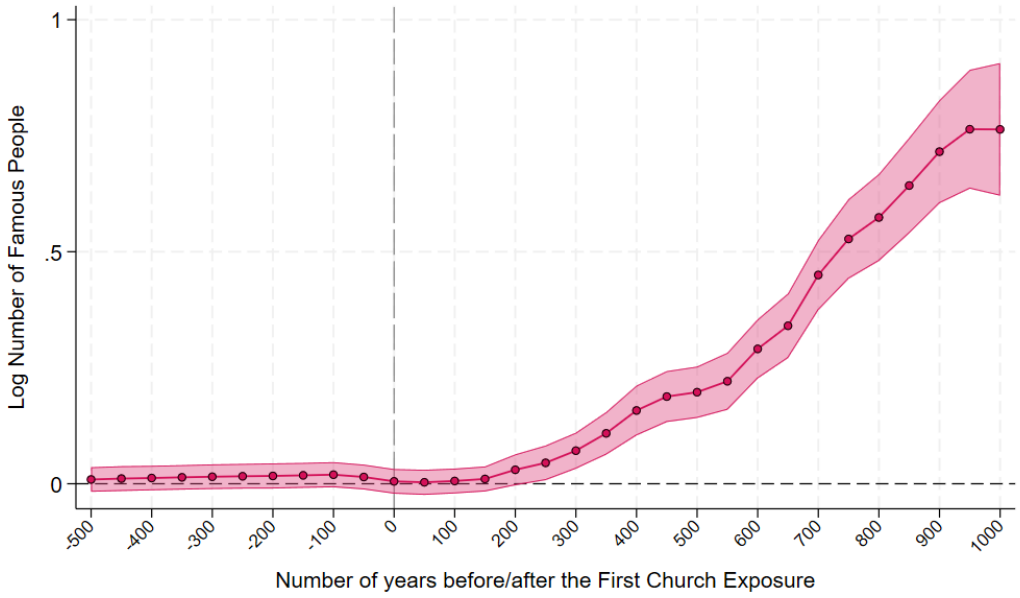


Figure B.12: Famous People and Church Exposure: Triple Difference (Death Place Assignment)

Notes: The figure reports two way fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives relative to non-creatives based on equation (1). Famouse people are assigned to grid cells based on their death locations. The unit of observation is grid cell by half-century interval by creative vs. non-creative. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroscedasticity robust grid cell-clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.2 Event Study Estimates

To explore our triple difference analysis, we run separate event studies on creatives and non-creatives, again exploiting the uneven timing of Christianization across Europe. Following best practices, we implement this staggered event-study design using the Callaway and Sant'Anna (2021) estimator. Formally, the estimation strategy is given by the following equation:

$$y_{gt} = \beta_0 + \sum_{\tau=1}^{T} \beta_\tau (Lag_\tau)_{gt} + \sum_{\tau=1}^{T} \beta_{-\tau} (Lead_\tau)_{gt} + \mu_t + \lambda_g + \varepsilon_{gt} \tag{8}$$

where y_{gt} is the log number of famous creatives born in the grid cell g in the 50-year period t between 500 and 1500 (plus one, to avoid dropping grid cells without famous creatives born in a given period);[14] μ_t and λ_g are period and grid cell fixed effects, absorbing general trends and local time invariant determinants of the production of famous creatives, respectively. Lags and leads are binary variables indicating the amount of time before/after the event date, $Event_g$, that establishes the first bishopric in grid cell g. These variables are thus constructed as follows:

$$(Lag_\tau)_{gt} = \mathbb{1}[t = Event_g - \tau] \tag{9}$$

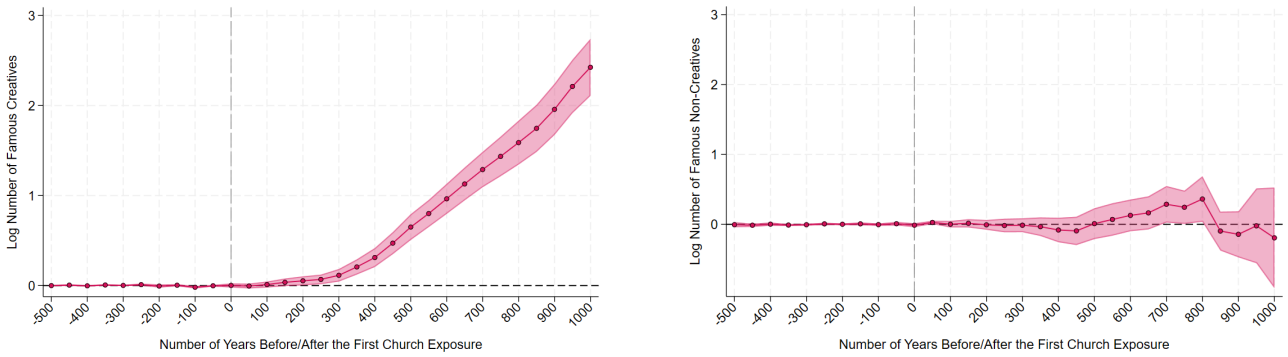
$$(Lead_\tau)_{gt} = \mathbb{1}[t = Event_g + \tau] \tag{10}$$

The parameters of interest are β_τ with $\tau > 0$. The Church-Innovation hypothesis predicts an overall increase in the birth of famous creatives after the arrival of a bishopric. Confidence intervals are computed using the bootstrap approach implemented in the package provided by Callaway and Sant'Anna (2021) and clustered at the grid cell level.

The identifying assumption underpinning this analysis is that, in the absence of any Church exposure, grid cells would not have exhibited systematically different changes in the production of famous creatives. Although this assumption cannot be verified directly, the event-study framework enables us to examine trends in the emergence of famous creatives preceding the establishment of bishoprics. The absence of systematic, significant differences in these pre-establishment dynamics (i.e., $\beta_\tau = 0$ for $\tau < 0$) would lend credibility to our event-study estimates. If such pre-trends existed, they might indicate the strategic placement of bishoprics by visionary Papal leadership or other astute decision-makers targeting emerging communities.

Figure B.13(a) summarizes the estimates of the Callaway and Sant'Anna (2021) estimator (hereafter the 'CSA estimator'). We find that after a delay of about two centuries, the production of creatives begins increasing exponentially (y-axis is logged). The magnitude of the effect stabilizes after about 8 centuries at an increase of $(\exp(2.5) - 1) \approx 1,118\%$ additional creatives per 50-year period for a grid cell. Crucially, we find no evidence of any trends prior to the arrival of the bishoprics. The long delay is expected if the mechanism involves a grass-roots

[14] The results are robust to using the untransformed number of famous creatives and estimating Poisson or Negative Binomial models (see Figures B.21 and B.22).



(a) Famous Creatives

(b) Famous Non-Creatives

Figure B.13: Event-study Estimates of the Effect of Church Exposure on Famous Creatives and Non-Creatives

Notes: The figure reports the CSA estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. Not yet treated grid cells are used as the control group. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

shift in the family structure of communities induced by the slow promulgation of the Church's policies surrounding marriage and the family. These changes were often resisted at the local level Goody (1983). A rapid takeoff would be more consistent with alternative mechanisms.

An important concern when interpreting these findings is that bishops and other Church affiliates might have been particularly adept at documenting notable individuals. If true, this could explain why famous creatives appear prominently in our data after a bishopric is established, thus driving the observed patterns in our event-study analysis. To address this concern, we performed a placebo test using the data on famous non-creative individuals. If it's simply a matter of improved documentation, we should observe a similar increase in the presence of other famous non-creatives following the arrival of a bishopric. Figure B.13, Panel (b), demonstrates that this is not the case. Non-creatives do not exhibit a parallel increase after bishoprics are established; specifically, there is no notable rise in the logged number of famous nobles, religious elites, military leaders, politicians or entrepreneurs following the arrival of a bishopric.

In Section B.3, we test the robustness of these results several ways, paralleling the approach taken above. First, using geographic subsample to assess heterogeneity, Figure B.17 shows the robustness of the effect across different geographic subsamples (Iberian Peninsula and Northern/Eastern Europe) with distinct control groups (Islamic and Pagan control groups). Second, to confirm that inclusion of notables after the medieval period is not influencing our result, we re-estimate our event study model using only data from 500 to 1500 CE (Figure B.24). Third, to address concerns that our results might simply arise from the arrival of clerics and other Churchmen to a region, we re-estimate our event study (Figure B.23) after dropping all non-secular (i.e., religious) notables from the sample (i.e., people who identified as clerics). Fourth, While we argue that the assignment of notables to grid cell based

on their birth location is the best approach (because it's more likely to be exogenous), we re-estimated our model using the death locations of notable instead (Figure B.25). Fifth, To assess the influence of specific estimation procedures, we re-estimate our event study design using three approach: see Figures B.14, B.15 and B.16 for the TWFE, De Chaisemartin and d'Haultfoeuille (2020) and Sun and Abraham (2021) estimates, respectively. Sixth, to assess the influence of our model's error distribution, we re-estimated the regression model using both Poisson (Figure B.21) and Negative Binomial link function (Figure B.22). Seventh, as a further check on the role of urban population size, in addition to using the production of non-creatives and holding population size constant to account for scale effect, we further control for urban population using data from Klein Goldewijk et al. (2017), see Figure B.18. Eighth, autocorrelation

Across all robustness checks, the results shown in Figure B.13 hold.

Nevertheless, concerns remain that could jeopardize a causal interpretation of these results. For example, if unobserved, time-varying factors caused both the establishment of bishoprics and the birth of famous creatives (but not non-creative), our event study could be misinterpreted as implying a causal relationship. For instance, if unobserved economic conditions improved (not captured by population size, urban population or the production of non-creatives), this might have influenced decisions to establish bishoprics and subsequently enhance local creativity and innovation. To tackle this issue, we estimate a triple difference-in-differences analysis.

B.3 Historical Creatives and the Medieval Church: Robustness

This section examines the robustness of the baseline event-study results reported in Figure B.13 along several dimensions.

First, Figures B.14 and B.15 re-estimate the baseline specification using alternative difference-in-differences estimators. Figure B.14 reports two-way fixed effects event-study estimates, while Figure B.15 applies the estimator proposed by De Chaisemartin and d'Haultfoeuille (2020), which is robust to treatment effect heterogeneity. In both cases, the dynamic response of famous creatives to church exposure remains qualitatively similar to the baseline pattern.

Figure B.16 further corroborates these findings using the interaction-weighted event-study estimator of Sun and Abraham (2021). The estimated coefficients closely track those obtained under the baseline specification, alleviating concerns that the results are driven by negative weighting or staggered-adoption bias.

Next, Figure B.17 investigates geographic heterogeneity by estimating the effect separately for grid cells located on the Iberian Peninsula and for those in Northern and Eastern Europe. While the magnitude of the estimates differs across regions, the timing and direction of the effects are consistent across subsamples.

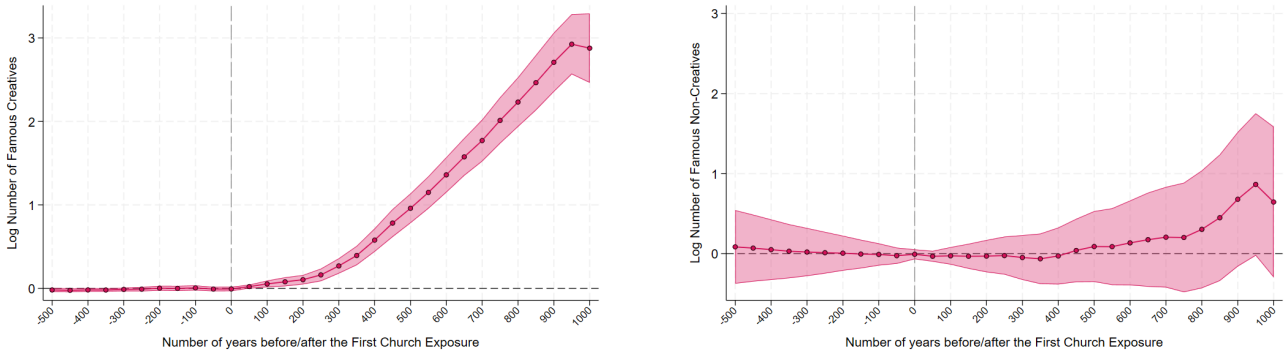
Figure B.18 addresses potential confounding from underlying population dynamics by explicitly controlling for grid-cell-level population using HYDE data. The estimated effects of church exposure on famous creatives remain stable after accounting for local population size.

Figures B.19 and B.20 examine the robustness of statistical inference to alternative assumptions about spatial and serial correlation. Figure B.19 reports confidence intervals based on Conley (1999) spatial correlation-robust standard errors, while Figure B.20 applies the inference procedure of Colella et al. (2019), which is robust to both spatial and temporal dependence. In both cases, the main results remain statistically and economically meaningful.

Figures B.21 and B.22 assess robustness to alternative distributional assumptions by estimating Poisson and negative binomial models for the count of famous creatives. The resulting estimates are again consistent with the baseline event-study results.

Finally, Figures B.23, B.24, and B.25 explore robustness to alternative sample definitions and assignment rules. Figure B.23 excludes non-secular famous individuals (i.e., clerics) from the sample, Figure B.24 restricts the analysis to the period 500–1500 CE, and Figure B.25 assigns famous individuals to grid cells based on their place of death rather than birth. Across all three exercises, the estimated effects of church exposure on famous creatives remain qualitatively unchanged.

