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ABSTRACT

Foreshadowing Mars: Religiosity and Pre-enlightenment Warfare*

Can religiosity sway a society's propensity for violence against outgroups? We first introduce two state-year-level religiosity measures for several pre-Enlightenment European states with the frequencies of (i) religious language in book publications and (ii) Christian names of newborns. To identify causal effects on warfare, we exploit the local visibility of solar eclipses – phenomena orthogonal to climatic, cultural, economic, environmental, and institutional developments that, in pre-Enlightenment Europe, were overwhelmingly viewed as supernatural, religious events. Accounting for dyad- and year-fixed effects, we observe positive, statistically significant, and quantitatively sizeable effects on subsequent attack war onset. Reduced form estimates, robustness checks (e.g., acknowledging dyad-specific time trends), and placebo exercises yield consistent patterns. Exploring mechanisms, religious terminology explicit to religious outgroups (specifically Jews and Muslims) spikes in solar eclipse years and predicts attack war onset, particularly against Islamic states. Finally, consistent with the idea of a religious primer highlighting ingroup-outgroup demarcations and exacerbating tensions along such lines, city-year-level solar eclipses also predict (i) Jewish expulsions and (ii) witch trials in pre-Enlightenment Europe.

JEL Classification: D74, F51, H56, N33, N43, Z12

Keywords: religiosity, warfare, ingroup-outgroup demarcations, anti-Semitism, witch trials

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1 Introduction

Can religiosity (i.e., the strength of religious feeling or belief) alter a society's propensity for violence directed at outgroups? Few questions generate such passionate debates between believers and non-believers, as well as among scholars of various disciplines. From Dawkins and Ward's (2006) position of "religion causes wars" to Jenkins' (2014) assertion that "[t]he sleep of religion brings forth monsters": The full range of positive, negative, and null relationships has been hypothesized in numerous viewpoints, anecdotes, descriptive case studies, and theories.[1] Thus, ultimately, the question of whether and how religiosity affects a society's appetite for violence against outgroups constitutes an empirical challenge.

However, plagued with endogeneity concerns, testing such relationships remains unusually difficult. Not one but all three types of endogeneity complicate empirical endeavors. First, reverse causality threatens identification, as experiencing conflict can drive religiosity in a populace (Henrich et al., 2019; Caluori et al., 2020; Cesur et al., 2020; Isaqzadeh, 2021). Second, omitted variables loom large as difficult-to-measure developments along cultural, economic, environmental, and institutional dimensions can inform both the degree of religiosity and warfare-related developments. Third, measurement error presents a serious threat as pinning down degrees of religiosity in a comparable and consistent manner within societies over time has remained elusive.

This paper's first contribution consists in introducing two independent state-year-level measures of religiosity from the early 16^{th} century until the dawn of the Enlightenment in the early 18^{th} century. First, we apply a comprehensive *linguistic dictionary of religious terminology* in the English language to *Google Ngram* (Michel et al., 2011).[2] This allows us to measure the annual frequency of religious language employed in British English-language book publications among 393 million words in 20,296 pre-Enlightenment books. To generate the same measure for other languages available on *Google Ngram*, we translate and apply the religiosity dictionary to Spanish (1.92 billion words in 17,829 books), French (1.58 billion words in 57,554 books), German (516 million words in 34,910 books), and Italian (208

[1] To provide just a short and necessarily incomplete list of associated readings, we refer to Martin (2006), Bushman et al. (2007), Atran and Ginges (2012), Atran (2016), Basedau et al. (2016), Norenzayan et al. (2016), and Skali (2017).

[2] Studying over 57 million words, the *Language Inquiry and Word Count* (*LIWC*) program captures over 86% of the words people have used in writing and speech between the years 1660 and 2008 (Tausczik and Pennebaker, 2010; Pennebaker et al., 2015, pp. 9–10). Its religiosity dictionary that we access here contains 174 words and stems.

million words in 38,525 books).[3] To the extent that language has been shown to be indicative and predictive of (i) genocide (Roozen and Shulman, 2014; Landry et al., 2022), (ii) time preferences and savings behavior (Chen, 2013), (iii) creativity and societal order (Jackson et al., 2019), (iv) revolutions (Leetaru, 2011), (v) ingroup-outgroup dynamics (Waldron, 2012), (vi) cheating (Turmunkh et al., 2019), as well as (vii) voting, political attitudes, and policy-making (Graham et al., 2009; Waytz et al., 2019; Enke, 2020; Kivikangas et al., 2021), studying *Google Ngram*'s collective body of writings allows for the derivation of a consistent and comparable *thermometer of religiosity* within a language over time.