Overall, the results across Figures B.14–B.25 indicate that the positive association between medieval church exposure and the emergence of famous creatives is robust to a wide range of alternative estimators, inference procedures, samples, and modeling assumptions.

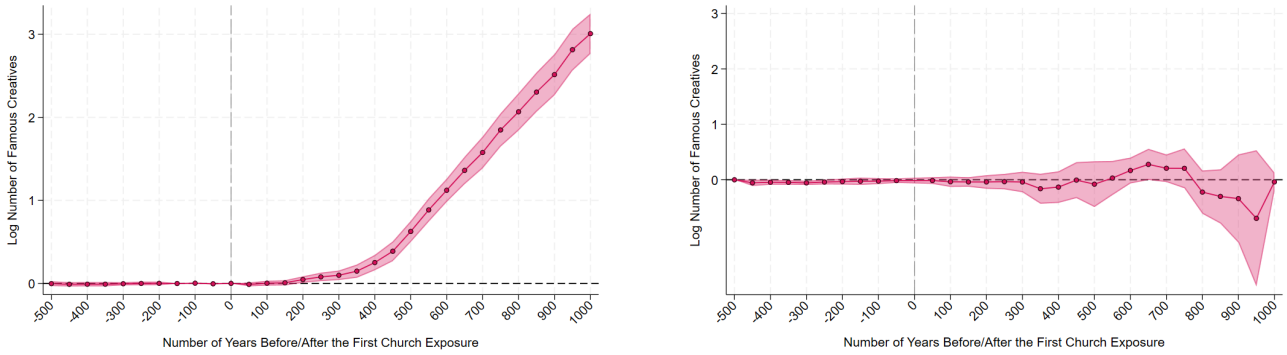


(a) Famous Creatives

(b) Famous Non-Creatives

Figure B.14: TWFE Event-study Estimates of the Effect of Church Exposure on Famous Creatives and Non-Creative

Notes: The figure reports a two way fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

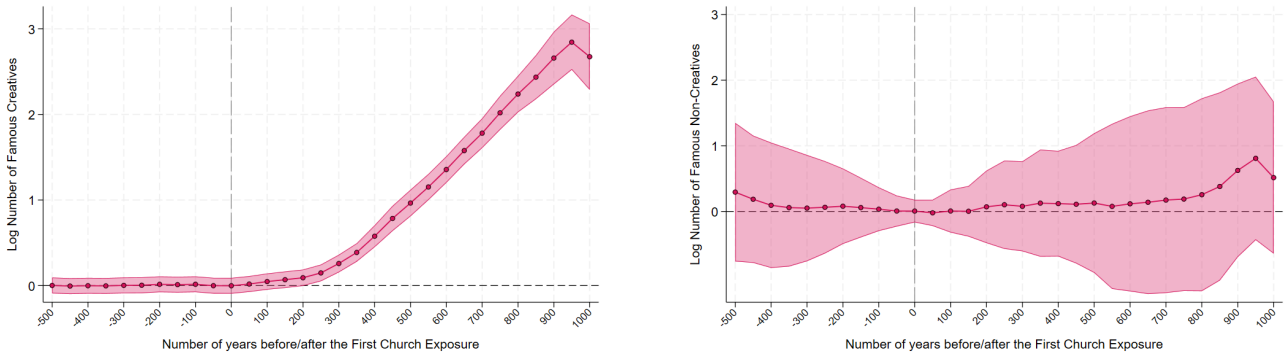


(a) Famous Creatives

(b) Famous Non-Creatives

Figure B.15: De Chaisemartin and d'Haultfoeuille (2020) Event-study Estimates of the Effect of Church Exposure on Famous Creatives and Non-Creatives

Notes: The figure reports a De Chaisemartin and d'Haultfoeuille (2020) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

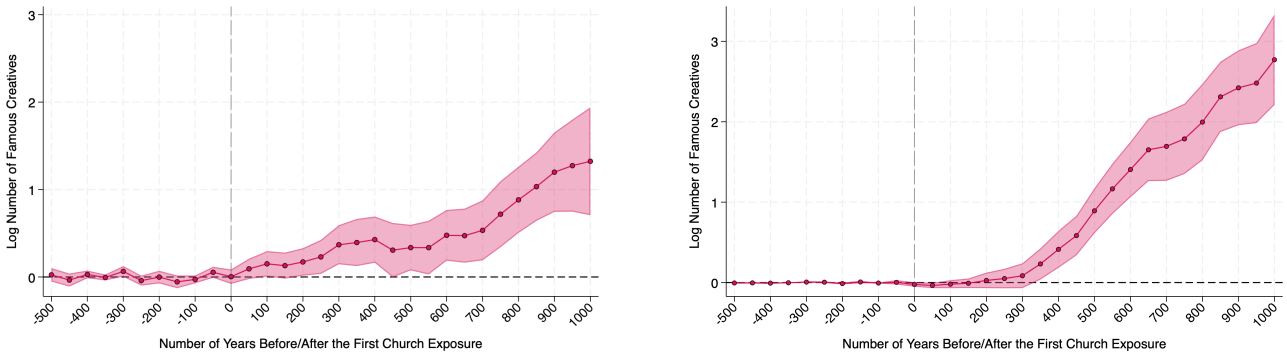


(a) Famous Creatives

(b) Famous Non-Creatives

Figure B.16: Sun and Abraham (2021) Event-study Estimates of the Effect of Church Exposure on Famous Creatives and Non-Creatives

Notes: The figure reports a Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

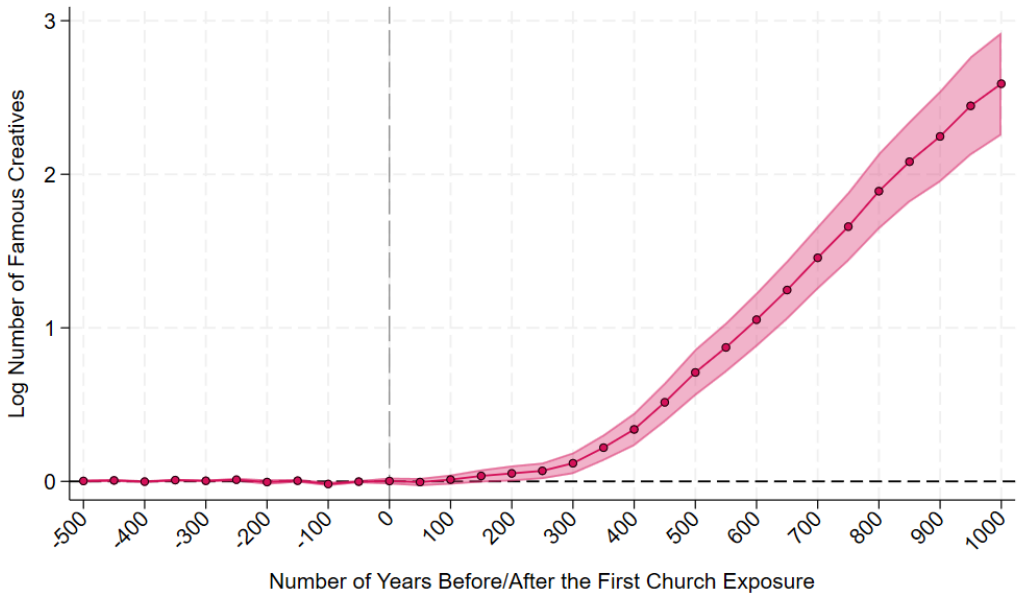


(a) Iberian Peninsula

(b) Northern and Eastern Europe

Figure B.17: Famous Creatives and Church Exposure: Geographic Sub-Samples

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) across gridcells on the Iberian Peninsula on Panel (a) and in the Northern and Eastern Europe on Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.



(a) Famous Creatives

Figure B.18: Famous Creatives and Church Exposure: Controlling for Population

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) between years 500 and 2000, while controlling for the population level according to HYDE data. The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

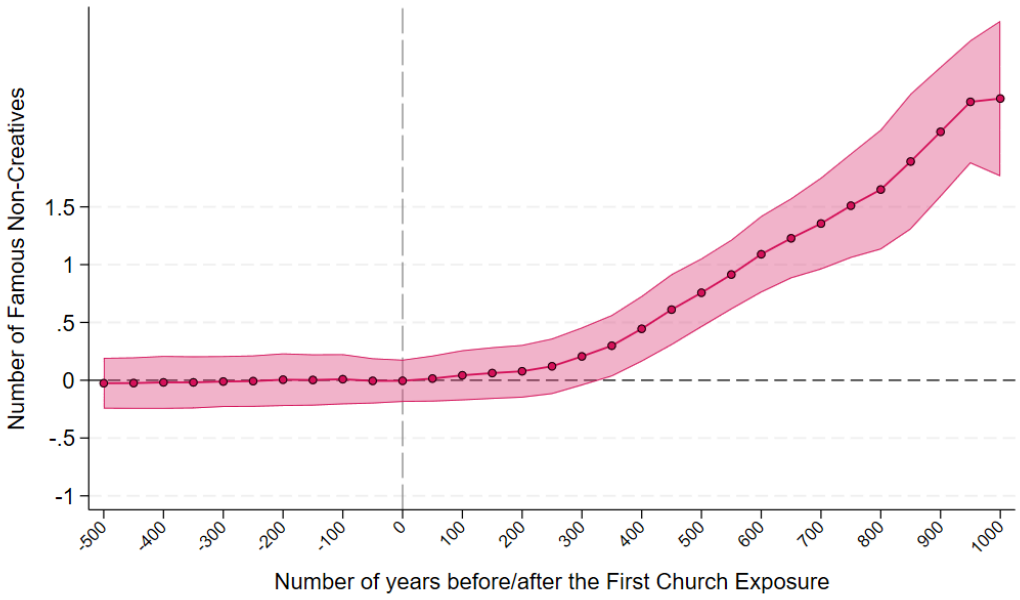


Figure B.19: Famous Creatives and Church Exposure: Conley (1999) Inference

Notes: The figure reports two-way fixed effects regression estimates and 95% confidence intervals for the effects of bishopric establishment on the number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on Conley (1999) spatial correlation-robust standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

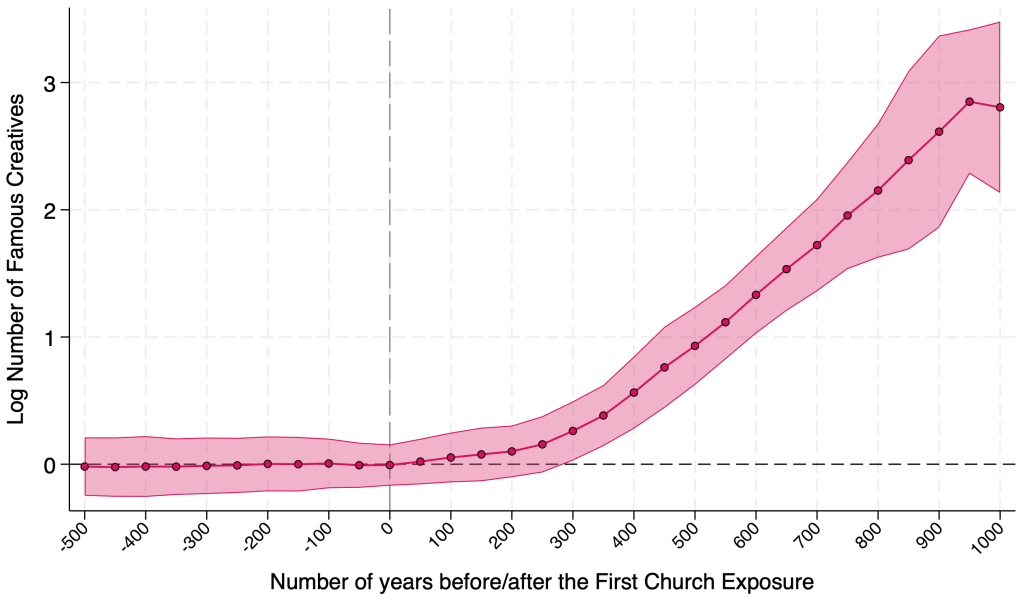


Figure B.20: Famous Creatives and Church Exposure: Colella et al. (2019) Inference

Notes: The figure reports two-way fixed effects regression estimates and 95% confidence intervals for the effects of bishopric establishment on the number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on Colella et al. (2019) spatial and temporal correlation-robust standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

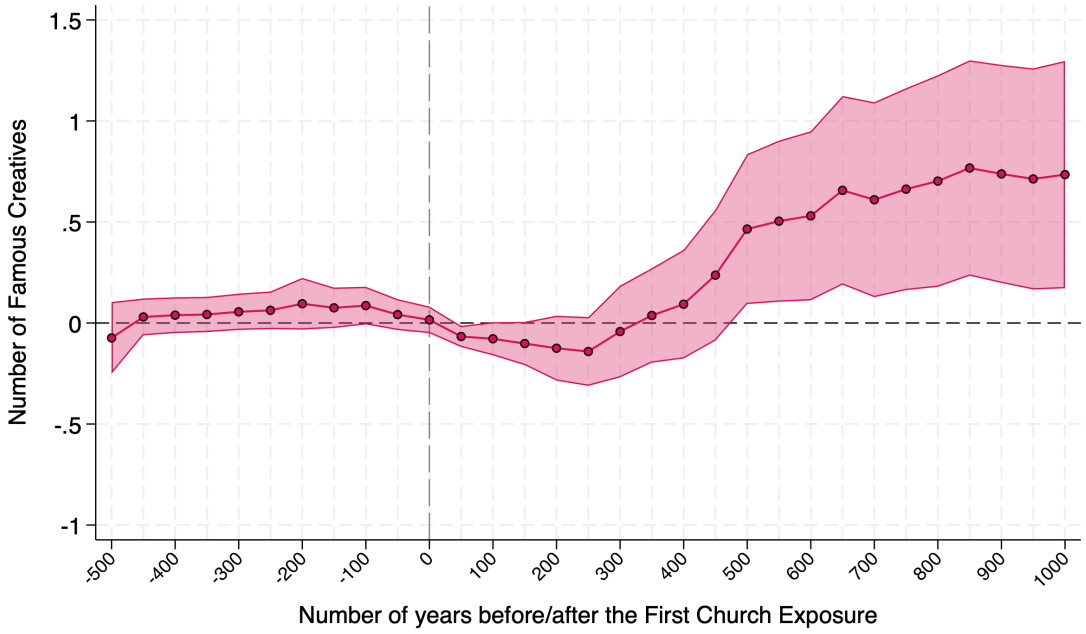


Figure B.21: Famous Creatives and Church Exposure: Poisson Regression

Notes: The figure reports two-way fixed effects Poisson regression estimates and 95% confidence intervals for the effects of bishopric establishment on the number of famous creatives (i.e., scientists and artists). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

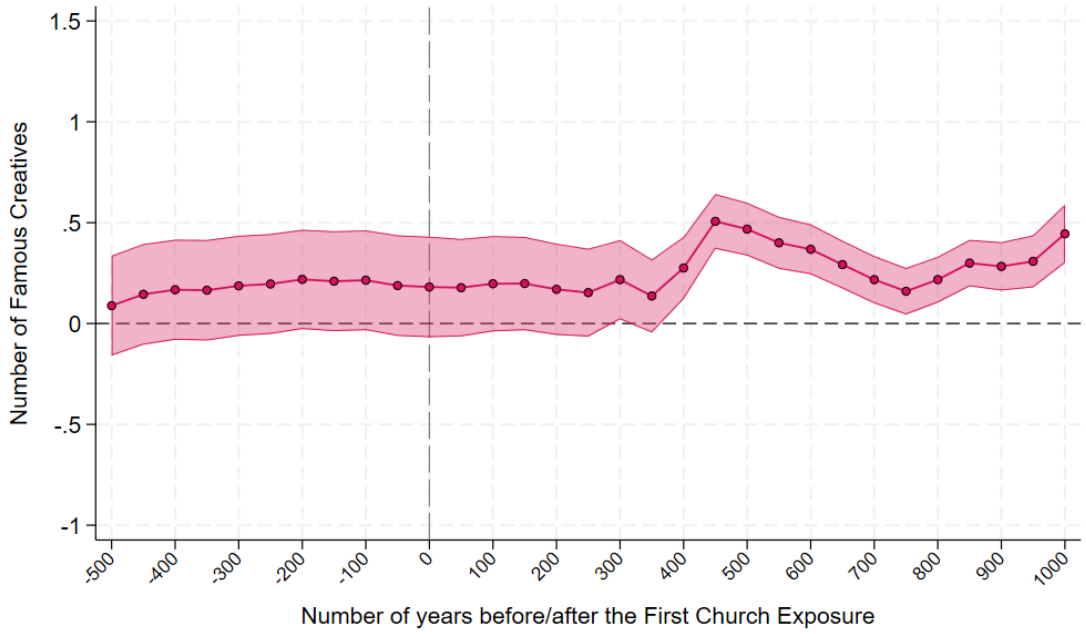
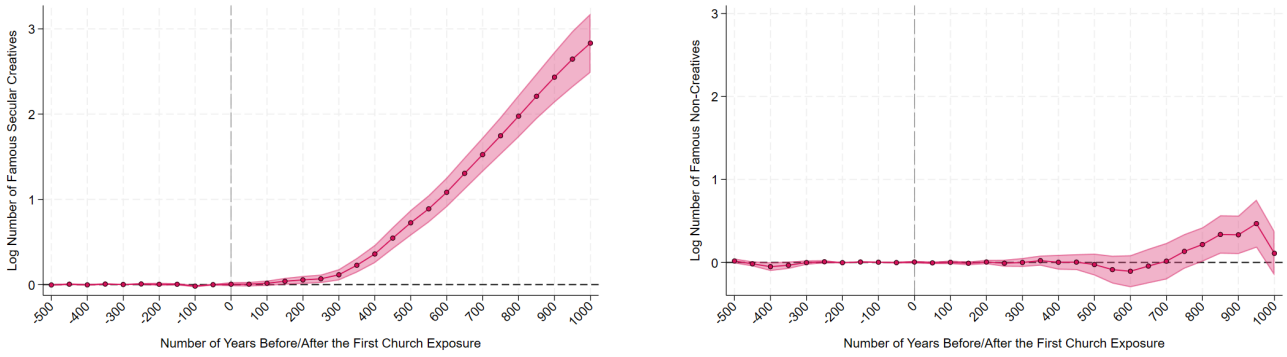


Figure B.22: Famous Creatives and Church Exposure: Negative Binomial Regression

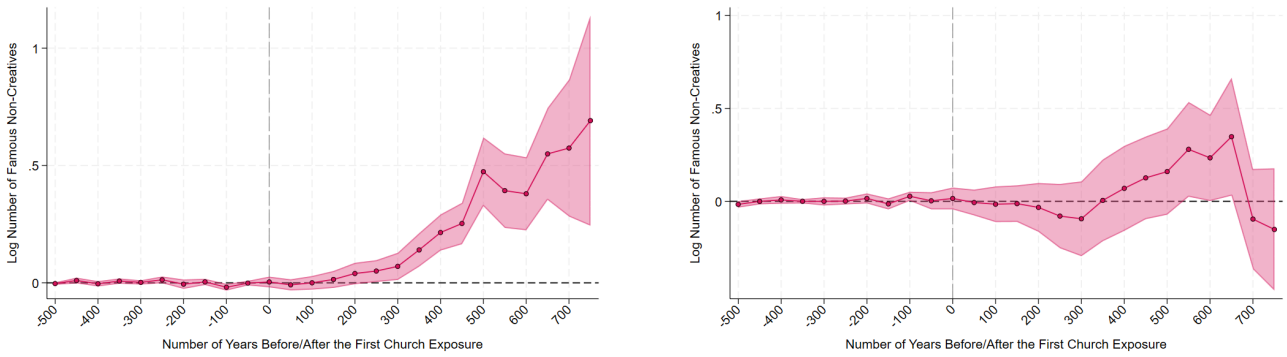
Notes: The figure reports two-way fixed effects negative binomial regression estimates and 95% confidence intervals for the effects of bishopric establishment on the number of famous creatives (i.e., scientists and artists). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.



(a) Famous Creatives (b) Famous Non-Creatives

Figure B.23: Famous Secular Creatives and Church Exposure: Event Study

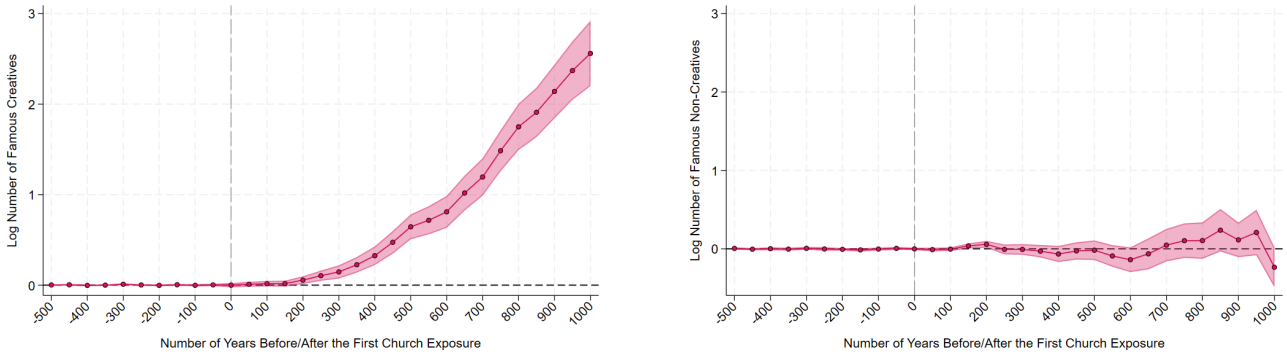
Notes: The figure reports a Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous secular creatives (i.e., scientists and artists) and secular non-creatives (e.g., political leaders, military and business people). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.



(a) Famous Creatives (b) Famous Non-Creatives

Figure B.24: Famous Creatives and Church Exposure: Event Study (500 – 1500)

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b) between years 500 and 1500 CE. The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.



(a) Famous Creatives

(b) Famous Non-Creatives

Figure B.25: Famous Creatives and Church Exposure: Event Study (Death Place Assignment)

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and non-creatives (e.g., businessmen, politicians and generals) in Panel (b) based on the death place assignment. The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.4 Creative Networks and Church Exposure: Robustness

Figures B.26–B.32 present a series of robustness analyses confirming that the estimated dynamic relationship between Church exposure and the evolution of the Creative Network is not sensitive to alternative specifications, inference methods, or sample definitions.

Figure B.26 introduces the most direct control for potential confounding effects of the Roman transport infrastructure. Specifically, it augments the baseline event–study specification by interacting the presence of Roman roads with period fixed effects, thereby allowing the dynamic evolution of the Creative Network to differ flexibly across grid cells with and without Roman roads. The resulting coefficients remain nearly identical to those from the baseline model: there is no indication of pre-treatment differences, and a steady increase in network centrality appears a few periods after the onset of Church exposure. This suggests that the baseline relationship is not spuriously driven by areas historically advantaged by Roman connectivity.

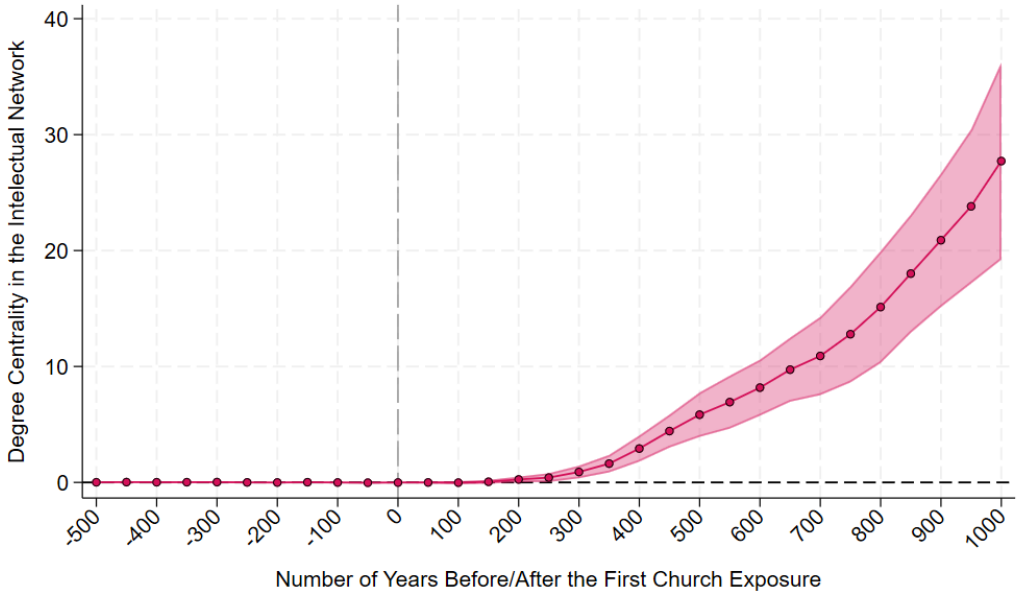


Figure B.26: Creative Networks and Church Exposure: Controlling for Roman Roads

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The specification controls for the heterogeneous dynamic influence of Roman transport infrastructure by interacting a Roman-road indicator with period fixed effects. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

Figure B.27 introduces a direct control for potential confounding effects related to local scale and settlement size. Specifically, it augments the baseline event–study specification by interacting grid-cell population (from HYDE) with period fixed effects, allowing the dynamic evolution of the Creative Network to vary flexibly across areas of different population sizes. The estimated coefficients closely track those of the baseline model: there is no evidence of differential pre-treatment trends, while a gradual increase in network centrality emerges several periods after

the establishment of a bishopric. This pattern indicates that the baseline results are not driven by differential population growth or the mechanical concentration of creatives in larger settlements.