As an alternative, we also calculate the relative frequency of religious versus scientific language. We do so by first accessing a comprehensive dictionary on *causation* (Tausczik and Pennebaker, 2010; Pennebaker et al., 2015) before relying on the same translators to produce these dictionaries in the other languages and applying them to *Google Ngram*.

For the second religiosity measure, we access the *FamilySearch* database (FamilySearch, 2022) – the largest free genealogy website, holding more than 6.3 billion historical records. We calculate the annual share of birth names that feature distinctly Christian names for eight predominantly Christian states, again from the early 16^{th} until the early 18^{th} century: (i) England, (ii) Scotland, (iii) Denmark, (iv) Switzerland, (v) the Netherlands, (vi) France, (vii) Spain, and $(viii)$ Ireland.[4] We define religious names as those listed by Hanks et al. (2006) and include name versions of the relevant languages.[5] Building on recent studies exploring naming patterns to measure contemporaneous attitudes, beliefs, and preferences (Lieberson, 2000; Fryer Jr and Levitt, 2004; Abramitzky et al., 2018; Fouka, 2019, 2020; Bazzi et al., 2020), we extend that strategy to proxy for the contemporaneous degree of religiosity. In a nutshell, we posit that an increased intensity of religious belief would, at an aggregate societal level, raise the share of newborns given a distinctly Christian name by their parents (also see Hacker, 1999).

[3] *Google Ngram* also features books in American English, simplified Chinese, Hebrew, and Russian, but the number of captured books remains much lower or zero for pre-Enlightenment times.

[4] Data availability on FamilySearch (2022) and the necessity of being able to connect an entry unambiguously to pre-Enlightenment state borders restricts us to these states. For example, we are unable to incorporate the predecessor states of Germany or Italy (Prussia and the Kingdom of Sardinia).

[5] To do so, we first access Bible translations in the respective language on Transcripture International (2023) and International Biblical Association (2023). Next, we explore the Wikipedia site of the respective religious figure for language-specific name versions. Finally, we google "[name] in Danish", for example. Overall, Hanks et al. (2006) lists 209 names in English, and Appendix C documents the full name list, including versions in the other languages. In robustness checks, we further include name variations of each of the relevant languages.

Reassuringly, we identify a positive and statistically significant correlation between this name-based religiosity measure and our first religiosity proxy stemming from the frequency of religious terminology on *Google Ngram* ($p < 0.001$). This is also the case once we control for state- and year-fixed effects ($p = 0.040$).

We then independently correlate each religiosity variable with subsequent attack war onset in a dyad-year-level database that connects the corresponding states with every state they warred with at least once from 1500 to 1714.[6] To do so, we access and systematically organize data from Brecke (2012a,b) at the dyad-year level. Controlling for dyad- and year-fixed effects, we observe positive but statistically and quantitatively modest correlations. Naturally, substantial endogeneity concerns remain in these specifications.

To alleviate these concerns, we introduce a plausibly exogenous primer of religiosity for pre-Enlightenment Europe: solar eclipses visible in the respective state capital. As with every instrumental variable (IV), two conditions need to be satisfied: (i) the predictive power of the IV and (ii) the exclusion restriction. For the former, the vast majority of pre-Enlightenment Europeans have arguably been unable to rationally explain a solar eclipse; rather, their only possible explanation was of a supernatural, religious nature (see Section 2.2 for details). This is also the reason why our main analyses stop at the onset of the Enlightenment, when scientific explanations for natural phenomena, such as solar eclipses, became much more prominent and widespread. Indeed, we find a firm positive relationship between locally visible solar eclipse occurrences in a state's capital and their society's contemporaneous language- and name-based religiosity measures. Solar eclipses also emerge as a positive and statistically significant predictor of religious relative to scientific language, thereby taking into account recent studies that propose solar eclipses had *long-run* effects on societies' degrees of scientific thinking (Boerner and Severgnini, 2015; Litina and Fernández, 2020; Boerner et al., 2021). Concerning the second IV condition, it remains difficult to think of credible violations of the exclusion restriction, as solar eclipses neither follow systematic spatial or temporal patterns on Earth nor affect natural environments in ways other

[6]For the language-based measure, we connect Spanish to Spain, French to France, German to Germany's main predecessor state Prussia, British English to England, and Italian to Italy's main predecessor state, the Kingdom of Sardinia. All results are consistent if we exclude Prussia and the Kingdom of Sardinia, as matching books written in German and Italian to these states remains imperfect. Excluding Spain, because of the potential influence of Latin American authors, also leaves our conclusions unaltered. Section 3.1 expands on why matching books to states is likely to be representative of the pre-Enlightenment era.

than a short stint of the sun being blocked.[7]

The corresponding IV results then consistently imply religiosity to be a positive, statistically significant, and quantitatively powerful predictor of a society's propensity to attack their dyadic counterpart the following year. This pattern emerges independently for all three religiosity measures (while accounting for dyad- and year-fixed effects) with a host of robustness checks producing consistent estimates (e.g., assuming dyad-specific time trends or implementing alternative solar eclipse definitions by applying various thresholds of obscuration rates). Reduced form specifications, in which we directly employ solar eclipses to predict subsequent attack war onset, produce positive and statistically significant coefficients. Further, an event study of the reduced form relationship, predicting dyadic attack war onset directly with preceding and subsequent solar eclipses, illustrates the spike only occurs in the first year after a solar eclipse – not in the years prior or thereafter. In contrast, neither attack war *end* nor *defense* war onset are predictable with solar eclipses, highlighting how solar eclipses are not merely followed by a change in the status quo of warfare but specifically by *attack war onset*. Finally, placebo exercises to study (i) solar eclipses occurring before sunset or after sunrise (which are unnoticeable to the naked eye) and (ii) post-Enlightenment data (when the scientific understanding of solar eclipses advanced and became much more widespread) produce precisely estimated null coefficients.

With these results in mind, we take a step towards better understanding the underlying mechanism. We begin by exploring the local average treatment effect (*LATE*), asking *which aspect* of religiosity is particularly made salient by solar eclipses. To do so, we study the *type* of religious language that is used more frequently in a solar eclipse year. Standing out on this list is explicitly *non-Christian* terminology, such as *hebraism*, *zen*, *Jew(ish)*, *paganism*, *Islamic*, and *Muslim(s)*. To systematically test that observation, we construct a sub-dictionary featuring explicitly non-Christian religious terminology and indeed find that language to be employed significantly more so in local solar eclipse years, while again accounting for state- and year-fixed effects ($p = 0.027$). In contrast, religious terminology that is *not* explicitly non-Christian does not spike in solar eclipse years ($p = 0.459$). Thus, the *LATE* operates

[7] Contrary to natural disasters, for example, solar eclipses do not affect economic characteristics (e.g., by destroying harvests or infrastructure), institutional developments, or other tangible society-relevant factors. With respect to our religiosity measures, the occurrence of solar eclipses neither correlates with the number of books captured by *Google Ngram* nor with the number of available names on *FamilySearch* (see Table E1; $p = 0.544$ and $p = 0.249$, respectively).

through more literary attention paid to religious outgroups in solar eclipse years.

Next, we ask how and when religiosity predicts dyadic attack war onset by (i) focusing on inter-religious dyads (i.e., a Christian versus an Islamic state, such as the Ottoman Empire or Algiers) and (ii) again delineating explicitly non-Christian religious language. First, two-stage-least-squares estimates from predicting attack war onsets against Islamic states are also positive and statistically significant – but they are three times larger in magnitude than those from our baseline IV specification. Second, estimates also spike considerably once we operationalize explicitly non-Christian religious language in our baseline IV framework (rather than religious language per se). This pattern is particularly pronounced when employing the Islam-specific sub-dictionary. While these results cannot comprehensively rule out other, potentially complementary mechanisms, they are consistent with a hypothesis suggesting a salient religiosity primer highlights ingroup-outgroup demarcations of religious identity that, in turn, predict a society's propensity to go to war, particularly against a target state that identifies with an outgroup religion or an outgroup religious denomination.

In the final segment of the paper, we put this ingroup-outgroup hypothesis to two tests that go beyond interstate warfare, employing the reduced form: Does a solar eclipse predict large-scale organized violence against religious outgroups? We combine data on city-year-level solar eclipses with two rich databases on pre-Enlightenment (i) Jewish persecutions (864 European cities; from Anderson et al., 2017) and (ii) witch trials (836 European cities; from Leeson and Russ, 2018).[8] In both databases, a locally visible solar eclipse emerges as a positive and statistically significant predictor of systematic violence against these religious outgroups, even when incorporating city- and year-fixed effects ($p < 0.001$ and $p = 0.019$, respectively). These results are again consistent with the hypothesis that a religious primer highlights demarcations along religious dimensions that can materialize in violent outbreaks against a religious outgroup.