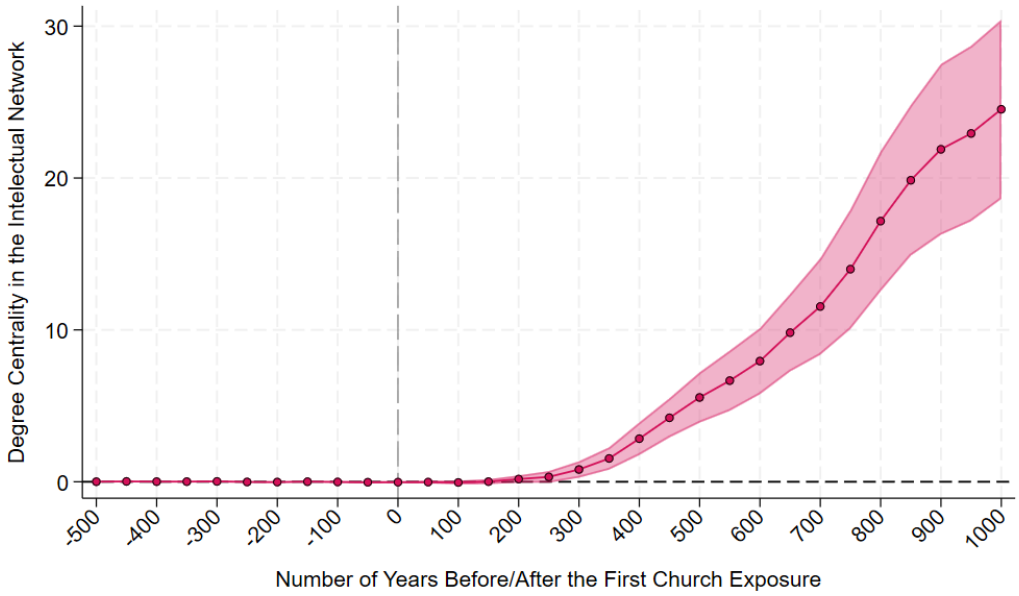


Figure B.27: Creative Networks and Church Exposure: Controlling for Population Size

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The specification controls for the heterogeneous dynamic influence of scale by interacting a population size (Klein Goldewijk et al., 2017) of the grid cell with period fixed effects. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

Figures B.28–B.30 report a complementary set of robustness checks based on alternative estimators and inference procedures. Figure B.28 shows results using a standard two-way fixed effects (TWFE) model, while Figures B.29 and B.30 apply the heterogeneous-treatment estimators proposed by De Chaisemartin and d'Haultfoeuille (2020) and Sun and Abraham (2021), respectively. Across all approaches, the estimated dynamic effects are virtually indistinguishable from the baseline: no evidence of differential pre-trends and a gradual, persistent increase in Creative Network centrality following exposure.

To account for possible spatial and temporal autocorrelation in residuals, we estimate the effects using the inference of Colella et al. (2019), and the confidence intervals remain highly consistent with the baseline as reported in Figure B.31.

Finally, Figure B.32 restricts the sample to the medieval period (500–1500 CE), ensuring that the estimated post-exposure effects are not driven by later economic or infrastructural developments. The pattern again closely replicates the baseline findings: flat coefficients before exposure and a steady rise in Creative Network centrality in the centuries following the diffusion of Church institutions.

Taken together, these results demonstrate the robustness of the main finding. Across specifications controlling

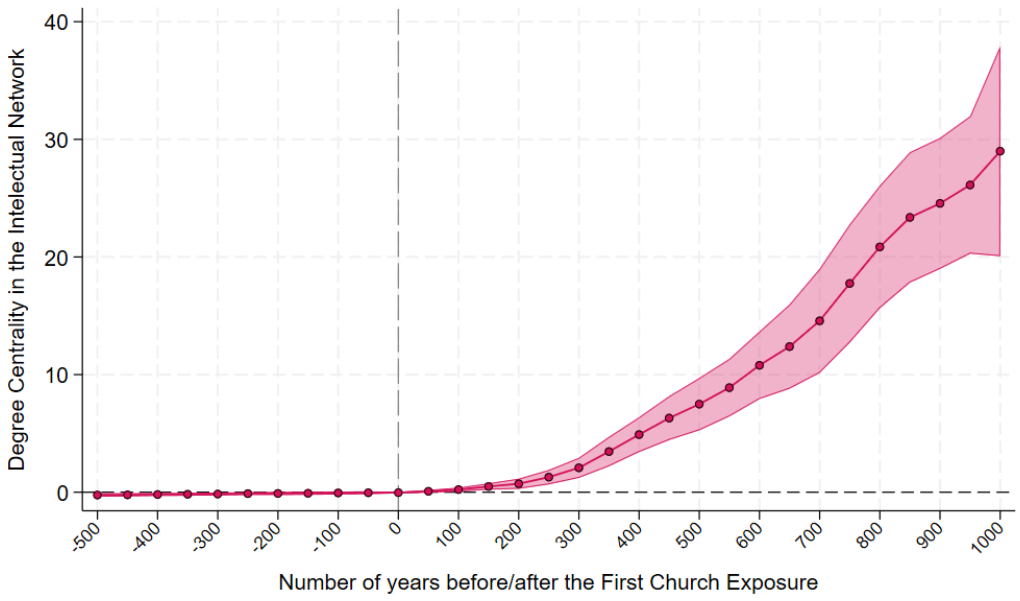


Figure B.28: Creative Networks and Church Exposure: Event Study TWFE

Notes: The figure reports two-way regression estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

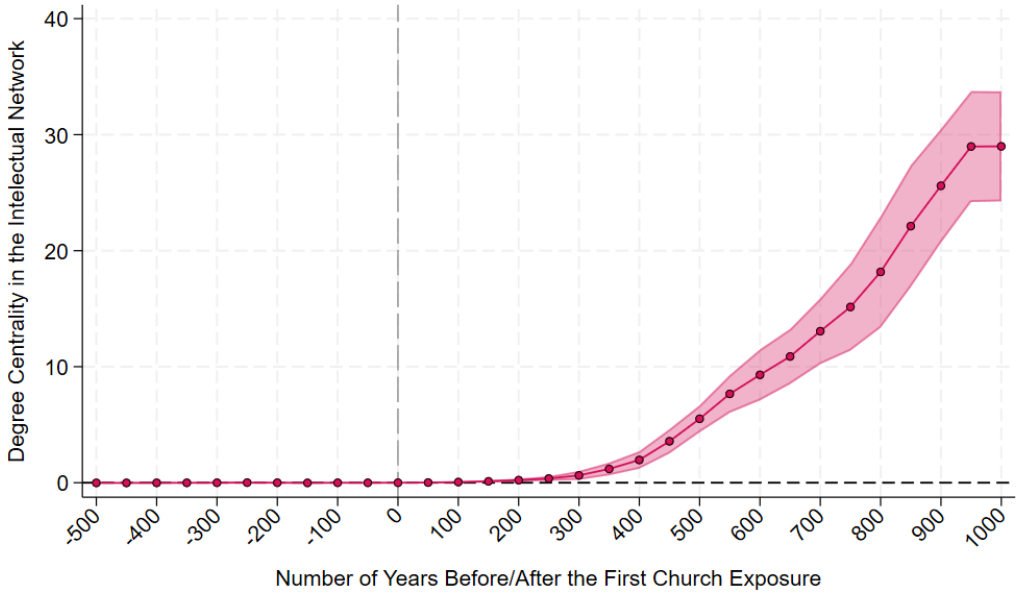


Figure B.29: Creative Networks and Church Exposure: Event Study De Chaisemartin and d'Haultfoeuille (2020)

Notes: The figure reports De Chaisemartin and d'Haultfoeuille (2020) estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

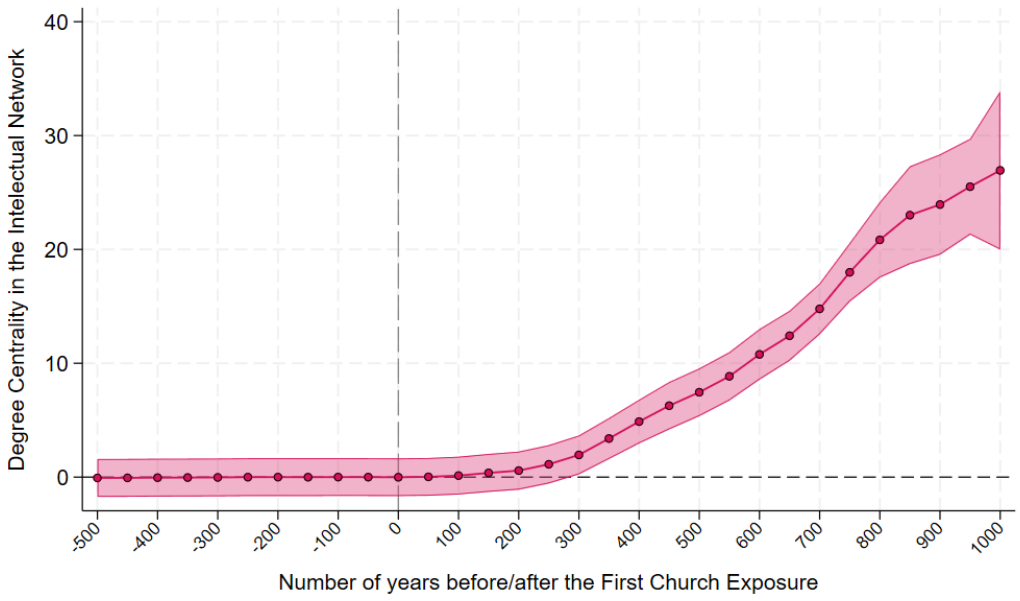


Figure B.30: Creative Networks and Church Exposure: Event Study Sun and Abraham (2021)

Notes: The figure reports Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

for Roman roads, employing alternative estimators, adjusting inference for spatial and temporal dependence, and restricting the temporal sample, the dynamic effects remain stable—showing no pre-trend and a consistent post-exposure increase in the centrality of the Creative Network.

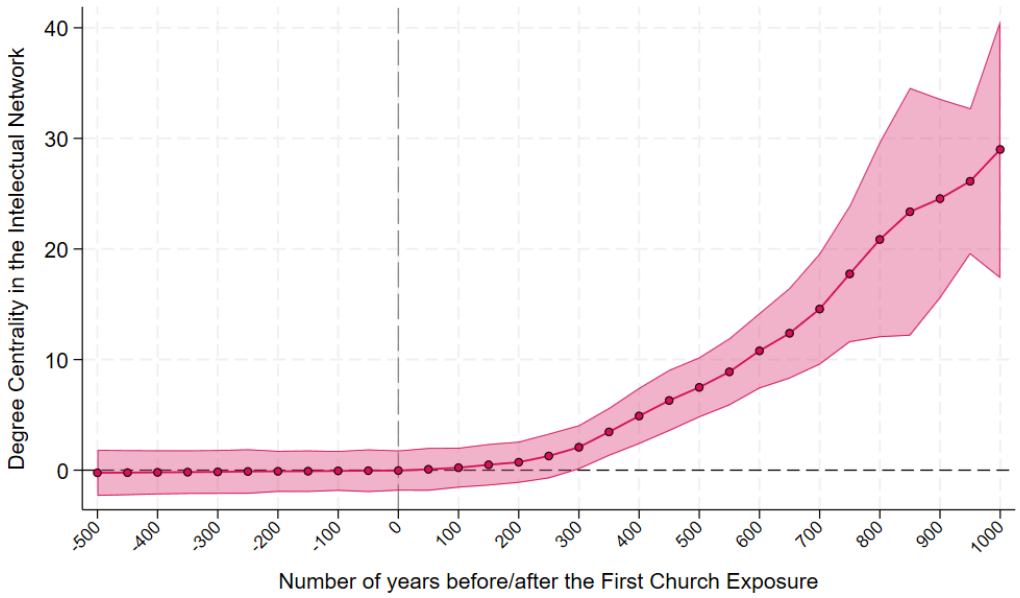


Figure B.31: Creative Networks and Church Exposure: Colella et al. (2019) Inference

Notes: The figure reports two-way regression fixed effects estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists). The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on Colella et al. (2019) spatial and temporal correlation-robust standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

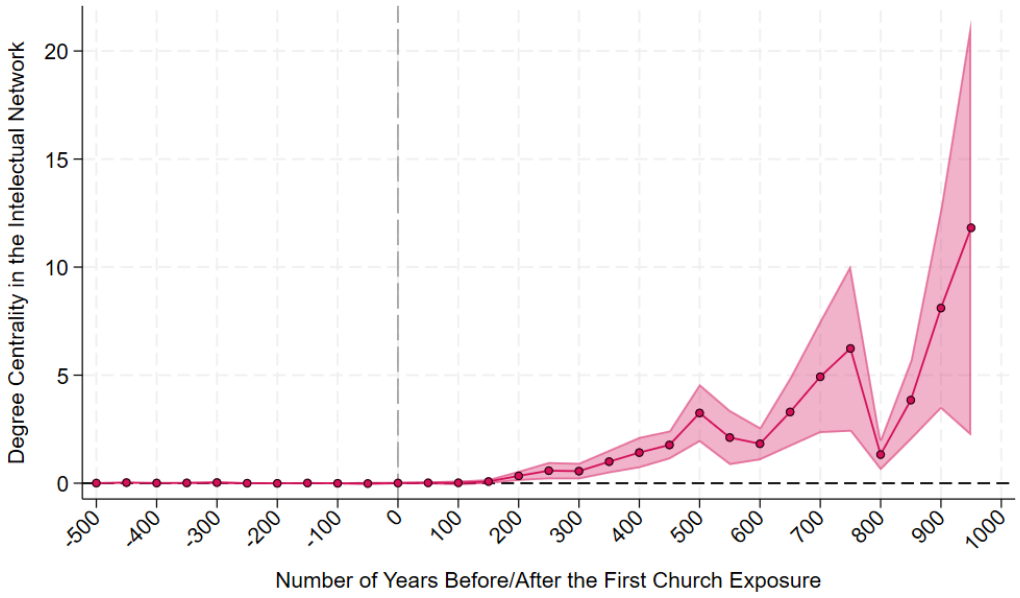


Figure B.32: Creative Networks and Church Exposure: Event Study (500 – 1500)

Notes: The figure reports Callaway and Sant'Anna (2021) estimates and 95% confidence intervals for the effects of bishopric establishment on the degree centrality of the grid cell in the migration network of famouse creatives (i.e., artists and scientists) between years 500 and 1500. The unit of observation is grid cell by half-century interval. The main independent variable is an indicator taking value one once the first bishopric is active, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.5 MFL Synods, Creativity, and Network Centrality: Robustness

This section presents a series of robustness analyses confirming that the estimated dynamic relationship between the exposure to the Marriage and Family Legislation of the early medieval Church and the production of Famous Creatives, as well as the evolution of the Creative Network, reported in Figure 9, is not sensitive to alternative specifications, inference methods, or sample definitions.