While our paper touches several branches of literature, three lie at its core.[9] The first concerns the

[8] In pre-Enlightenment Europe, witch trials were conducted to persecute various groups and individuals considered outsiders to the religious ingroup, including alleged heretics, side-switchers, and witches. For example, referring to the Middle Ages, Buc (2023, p. 129) observes that "[w]ar in a Christian universe entailed what may seem like a paranoid attention to side-switchers" (see also, in a similar vein, Kaplan, 2007).

[9] Broadly, scholarship on the *(new) economics of religion* explores how various aspects of religion inform cultural, economic, and institutional developments. For a necessarily incomplete list, we refer to Iannaccone (1998), Barro and McCleary (2003), Guiso et al. (2003), McCleary and Barro (2006), Young (2009), Durlauf et al. (2012), Woodberry (2012), Belloc et al. (2016),

conflict-relevant effects of religiosity. Importantly, the concept of religiosity differs from those concerned with the characteristics and evolution of particular religions (e.g., Christianity or Islam) and religious denominations per se (e.g., Catholicism, Protestantism, or the Protestant Reformation) or their institutions (e.g., the Catholic Church or the Church of England). Specifically, we explore the conflict-related consequences of religiosity in Christian societies by first introducing state-year measures of religiosity and then by presenting an explicit identification strategy to circumvent latent endogeneity concerns. We can only expand the reach of our empirical specifications towards including non-Christian states in reduced form estimations, predicting attack war onset directly with locally visible solar eclipses in the respective state capitals.

In terms of causally identifying conflict-relevant consequences of religiosity, our closest predecessor comes from Clingingsmith et al. (2009) who find randomized participation in the Hajj pilgrimage increases Muslims' self-reported sense of peace towards religious outgroups.[10] Our work differs in that we study (i) pre-Enlightenment Christian societies in Europe (as opposed to Pakistani Muslims in 2006); (ii) tangible conflict outcomes with interstate warfare, Jewish pogroms, and witch trials (as opposed to survey-elicited sentiments); and (iii) consequences at the societal (rather than the individual) level. To our knowledge, our study is the first to present an explicit identification strategy to connect religiosity to warfare and large-scale organized violence at societal levels across space and time.

The second main research area constitutes *religiosity-related causes of warfare and large-scale organized violence aimed at outgroups*. Atran and Ginges (2012) summarize a large body of scholarship to contest religion "increases ingroup trust but also may increase mistrust and conflict with outgroups." Exploring cross-country panel data, Basedau et al. (2016) find intrastate armed conflict onset correlates with some religious characteristics in a sample of 130 developing countries from 1990 to 2010. Similarly, the prevalence of moralizing gods (as an important characteristic of some religions) in society has been linked to heightened conflict experiences (Skali, 2017).[11] Nevertheless, isolating causal relation-

Iyer (2016), Basedau et al. (2018), Squicciarini (2020), Becker et al. (2021), and Bénabou et al. (2022).

[10]For causal identification strategies pertaining to other (not specifically conflict-related) consequences of religiosity, we refer to Campante and Yanagizawa-Drott (2015), Bryan et al. (2021), and Andersen and Bentzen (2022).

[11]The perceived existence of moralizing Gods may have played an important role in fostering pro-sociality and within-group cohesion (Roes and Raymond, 2003; Johnson and Krüger, 2004; Norenzayan and Shariff, 2008; Norenzayan, 2013; McNamara et al., 2016; Purzycki et al., 2016). Skali (2017) further discusses the concept of limited morality (Tabellini, 2008; Gorodnichenko and Roland, 2011), which implies morally questionable behavior against an outgroup can be acceptable and

ships between religiosity-related factors and large-scale organized violence has remained extraordinarily difficult due to measurement and identification issues.

Third and final, violent expressions towards religious outgroups have occurred throughout history, with perhaps *Jewish persecutions* forming some of the most prominent, reoccurring examples. A growing body of empirical scholarship explores the causes of anti-Semitism, from its long-run roots over historical persecution events to the Holocaust.[12] In this context, we present novel empirical evidence consistent with the idea that priming religiosity can lead to systematic violence against religious outgroups within society, such as Jewish populations and alleged non-conformists through witch trials.[13]

2 Historical Background

Our main period of study starts in the early 1500s (when records informing our religiosity variables become available) and ends with the beginning of the Enlightenment, commonly dated to the early 18^{th} century. During that period, European societies were still largely shaped by medieval Christian traditions. This Section briefly summarizes the contemporary relationships between (i) religiosity and warfare, as well as (ii) solar eclipses and religiosity.

2.1 Religiosity and Warfare in Europe from the Middle Ages to Enlightenment

Throughout history, numerous European wars featured religious overtones, pitting different faiths against each other. Prominent examples concern the *Crusades* (e.g., see Baldwin and Setton, 2016 or Riley-Smith and Throop, 2022), the *European Wars of Religion*,[14] and Ottoman advances into Europe (e.g.,

justified under moralizing gods.

[12]For long-run causes of anti-Semitism, we refer to Becker and Pascali (2019) and D'Acunto et al. (2019) (also see Becker et al., 2021). Concerning the explanation of particular outbreaks of Jewish persecution over the past millenium, Anderson et al. (2017), Finley and Koyama (2018), Jedwab et al. (2019), and Grosfeld et al. (2020) provide insightful empirical analyses. For empirical studies exploring predictors and consequences of the Holocaust, see Acemoglu et al. (2011), Hoffman (2011), Voigtländer and Voth (2012, 2015), and Braun (2016).

[13]For empirical scholarship on the causes of witch trials, we refer to Oster (2004), Miguel (2005), and Leeson and Russ (2018), as well as references discussed therein.

[14]This umbrella term for religiously inspired conflicts of the 16^{th}, 17^{th} and early 18^{th} centuries includes wars such as the *German Peasants' War* (1524–25), the *Schmalkaldic War* (1546–47), the *Thirty Years' War* (1618–48), the *Wars of the Three Kingdoms* (1639–51) and the *War of the Spanish Succession* (1701–14).

see Iyigun, 2008).[15] While such events are often used to point out the destructive force of religiosity, the absence of a credible counterfactual precludes certainty about whether heightened religiosity indeed *causes* warfare, whether religion was merely employed as a pretext, or whether warfare would have been yet more abundant in its absence. At the same time, wars *not* featuring a religious theme as their main headline could still have been forcefully influenced by religiosity.[16]

In pre-Enlightenment Europe, interstate war was a constant presence. During the 16^{th} and 17^{th} centuries, almost every year saw a war between the great European powers (Voigtländer and Voth, 2013, p. 174). Religion and state were closely entangled as polities, from towns to states, shared a "spiritual dimension" (Kaplan, 2007, p. 60). A state was seen as a *corpus Christianum*: "Mystically united, head and members formed a Christian community that would prosper or suffer, depending on whether it earned God's blessing or wrath" (Kaplan, 2007, p. 100).

Non-Christians, in particular Jews and Muslims, were considered *unbelievers* or "'infidels' (...) – alien tribes who worshipped different gods" (Kaplan, 2007, pp. 2–3). These *unbelievers* differed from heretics who allegedly knew better but conducted "a sinful act of malicious will" by rebelling "against God, against his agents on earth, and even against their own consciences" (Kaplan, 2007, pp. 26–27). This "heritage of Christian thought that legitimized persecution" of these groups continued to be shared by Catholics and Protestants alike, even after the *Protestant Reformation* in the 1500s (Kaplan, 2007, p. 25). Prominent examples of large-scale persecutions against members of these religious outgroups can be found in the *Spanish Inquisition* (1478–1834), Jewish pogroms and expulsions, and witch trials.[17] Against the backdrop of these religiously-branded wars and acts of persecution, states eventually attempted to establish rules of religious toleration and confessional coexistence (Nexon, 2009). These rules included the 'cuius regio eius religio' ('whose realm, their religion') principle of the *Peace of Augs-*

[15]There is a debate between *traditionalists* and *pluralists* on whether to define the *Crusades* narrowly (i.e., only expeditions to the Holy Land in 1095–1291) or widely (i.e., including other parts of Europe and the post-1291 era; e.g., see Asbridge, 2012 and Tyerman, 2013).

[16]Theological reasoning also influenced "non-religious warfare and armed violence in the High and Late Middle Ages, by giving them form, meaning, and meaningfulness" (Buc, 2023, p. 139). For instance, the justification of war was often religiously framed by claiming it had the "right intention" to be *just* (Buc, 2023, p. 128).