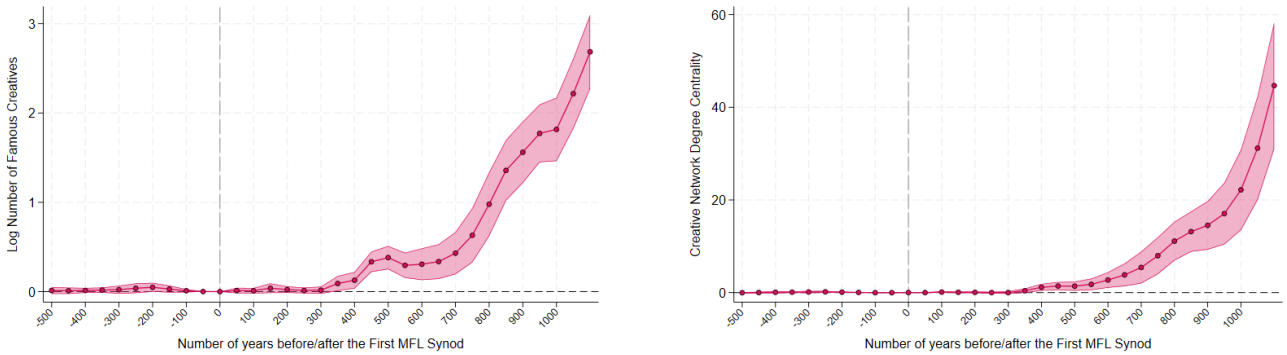
Table B.2 reports summary statistics for synod attendance across bishops. On average, bishops attended more MFL synods than non-MFL synods, though both measures exhibit substantial variation. While the correlation between the two is positive, it is not particularly high, suggesting that participation in MFL and non-MFL synods captures related but distinct dimensions of episcopal activity.

Table B.2: Synod Attendance by Bishops: Summary Statistics

	Mean	SD	Min	Max	Corr
MFL Synods	2.59	2.02	0	9	0.29
Non-MFL Synods	1.87	2.56	0	11	

Figures B.33–B.35 report a complementary set of robustness checks based on alternative event-study estimators for the effect of exposure to MFL Synods. Figure B.33 presents estimates obtained from a standard two-way fixed effects (TWFE) specification, while Figures B.34 and B.35 apply the heterogeneous-treatment estimators proposed by De Chaisemartin and d'Haultfoeuille (2020) and Sun and Abraham (2021), respectively.

Across all three approaches, the estimated dynamic effects are highly consistent with our baseline results. In particular, we find no evidence of differential pre-trends in either the log number of famous creatives or creative network degree centrality prior to treatment. Following exposure to MFL Synods, both outcomes exhibit a gradual and persistent increase, with effects building over time and remaining positive in the long run.

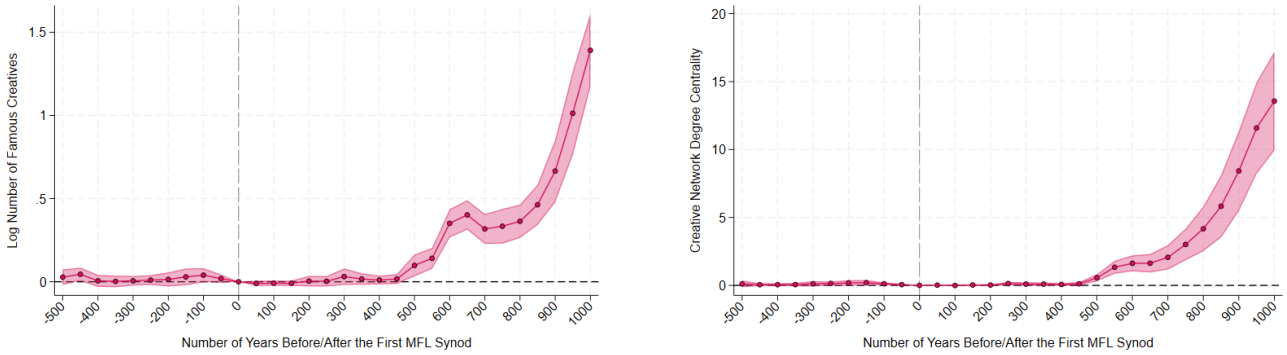


(a) Log Famous Creatives

(b) Creative Network Degree Centrality

Figure B.33: TWFE Event-study Estimates of the Effect of MFL Synods on Famous Creatives and Network Centrality

Notes: The figure reports a two way fixed effects estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and creative network degree centrality in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

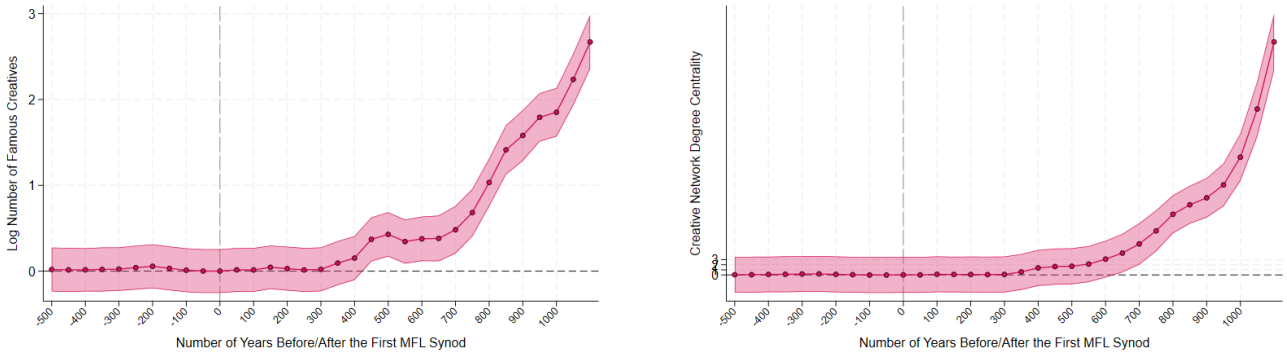


(a) Log Famous Creatives

(b) Creative Network Degree Centrality

Figure B.34: De Chaisemartin and d'Haultfoeuille (2020) Event-study Estimates of the Effect of MFL Synods on Famous Creatives and Network Centrality

Notes: The figure reports a De Chaisemartin and d'Haultfoeuille (2020) estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and creative network degree centrality in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

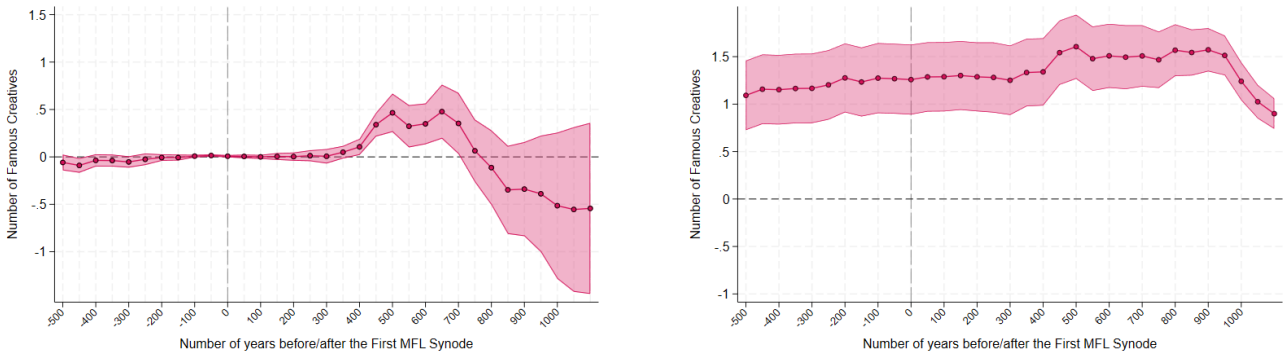


(a) Log Famous Creatives

(b) Creative Network Degree Centrality

Figure B.35: Sun and Abraham (2021) Event-study Estimates of the Effect of MFL Synods on Famous Creatives and Network Centrality

Notes: The figure reports a Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and creative network degree centrality in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.



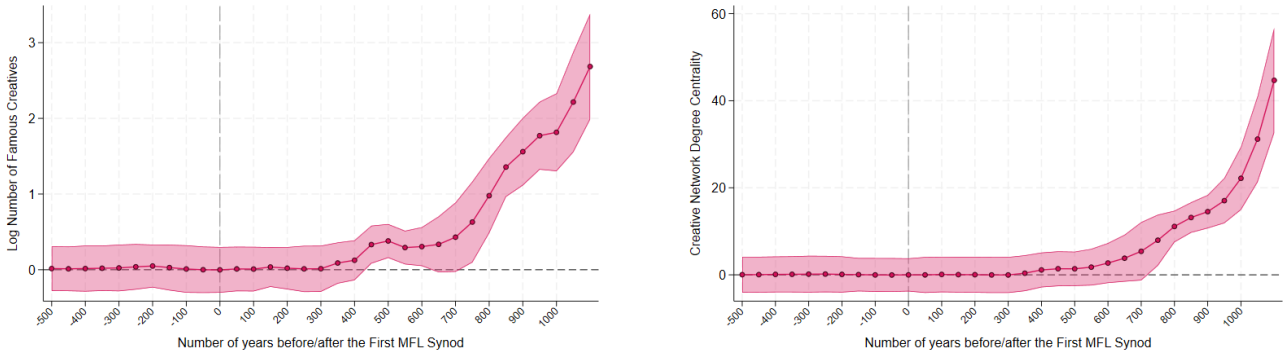
(a) Poisson Regression

(b) Negative Binomial Regression

Figure B.36: Event-study Estimates of the Effect of MFL Synods on Famous Creatives: Alternative Estimation

Notes: The figure reports two-way fixed effects Poisson regression estimates with 95% confidence intervals in Panel (a) and two-way fixed effects negative binomial regression estimates with corresponding 95% confidence intervals in Panel (b) for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on Colella et al. (2019) spatial and temporal correlation-robust standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

Figure B.37 examines the robustness of statistical inference to alternative assumptions about spatial and temporal dependence. The figure reports confidence intervals constructed using the procedure of Colella et al. (2019), which is robust to both spatial and serial correlation in the error terms. Reassuringly, the estimated dynamic effects remain qualitatively unchanged and statistically meaningful under this more demanding inference approach, confirming that our results are not driven by understated standard errors due to spatial or temporal dependence.



(a) Log Famous Creatives

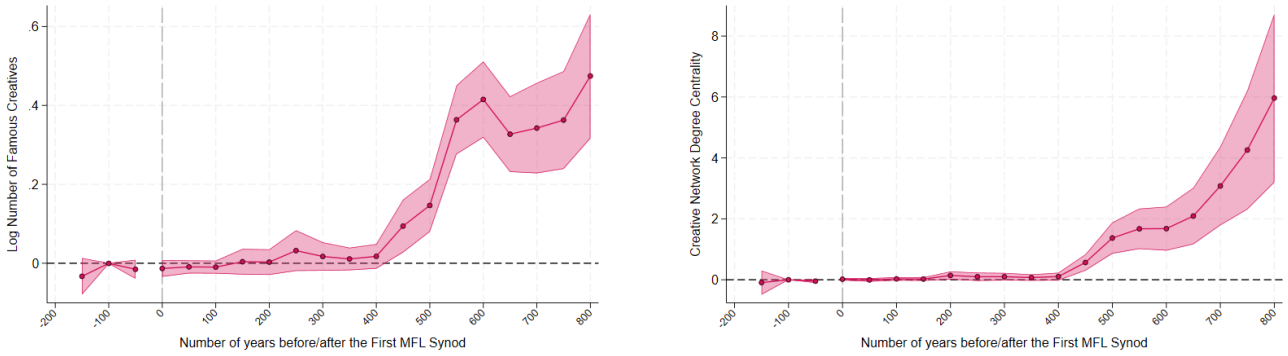
(b) Creative Network Degree Centrality

Figure B.37: Event-study Estimates of the Effect of MFL Synods on Famous Creatives and Network Centrality with Colella et al. (2019) Inference

Notes: The figure reports two-way fixed effects regression estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and creative network degree centrality in Panel (b). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on Colella et al. (2019) spatial and temporal correlation-robust standard errors. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

To evaluate the stability of the results across alternative sample definitions and subsamples, Figures B.38 and

B.39 restrict the analysis to medieval observations between 500 and 1500 CE and to secular creatives, respectively. Figure B.38 shows that the main patterns remain unchanged when focusing exclusively on the medieval period: we find no evidence of differential pre-trends and observe a gradual and persistent increase in both the log number of famous creatives and creative network degree centrality following exposure to MFL Synods. Figure B.39 further demonstrates that these effects are not driven by religious figures, as the results remain qualitatively similar when restricting the outcome to secular creatives only. Taken together, these findings indicate that our results are not sensitive to the inclusion of later periods or to the presence of religious occupations, reinforcing the interpretation that exposure to MFL Synods is associated with sustained increases in creative production and network connectivity.