[17]For example, according to Contreras and Henningsen (1986, p. 114), almost 19,000 cases of *major heresies* – practised by *conversos* and *moriscos* (local terms for Jewish and Moorish converts), Illuminists, and Lutherans – and some 25,000 cases of *minor heresies* (such as bigamy and superstition) were dealt with by the courts of the *Spanish Inquisition* from 1540 to 1700, resulting in over 1,600 death sentences.

burg (1555) and the toleration of Protestant Huguenots in the *Edict of Nantes* (1598). For example, the *Peace of Westphalia* (1648) prohibited rulers to force-convert their subjects.

In sum, religiosity, as well as the distinction between religious in- and outgroups, was an ever-present artifact of pre-Enlightenment European societies. Conflict often occurred along religious fault lines, such as Christians versus Muslims (often the Ottomans) or Christian societies persecuting members of their own communities who believed differently.

2.2 Solar Eclipses and Religiosity in Pre-Enlightenment Europe

Religion permeated all aspects of daily life, not only state affairs but also the observation of natural phenomena. In this context, an important assumption of our identification strategy is that solar eclipses were predominantly interpreted as supernatural, religious phenomena in pre-Enlightenment Europe, thereby making religiosity salient. This Subsection briefly surveys the associated historical evidence.

For millennia, nature and gods constituted central, inter-connected features of Western thinking. While ancient Greeks and Romans saw gods as part of nature, this changed with the Christianization of the Roman Empire: "Then, from a cosmic principle, nature got downgraded to a simple (though magnificent) tool in the hands of God, and even the mere material result of his action" (Ducarme and Couvet, 2020, p. 3). Medieval Christian scholarship (e.g., by Augustine of Hippo, Peter Lombard, and Thomas Aquinas) introduced a dualism contrasting *the natural* with *what is beyond nature* (*praeter naturam* or, in modern terminology: the supernatural; Saler, 1977; Bartlett, 2008).[18]

Under this dichotomy, it is important to understand whether solar eclipses were interpreted as natural or supernatural phenomena. In general, unusual, surprising, and rare celestial events were more likely attributed to the supernatural realm.[19] They played an important role in pre-Enlightenment Europe, precisely because they seemed to be beyond scientific understanding or the laws of nature (Brewer,

[18] According to ecclesiastical, medieval thinking, "God had implanted the seminal causes in things – a horse will give birth to a horse, an apple tree bears apples – but had reserved certain things to him alone", that is, things that "are beyond nature [and have] their cause (...) in God alone" (Bartlett, 2008, pp. 6–7). Hence, all natural things had their origins in God's creation but once God had created them, they continued to evolve on their own. The occurrence and timing of supernatural phenomena were, in turn, considered to be entirely at God's discretion.

[19] In the 18^{th} century, Adam Smith pointed out that, in earlier times of human history, "it is the irregular events of nature only that are ascribed to the agency and power of their gods" (Smith, 1982, HA 49-50, EPS).

2016) and rendered religiosity salient.[20] Addressing pre-Enlightenment times in Europe, Boerner and Severgnini (2015) summarize "the movement and constellation of the celestial bodies was very much understood as God's work" and further "[s]olar eclipses have elicited a special fascination. They could be observed by everyone, and due to their rare appearance, they were perceived as sudden, irregular, and often supernatural events."[21] An abundance of historical records indicates how solar eclipses were ascribed to the supernatural domain with religious descriptors (Bartlett, 2008; Campion, 2012; Brewer, 2016).

While a handful of medieval scholars reportedly understood why solar eclipses occurred, scientific and natural (as opposed to supernatural) interpretations were scarce in pre-Enlightenment Europe. In fact, by the late Middle Ages and the Early Modern Period, "the ancient Greek knowledge [with respect to solar eclipses and astronomy in general] was almost forgotten" (Boerner and Severgnini, 2015). Not only was there a substantial knowledge gap between the (few) learned and the (many) unlearned, but astronomers were also mainly concerned with solving more practical religious problems, such as determining the date of Easter (Steele, 1998; McCluskey, 2000). Overall, there was "very little interest in observing eclipses by European astronomers in the Later Medieval and Renaissance periods" (Steele, 1998, p. 96). In addition, solar eclipses were extremely difficult to predict, largely because of the complexity of bodily motions. One needed to "possess a detailed knowledge of the geometry of the Earth, Moon, and Sun, and the geographical position of the observer on the Earth's surface" (Steele, 1998, p. 16). In fact, exact predictions of solar eclipses were possible only in the 20^{th} century (Morrison and Stephenson, 2001).[22] In sum, neither the scientific fundamentals nor the scholarly interest in explaining

[20] Celestial phenomena no longer surprise people today. This does not preclude, however, that such phenomena could be described as divine or that people believe in supernatural influences. For instance, after experiencing a solar eclipse in Vienna in 1842, Adalbert Stifter wrote "(l)et it not be protested that the matter is, of course, natural and easy to calculate from the laws of bodily motion; the wonderful magic of beauty that God imparted to things asks not for such calculations; it is there because it is there, truly, it is there in spite of calculations (...)" (Stifter and Holland, 2015, p. 254).