(a) Log Famous Creatives

(b) Creative Network Degree Centrality

Figure B.38: Callaway and Sant'Anna (2021) Event-study Estimates of the Effect of MFL Synods on Famous Creatives and Network Centrality (500 – 1500)

Notes: The figure reports a Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous creatives (i.e., scientists and artists) in Panel (a) and creative network degree centrality in Panel (b) between years 500 and 1500 CE. The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

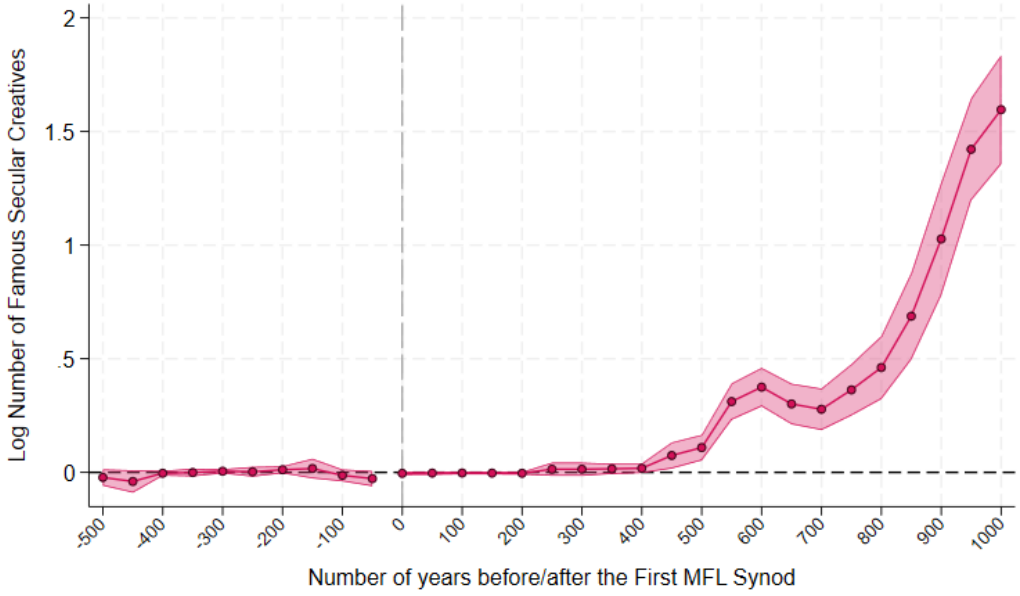


Figure B.39: Callaway and Sant'Anna (2021) Event-study Estimates of the Effect of MFL Synods on Secular Famous Creatives

Notes: The figure reports a Sun and Abraham (2021) estimates and 95% confidence intervals for the effects of first MFL Synods exposure on the log number of famous secular creatives (i.e., secular scientists and artists). The unit of observation is 1.5 by 1.5-degree grid cell by half-century interval. The main independent variable is an indicator taking value one once the bishop from the grid cell attends the first MFL Synod, and zero otherwise. Confidence intervals are based on heteroskedasticity-robust, grid-cell clustered asymptotic standard errors obtained via influence functions. The x-axis reports years to/from the establishment of the first bishopric in a grid cell.

B.6 Medieval Church Exposures and Monasteries

Table B.3 reports cross-sectional OLS estimates linking exposure to the medieval Catholic Church to the presence of major monastic orders across European grid cells. The coefficient on Church Exposure is positive and highly significant across all specifications, indicating that areas longer exposed to Church influence between 500 and 1500 CE are systematically more likely to host monasteries of the Cistercian, Cluniac, Dominican, Franciscan, and Premonstratensian orders, as well as any monastic foundation more broadly. The magnitudes are sizable and consistent across orders, ranging from 0.04 to 0.19 standard deviations per one standard deviation increase in Church exposure. Results remain robust when controlling for country fixed effects, geographic characteristics (elevation, ruggedness, climate, and proximity to waterways), and additional regional covariates such as population and area. Overall, the estimates suggest a strong and geographically persistent association between early Church presence and the subsequent diffusion of monastic institutions across medieval Europe.

Table B.3: Church Exposure and Monasteries

	Presence of Medieval Monasteries:					
	Cist	Clun	Domi	Fran	Prea	Any
	(1)	(2)	(3)	(4)	(5)	(6)
Medieval Church Exposure	0.09***	0.19***	0.09***	0.04***	0.13***	0.12***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.63	0.77	0.78	0.69	0.73	0.71
Observations	50979	50979	50979	50979	50979	50979

Notes: Using OLS regression, this table establishes a positive significant relation between: the the number of centuries spent under the exposure to Catholic church from year 500 to 1500 and the number of Monasteries of Premonstratensian, Dominican, Franciscan, Cluny, Cistercian orders (Columns 1 – 5), as well as all any of them (Column 6) across the 0,125 by 0,125 degree cells in Europe. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B.7 Robustness to Alternative Mechanisms

Empirical Model

To account for the potentially confounding effect of the alternative mechanism, we employ the following specification (11), which estimates a dynamic event-study model in which the outcome variable y_{gt} (i.e., the log number or share of famous creatives and creative network degree centrality) is related to a full set of post-treatment indicators

$(Lag_\tau)_{gt}$ and pre-treatment placebo indicators $(Lead_\tau)_{gt}$. In Columns 2 and 3 of Figures 10, 11, and 12 we report the coefficients β_τ trace out the dynamic effects of treatment up to 20 periods after adoption, while $\beta_{-\tau}$ capture placebo (pre-treatment) dynamics up to 10 periods prior to treatment, providing a test for the presence of pre-trends.

$$y_{gt} = \beta_0 + \sum_{\tau=0}^{T} \beta_\tau (Lag_\tau)_{gt} + \sum_{\tau=1}^{T} \beta_{-\tau} (Lead_\tau)_{gt} + \delta X_{gt} + \mu_t + \lambda_g + \varepsilon_{gt} \tag{11}$$

Importantly, the specification includes a time-varying control X_{gt} (i.e., one of the proxies for state capacity, market integration, or economic development), allowing us to assess whether the estimated treatment effects persist after accounting for this alternative mechanism. Grid-cell fixed effects λ_g absorb time-invariant heterogeneity across locations, while period fixed effects μ_t capture common shocks. Standard errors are clustered at the grid-cell level.

Decomposition of the "State Actors" Effect

Building on the baseline results, Figure B.40 further demonstrates that our findings are robust to a finer decomposition of the "state actors" category into its constituent components—lawyers/administrators, politicians, nobles, and military leaders. Across all four rows, the event-study patterns in Column 1 do not exhibit dynamics that mirror the sustained post-treatment rise observed for creatives and network centrality. More importantly, Columns 2 and 3 show that controlling separately for each of these disaggregated proxies leaves our main coefficients largely unchanged in both magnitude and significance.

This parallels the broader evidence in the paper that alternative mechanisms—such as state capacity, market size, or direct Church employment—do not account for the core relationship between bishopric exposure and innovation outcomes. Taken together, these results indicate that our findings are not driven by any single component of elite state formation, but instead reflect a distinct channel consistent with the Church-induced transformation in social structure and network formation.

In addition, Figure B.41 extends the analysis of alternative mechanisms by decomposing the "state actors" category into its constituent components and examining their shares among all notables. Mirroring the structure of Figure 11, the first column presents event-study estimates for the shares of lawyers/administrators, politicians, nobles, and military figures, while the second column re-estimates our main specification for creative production controlling for each of these components separately.

Consistent with the baseline results, the dynamics of these disaggregated categories do not mirror the sustained post-treatment increase observed for creatives. While some categories exhibit modest adjustments following the arrival of bishoprics, these effects are generally short-lived and do not display the same persistent upward trajectory. Moreover, controlling for each component individually leaves the estimated effects on creative production largely unchanged in both magnitude and significance.

These findings reinforce the conclusion that our main results are not driven by shifts in any particular di-

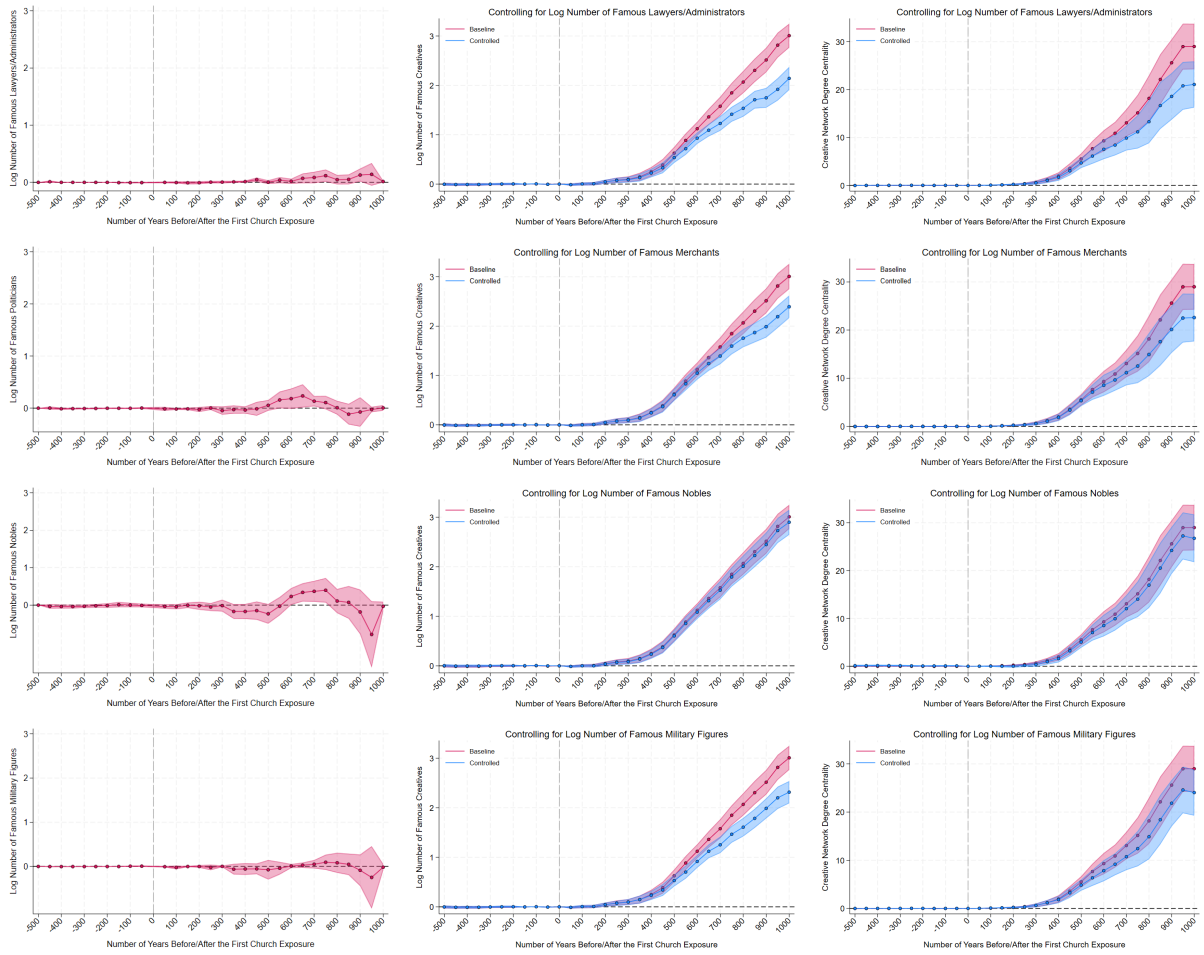


Figure B.40: Robustness to Alternative Mechanisms: Decomposition of "State Actors"

Note: To further account for alternative mechanism, we explore the role of four proxy measures derived for the Notable dataset that go into the measure of "state actors" used in the baseline analysis. We consider a role for state capacity by studying the dynamics of lawyers/administrators (Row 1), politicians (Row 2), nobles (Row 3), and military leaders (Row 4). Column 1 provide an event analysis, paralleling our approach above for creatives and network centrality. Columns 2 and 3 re-run our main event analysis controlling for these proxies to assess their influence on main results.

mension of elite state formation. Rather, even when accounting for the composition of state actors at a granular level, the relationship between bishopric exposure and creative outcomes remains robust, further supporting the interpretation that alternative mechanisms cannot account for the observed patterns.

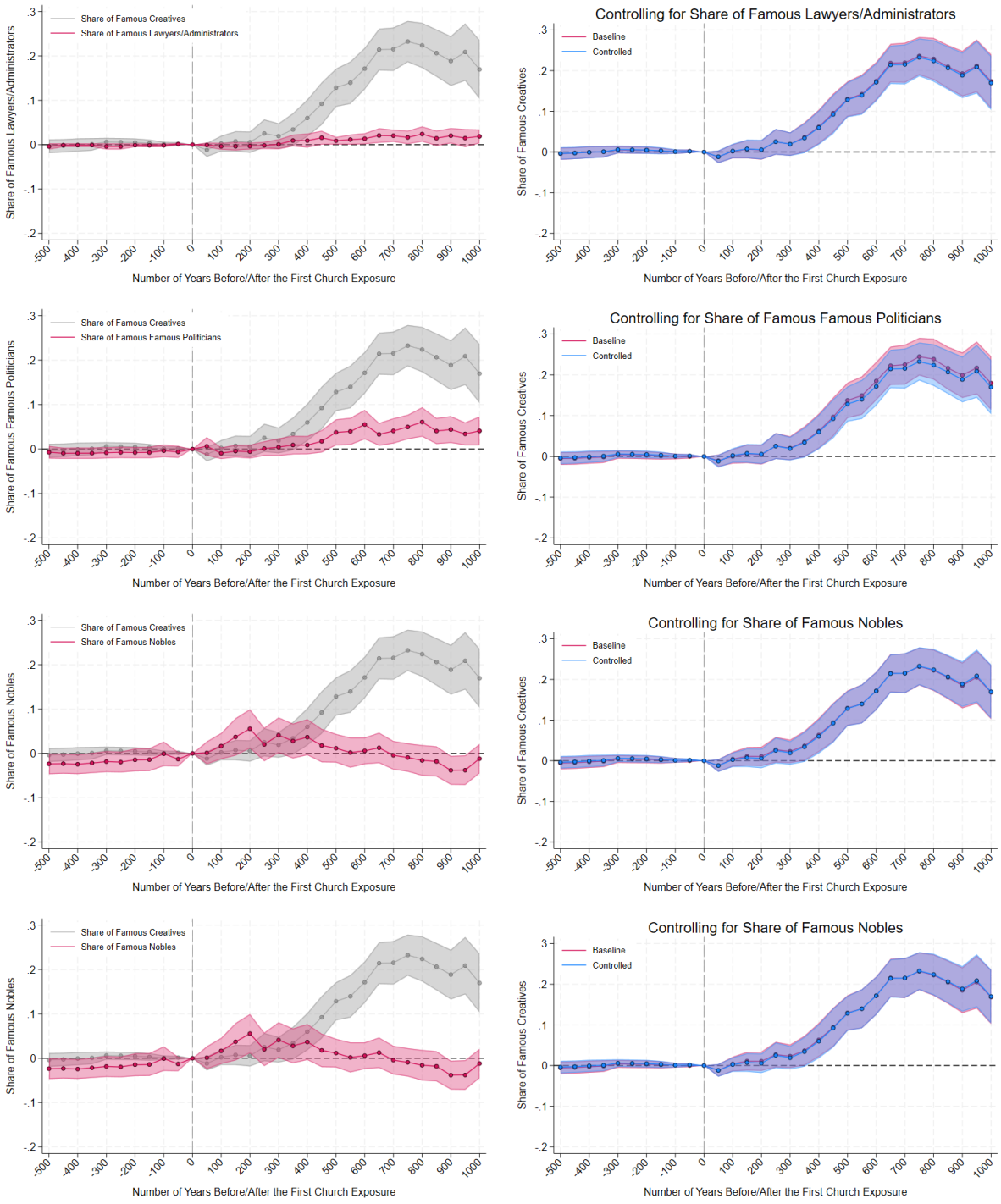


Figure B.41: Shares of Different Categories of Famous People out of all Famous People: Decomposition of "State Actors"

Note: To further account for alternative mechanism, we explore the role of four proxy measures derived for the Notable dataset that go into the measure of "state actors" used in the baseline analysis. We consider a role for state capacity by studying the share of lawyers/administrators, politicians, nobles, and military leaders (Row 1). To capture market scale, Row 2 examines the share of notable business people. To assess direct employment by the Church, Row 3 focuses on the share of famous religious figures. Column 1 presents event-study estimates, paralleling our baseline approach but using shares rather than log counts. Column 2 re-estimates our main specification while controlling for these proxies to assess their influence on the core results.

B.8 Famous Creatives and Innovation: Validation

This section validates the use of the number of famous creatives as a historical proxy for the level of innovation in a given grid cell. Table B.4 presents evidence linking historical creative activity to contemporary innovative outcomes. Specifically, the table reports a positive and statistically significant relationship between the number of patents per capita during the period 1980–2010 and the number of famous creatives alive during a 50-year window beginning in each century between 1400 and 2000 (Columns 1–7). Starting with the cohort corresponding to the year 1300, the estimated relationship is consistently positive and statistically significant. Moreover, the magnitude of the association increases over time, reaching a standardized beta coefficient of approximately 0.34 in the most recent historical window.

To assess whether this relationship simply reflects the presence of historically prominent individuals more generally, rather than creative activity specifically, we also include the log counts of famous non-creatives in the analysis. In contrast to the results for creatives, the estimated effects for famous non-creatives display no consistent pattern of statistical significance across periods, despite several individual coefficients reaching conventional significance levels. This comparison suggests that the predictive relationship with modern patenting is specific to historical creative activity rather than to the general historical prominence of individuals in a location.

Table B.4: Innovation and Famous People: Validation

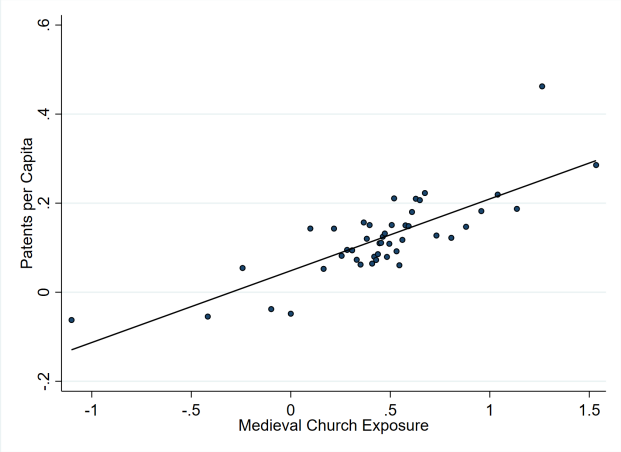
	Patents per Capita							
	1300	1400	1500	1600	1700	1800	1900	2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of Famous Creatives (Log)	0.09*	0.10*	0.22**	0.13	0.11	0.34***	0.20**	0.24**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of Famous Non-Creatives (Log)	-0.06	0.00	0.07	0.11	0.20***	-0.01	0.25**	0.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.31	0.32	0.34	0.33	0.34	0.34	0.35	0.36
Observations	863	863	863	863	863	863	863	863

Notes: Using OLS regression, this table establishes a positive significant relation between the number of patents per capita and the number of famous creatives that were born in the 1,5 by 1,5 degree cells during the corresponding century across Europe. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, temperature and precipitation annual mean and standard variation. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

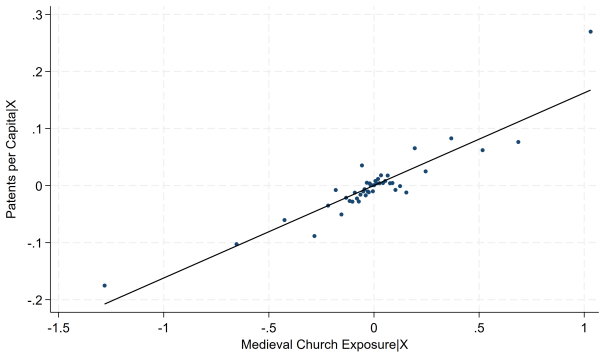
C Additional Contemporary Results

C.1 Binned Scatter Plots

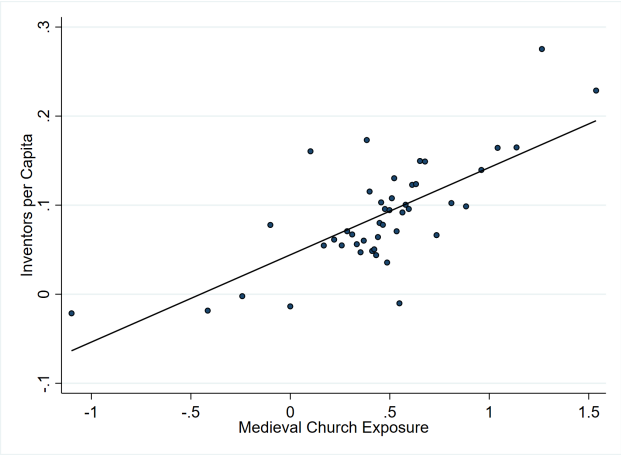
Figure C.1 presents binned scatter plots illustrating the relationship between medieval Church exposure and innovation outcomes corresponding to the specifications reported in Columns (1) and (6) of Panels A–C in Table 2. The figure contains six subpanels. Panels (a), (c), and (e) display the baseline bivariate relationships between Church exposure and patents per capita, inventors per capita, and the share of famous creatives, corresponding to Column (1) of the table. Panels (b), (d), and (f) show the corresponding residualized relationships from the fully controlled specification reported in Column (6), after accounting for country fixed effects, geographic characteristics, and additional controls. Consistent with the regression estimates, the plots reveal a positive association between Church exposure and all three measures of innovation. The binned scatter plots provide a transparent visualization of the underlying relationships across European grid cells.



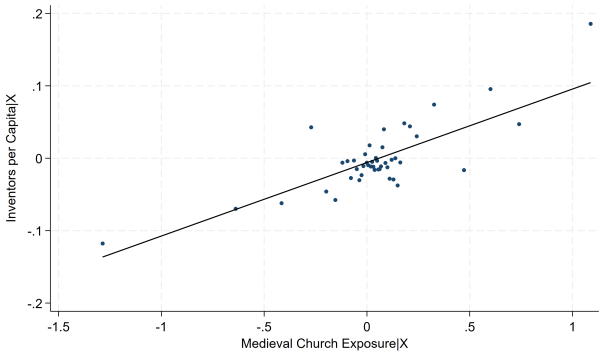
(a) Patents, Bivariate



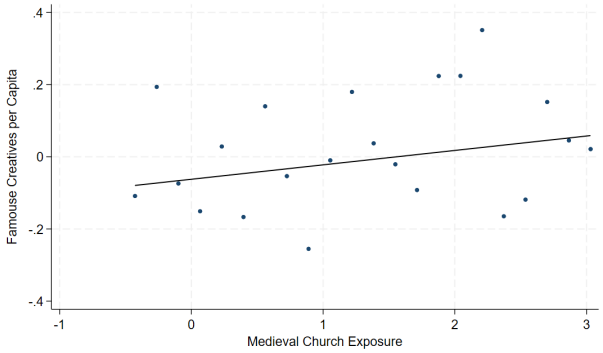
(b) Patents, Residualized



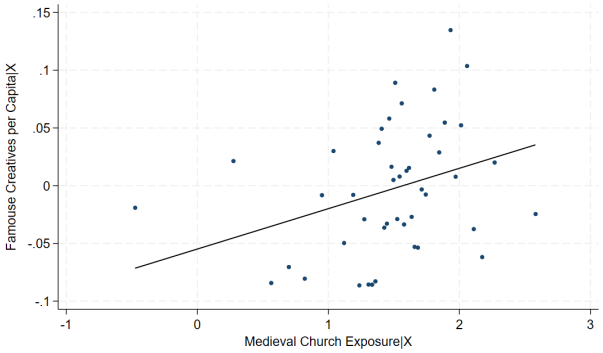
(c) Inventors, Bivariate



(d) Inventors, Residualized



(e) Famous Creatives, Bivariate



(f) Famous Creatives, Residualized

Figure C.1: Innovation Proxies and Church Exposure: Binned Scatter Plots Across Grid Cells in Europe

C.2 Historical Experiment: Suppression of the Bishoprics

After their establishment, bishoprics were sometimes 'suppressed' because the region or city was seized by a non-Christian power, effectively disconnecting the conquered bishopric from the Church's network and limit or eliminating the power of the local bishops. The seizures include pagan uprisings in Germany and England as well as Muslim conquests in Spain and Italy. The extent to which Christians were suppressed varies across cases.

For example, the Saxons in northern Germany rebelled in 772 against Charlemagne's Christian Empire in the 8th century after Charlemagne destroyed a sacred pagan. It took the Empire roughly three decades to end this uprising. By contrast, over in the Elbe-Baltic region, Wendish pagans seized control for nearly two centuries, rendering the bishoprics titular powers only. In Sicily, Muslim conquests in 827 CE left the Catholic bishoprics intact, but without the support of the political leadership, their ability to implement Church policies was weak. After the Norman conquest of 1061, Sicily's bishoprics enter the Catholic hierarchy, under the bishopric in Rome. Eventually, by 1500 CE, all suspended bishoprics had been restored to the Catholic fold CE.

These suppressive events offer a degree of random variation. Clearly, from the point of view of those who founded particular bishoprics, successful uprisings and conquests were not planned and the vagaries of battle add a stochastic element—many pagan uprisings and Muslim efforts at conquests failed. For example, in 732 CE a large Muslim force crossed the Pyrenees, established control of Septimania (in Narbonne) and sent a raid into Bordeaux. In a battle near Tours, the Muslim commander was killed in the melee, resulting in chaos and confusion in the Muslim ranks, resulting in a rapid withdrawal that night. This chance death effectively ended a promising campaign into the heart of Frankish territory. The victory boosted the prestige of the Frankish leader, Charles Martel and his lineage. Martel's grandson, Charlemagne, was crowned Emperor in 800 CE by Pope Leo III.