[21] For example, Gerald of Wales (1146-1223) stated people "completely neglect to wonder at the rising and setting of the sun, although nothing is more beautiful in the [whole] world, nothing more worthy of amazement. However, the whole world is struck dumb at an eclipse of the sun, because it happens only rarely" (quoted in Brewer, 2016, p. 35). Querejeta (2011, p. 5) writes that, among all heavenly phenomena, "solar eclipses stand out (...) as some of the most spectacular astronomical events that can be witnessed."

[22] Nevertheless, the literature is full of claimed successful predictions of solar eclipses. For example, modern scholars agree that *Thales of Miletus* who, according to *Herodotus* and *Pliny*, had predicted the solar eclipse of 585BCE that reportedly stopped a battle in the war between the *Medes* and the *Lydians*, could have done so only by chance, if at all (Couprie, 2004; Querejeta, 2011). Other anecdotes include those of "rational Europeans [who] can use their scientific knowledge [of solar and lunar eclipses] to terrify the backward natives" (Bartlett, 2008, p. 60). The most famous such story refers to Christopher

solar eclipses featured prominently in pre-Enlightenment European societies.

Nevertheless, our empirical analysis will put this religiosity-related interpretation of solar eclipses to the test: If solar eclipses were not predominantly interpreted as religious primers, then we should not be able to observe systematic spikes in (i) religious terminology employed in publications or (ii) the frequency of distinctly Christian names among newborns. In addition, our alternative approach of exploring religious language relative to *causation*-specific terminology aims to account for scientific explanations of solar eclipses and their own influence on contemporary thinking.

3 Data

3.1 Religious Terminology in Books

For our first proxy of religiosity, we apply the *Language Inquiry and Word Count*'s (*LIWC*) religiosity dictionary (Tausczik and Pennebaker, 2010; Pennebaker et al., 2015) to *Google Ngram* (Michel et al., 2011). Having studied over 57 million words, the *LIWC* program captures over 86% of the words people have used in writing and speech between the years 1660 and 2008 (Tausczik and Pennebaker, 2010; Pennebaker et al., 2015, p. 10). The *LIWC*'s dictionary on religious terminology contains 174 words and stems, with Appendix A listing the full dictionary.[23]

To study the frequency of religious terminology over time, we access the universe of books recorded by *Google Ngram* from its starting point in the early 1500s until 1714, i.e., just before the Enlightenment. Note that precisely dating the beginning of the Enlightenment remains difficult because of differences between states and scholarly disagreement on this issue. We pick the year 1715 in our main specifications for two reasons (although results are consistent if we alternatively select the years 1720 or 1730, for example). First, the beginning of France's *siècle des lumières* is frequently connected to the death of Louis XIV in 1715 (Ayres and Ayres, 2020). Second, and more importantly given our identification strategy, in early 1715, Edmond Halley drew and published an eclipse chart in advance of the total solar

Columbus who allegedly used his knowledge of an upcoming lunar eclipse during his 1502–04 journey to Jamaica to convince the indigenous population to provide food for the foreigners.

[23] To comply with *Google Ngram*'s restriction of being able to download case-insensitive words but not stems (i.e., each stem has to be downloaded twice, once with a lower-case first letter and once with an upper-case first letter), this eventually produces 233 words and stems.

eclipse of May 3, 1715, in London and the Southern part of England, with which the "modern era of eclipse observing" began (Pasachoff, 2009, p. 790). This chart predicted the track of the eclipse, i.e., places in which one would see totality and in which only a partial eclipse. This was the first public announcement of a solar eclipse and made an enormous impression on a large audience, although it turned out that Halley's prediction was four minutes and 32 kilometers off (Pasachoff, 1999; Walters, 1999).