Harnessing this checkered history, C.1 reports the results of estimating five models that split our singular measure of Church Exposure into two components: one component that represents the years since the original founding of the bishopric and a second that represents the number of years the bishopric was suppressed, meaning the territory was under the political control or influence of non-Christian powers.

The analysis reveals robust and significant coefficients for both components. Notably, even in our strictest specification, which compares only grid-cells within the same subnational regions, more years of suppression is associated with fewer patents and inventors today. While the first predictor likely contains substantial random variation, rooted in historical contingency, it should also capture any strategic thinking by Church leaders in deciding when and where to put bishoprics. The second variable captures the duration of any subsequent disruptions and thus should isolate variation from the vagaries of war and conflict.

If the association between medieval Church exposure and innovation were due to confounding factors, such as an undocumented effort by the Church to target regions with high innovative potential, we'd expect to see most or all of the Church's influence operating through the first variable, the time since the Church established its first bishopric, and a near-zero coefficient for the second predictor, the duration of the disruption. However, a negative coefficient contradicts this interpretation, indicating that regions initially targeted by the Church but which experienced Church-rule disruptions are less innovative today.

Table C.1: Innovation and Suppressed Bishoprics: Cells in Europe

	Patents per Capita		Inventors per Capita		Share of Fam Creatives	
	(1)	(2)	(3)	(4)	(5)	(6)
Medieval Church Exposure	0.14***		0.10***		0.05***	
	(0.03)		(0.02)		(0.02)	
Years since first Bishopric		0.19***		0.13***		0.07***
		(0.04)		(0.02)		(0.02)
Years Bishopric Suppressed		-0.04***		-0.02*		-0.03***
		(0.02)		(0.01)		(0.01)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.19	0.19	0.14	0.15	0.06	0.07
Observations	31242	31242	31018	31018	17804	17804

Notes: Using OLS regression, this table establishes a positive significant relation between the number of patents per capita and the number of years since the establishment of the first bishopric in the 100km radius, as well as the negative effect of the number of years the bishopric was suppressed across the 0,125 by 0,125 degree cells in Europe. Latitude and longitude polynomial is of a second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population, distance to the closest roman road, distance from Wittenberg. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C.3 Church Institutions, Social Structure, and WEIRD Psychology

Table C.2 presents OLS estimates of the relationship between historical exposure to Church institutions—measured both by medieval Church presence and exposure to Marriage and Family Legislation (MFL) Synods—and contemporary psychological outcomes across European NUTS-3 regions. The table decomposes the composite WEIRD index into its underlying dimensions, allowing us to identify which components drive the overall relationship.

Across specifications, medieval Church exposure is positively and consistently associated with all four dimensions of WEIRD psychology. The relationship with non-conformity (Panel D) is particularly strong, large in magnitude, and highly robust across all specifications. Similarly, individualism (Panel C) exhibits a stable and statistically significant positive association throughout, although the magnitude is more modest.

Importantly, the results also reveal robust positive relationships with universal trust (Panel A) and universal fairness (Panel B). While the magnitude of the trust coefficient declines once additional controls are introduced, it remains positive and statistically significant in the more demanding specifications. The association with universal fairness is also consistently positive and statistically significant across specifications, indicating that Church exposure is linked not only to independence-related traits but also to broader prosocial norms.

The role of MFL synod exposure is most pronounced for non-conformity, where the coefficients are large, positive, and highly significant. There is also some weaker evidence of a positive association with fairness and individualism in certain specifications. In contrast, placebo synods show no systematic positive effects and, in the

case of non-conformity, are negatively associated with the outcome, reinforcing the interpretation that the observed relationships are specific to Church institutions governing kinship.

Taken together, the results suggest that the relationship between historical Church institutions and the composite WEIRD index is broad-based, encompassing both psychological independence (non-conformity and individualism) and prosocial universalism (trust and fairness).

Table C.2: Social Structure, WEIRD Psychology, and Church Exposure: NUTS 3 Regions in Europe (OLS)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:			Universal Trust			
Medieval Church Exposure	0.22***	0.10	0.10	0.10***	0.10***	
	(0.07)	(0.07)	(0.06)	(0.03)	(0.03)	
MFL Synods Attended by the Bishop				0.01	0.01	0.02
				(0.02)	(0.02)	(0.02)
Placebo Synods Attended by the Bishop					0.01	0.00
					(0.05)	(0.05)
Adjusted-R^2	0.88	0.89	0.89	0.89	0.89	0.89
Observations	1149	1149	1149	1149	1149	1149
Panel B:			Universal Fairness			
Medieval Church Exposure	0.13***	0.05**	0.06***	0.05**	0.05**	
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	
MFL Synods Attended by the Bishop				0.02*	0.02	0.03
				(0.01)	(0.02)	(0.02)
Placebo Synods Attended by the Bishop					0.01	0.00
					(0.03)	(0.03)
Adjusted-R^2	0.92	0.93	0.93	0.93	0.93	0.93
Observations	1149	1149	1149	1149	1149	1149
Panel C:			Individualism			
Medieval Church Exposure	0.03***	0.03***	0.03***	0.03***	0.03***	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
MFL Synods Attended by the Bishop				-0.00	0.01	0.01*
				(0.00)	(0.01)	(0.01)
Placebo Synods Attended by the Bishop					-0.01	-0.02*
					(0.01)	(0.01)
Adjusted-R^2	0.91	0.91	0.91	0.91	0.91	0.91
Observations	1149	1149	1149	1149	1149	1149
Panel D:			Non-Conformity			
Medieval Church Exposure	0.23***	0.20***	0.21***	0.19***	0.18***	
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	
MFL Synods Attended by the Bishop				0.07***	0.12***	0.15***
				(0.02)	(0.02)	(0.02)
Placebo Synods Attended by the Bishop					-0.12***	-0.14***
					(0.04)	(0.04)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	No	Yes	Yes	Yes	Yes	Yes
Geographic Controls	No	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	No	Yes	Yes	Yes	Yes
Religiosity	No	No	Yes	Yes	Yes	Yes
Adjusted-R^2	0.84	0.85	0.85	0.85	0.85	0.85
Observations	1149	1149	1149	1149	1149	1149

Notes: Using OLS regression, this table establishes a positive significant relationship between the Church Exposure and: (Panel A) universal trust, (Panel B) universal fairness, (Panel C) individualism, and (Panel D) non-conformity across the NUTS 3 region in Europe. Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area and population. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C.4 Innovation and WEIRD Psychology

Table C.3 reports OLS estimates of the relationship between dimensions of WEIRD psychology and innovation outcomes across European NUTS-3 regions. Innovation is measured using three complementary indicators: patents per capita, inventors per capita, and the share of famous creatives. The table examines each psychological dimension separately to assess their differential associations with innovative activity.

Across specifications, all four dimensions of WEIRD psychology exhibit positive and statistically significant relationships with innovation outcomes, although the strength and robustness of these associations vary across measures. Universal trust (Panel A) and universal fairness (Panel B) are strongly associated with patents and inventors per capita. These relationships remain highly significant even in specifications that include a rich set of controls, suggesting that prosocial norms and generalized cooperation are closely linked to modern innovative activity. However, their association with the share of famous creatives is weaker and less robust, particularly in the most demanding specifications.

Individualism (Panel C) displays the most consistent and robust relationship with innovation across all three outcomes. The coefficients are large, positive, and highly statistically significant in all specifications, including those with full controls. This pattern suggests that individualistic norms—emphasizing independence, original thinking, and self-expression—are strongly associated with both modern innovation (patents and inventors) and historical creative achievement.

A similar pattern emerges for non-conformity (captured inversely by conformity in Panel D). Higher levels of non-conformity are strongly and consistently associated with all measures of innovation, with large and highly significant coefficients across specifications. This finding highlights the importance of deviation from social norms and openness to unconventional ideas as key drivers of both technological and cultural innovation.

Taken together, the results suggest that while prosocial traits such as trust and fairness are important for facilitating modern innovative activity, psychological traits related to independence—particularly individualism and non-conformity—play a central and more universal role across both technological and creative domains. This evidence is consistent with the view that innovation thrives in environments that both support cooperation and reward independent thinking.

Table C.3: Innovation, Social Structure, and WEIRD Psychology: NUTS 3 Regions in Europe (OLS)

	Patents per Capita		Inventors per Capita		Share of Fam Creatives	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:						
Universal Trust	0.27***	0.32***	0.38***	0.32***	0.07**	0.11
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Adjusted-R^2	0.09	0.49	0.16	0.52	0.01	0.46
Observations	1474	1474	1474	1474	1453	1453
Panel B:						
Universal Fairness	0.36***	0.26***	0.44***	0.26***	0.23***	0.16
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.02)
Adjusted-R^2	0.14	0.48	0.20	0.51	0.05	0.46
Observations	1474	1474	1474	1474	1453	1453
Panel C:						
Individualism	0.52***	0.28***	0.55***	0.27***	0.43***	0.20***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Adjusted-R^2	0.28	0.49	0.30	0.51	0.17	0.46
Observations	1474	1474	1474	1474	1453	1453
Panel D:						
Non-Conformity	0.51***	0.28***	0.54***	0.30***	0.39***	0.22***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes	No	Yes
Lon/Lat Polynomial	No	Yes	No	Yes	No	Yes
Geographic Controls	No	Yes	No	Yes	No	Yes
Religiosity	No	Yes	No	Yes	No	Yes
Adjusted-R^2	0.27	0.49	0.28	0.52	0.14	0.47
Observations	1474	1474	1474	1474	1453	1453

Notes: Using OLS regression, this table establishes a positive significant relationship between the number of patents per capita and: (Panel A) universal trust, (Panle B) universal fairness, (Panel C) individualism, and (Panel D) non-conformity across NUTS 3 regions in Europe. Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C.5 Innovation, Church Exposure and Religiosity

Table C.4 examines the relationship between historical exposure to the medieval Church and contemporary religiosity across European NUTS-3 regions. In the bivariate specification (Column 1), Church exposure is negatively and strongly associated with religiosity. Once country fixed effects are introduced (Column 2), the magnitude of the coefficient declines substantially and becomes statistically insignificant. However, as additional geographic and socioeconomic controls are included (Columns 3–5), the estimated relationship stabilizes and remains negative, regaining statistical significance at conventional levels in the most demanding specifications.

Overall, the results suggest that historical Church exposure is associated with lower levels of present-day religiosity within countries, although the magnitude of this relationship is modest once cross-country and geographic heterogeneity are taken into account.

Table C.4: Religiosity and Church Exposure: NUTS3 Regions in Europe

	Religiosity				
	(1)	(2)	(3)	(4)	(5)
Medieval Church Exposure	-0.44***	-0.10	-0.08	-0.11*	-0.11*
	(0.09)	(0.07)	(0.07)	(0.06)	(0.06)
Country FE	No	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	No	No	Yes	Yes	Yes
Geographic Controls	No	No	No	Yes	Yes
Additional Controls	No	No	No	No	Yes
Adjusted-R^2	0.18	0.92	0.92	0.93	0.93
Observations	1474	1474	1474	1474	1474

Notes: Using OLS regression, this table examines the relationship between medieval Church exposure and contemporary religiosity across NUTS 3 regions in Europe. Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population, and a dummy for a socialist past. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.5 examines the relationship between contemporary religiosity, medieval Church exposure, and innovation across European NUTS-3 regions, using patents per capita, inventors per capita, and the share of famous creatives as outcome measures. Across specifications, religiosity is not significantly related to patents per capita (Columns 1–2), but exhibits a negative association with inventors per capita that is weakly significant in baseline specifications (Column 3) and becomes statistically insignificant once Church exposure is included (Column 4). In contrast, religiosity is strongly and robustly negatively associated with the share of famous creatives (Columns 5–6), with large and statistically significant coefficients across specifications.

Medieval Church exposure, by contrast, is positively and significantly associated with both patents per capita (Column 2) and inventors per capita (Column 4), suggesting a robust link between historical Church presence and modern technological innovation. However, its relationship with the share of famous creatives is positive but not statistically significant (Column 6).

Overall, the results indicate that while historical Church exposure is positively correlated with contemporary technological innovation, contemporary religiosity does not display a consistent positive relationship with innovation and is, if anything, negatively associated with creative outcomes. This pattern suggests a divergence between the long-run institutional effects of the Church and the role of present-day religiosity in shaping innovative activity.

Table C.5: Religiosity, Church Exposure, and Innovation: NUTS3 Regions in Europe

	Patents per capita					
	Patents per Capita		Inventors per Capita		Share of Fam Creatives	
	(1)	(2)	(3)	(4)	(5)	(6)
Religiosity	-0.00	0.01	-0.08*	-0.05	-0.23***	-0.22***
	(0.04)	(0.04)	(0.05)	(0.05)	(0.07)	(0.07)
Medieval Church Exposure		0.09**		0.13***		0.04
		(0.04)		(0.04)		(0.05)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.49	0.49	0.51	0.52	0.47	0.47
Observations	1474	1474	1474	1474	1453	1453

Notes: Using OLS regression, this table examines the relationship between religiosity, medieval Church exposure, and innovation outcomes across NUTS 3 regions in Europe. Innovation is measured by patents per capita (Columns 1–2), inventors per capita (Columns 3–4), and the share of famous creatives (Columns 5–6). Latitude and longitude polynomial is of second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population, and a dummy for socialist past. All variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of one standard deviation in the independent variable in terms of standard deviations of the dependent variable. Spatial correlation robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.