Google Ngram is estimated to contain approximately 6% of all books ever published (Younes and Reips, 2019).[24] Naturally, the number of books captured in earlier decades remains smaller because of data availability, but our econometric structure imposes year-fixed effects to account for such heterogeneity. We focus on those five languages for which *Google Ngram* features a substantial number of books, even in the 16^{th} century:[25] Spanish (1.92 billion words in 17,829 books), French (1.58 billion words in 57,554 books), German (516 million words in 34,910 books), British English (323 million words in 17,335 books), and Italian (208 million words in 38,525 books).

To translate the English-language religiosity dictionary into the other four languages, we contracted native-speaking translators and linguistic experts (see Appendix A for full dictionaries).[26] Finally, for each language and year, we calculate the sum of frequencies of all religiosity words and stems. To provide an overview, Table A1 lists the ten most frequent words and stems for each language over the entire time-frame. Perhaps not surprisingly, variants of the word *god* emerge with the most frequent mentions across all five languages. Figure A1 visualizes frequencies for each language over time.

To connect this proxy of religiosity to the warring of states, we assign each language to their predominant state that, especially before 1715, housed the vast majority of authors writing in the respective language.[27] Thus, we match (i) Spanish to Spain beginning with the 1479 War of the Castilian succes-

[24]Recent quantitative analyses using *Google Ngram* include the evolution of egalitarian sociolinguistic conventions (Naidu et al., 2017), references to working mothers in the US (Bastian, 2020), contrasting emotion with reason in political language (Gennaro and Ash, 2022), mentions of specific books (Beach and Hanlon, 2022; Giorcelli et al., 2022), and the popularity of Karl Marx (Magness and Makovi, 2023).

[25]For the remaining four languages (American English, simplified Chinese, Hebrew, and Russian), the included numbers of books before 1715 are minimal or zero in most years.

[26]Note that the respective dictionaries for the non-English languages contain more entries than the original British-English-language dictionary. This is largely because these other languages often have multiple synonymous translations of the same English word. For example, the English word *holy* can be translated as *santo* or *sagrado* in Spanish.

[27]Potentially, this assignment could be biased by book production outside the five states' mainlands such as, for instance, in their colonies. However, Germany (the Kingdom of Prussia), Italy (the Kingdom of Sardinia), and France had only very

sion, (ii) French to early modern France, (iii) German to Prussia, (iv) British English to England, and (v) Italian to the Kingdom of Sardinia. In our robustness checks, we exclude Prussia and the Kingdom of Sardinia because the assignment of German and Italian books to only these states may be imprecise (see Table E2). We also exclude Spain in a robustness check because of Latin American authors (see Table E2). Table 1 summarizes the corresponding results. In Spanish, for example, 1.726% of words (or every 58^{th} word) written in an average year appear in the religiosity dictionary.

Table 1: Summary statistics for the frequency of religious language from 1500 to 1714, as derived from *Google Ngram* (Michel et al., 2011).

	Google Ngram coverage		% religious terminology		$\frac{\%\ religious\ terminology}{\%\ religious + \%\ scientific\ terminology}$	
Language (associated state)	Available years	Mean words/year (median)	Mean (Std. dev.)	Min. (Max.)	Mean (Std. dev.)	Min. (Max.)
Spanish (Spain)	203 of 208	9,458,121 (9,546,705)	1.726 (0.616)	0 (2.725)	0.431 (0.278)	0 (3.719)
French (France)	208 of 211	7,610,217 (3,111,277)	0.807 (0.399)	0 (1.766)	0.250 (0.132)	0 (1.082)
German (Prussia)	176 of 176	2,933,001 (2,217,223)	1.460 (0.436)	0.529 (2.826)	0.299 (0.090)	0.121 (0.842)
British English (England)	186 of 197	2,110,916 (748,364)	1.068 (0.626)	0 (3.022)	0.571 (0.374)	0 (3.409)
Italian (Kingdom of Sardinia)	214 of 214	970,599 (561,533)	0.809 (0.389)	0 (2.048)	0.259 (0.138)	0 (1.058)

In additional specifications, to derive a measure of religiosity relative to scientific thinking, we incorporate the *LIWC* dictionary on *causation*. Featuring 135 words and stems in the English language, we draw on the same language experts to provide translations into Spanish, French, German, and Italian. Appendix B lists the full dictionaries. Next, we apply the respective dictionaries to *Google Ngram* to derive a proxy for the frequency of scientific language for each language and year. Combining these data with our measure for religious language, we then calculate the share of religious terminology employed in books relative to scientific terminology with $\frac{\%\ religious\ terminology}{(\%\ religious + \%scientific\ terminology)}$. The resulting

few colonies, or no colonies at all, by 1714. The Spanish colonies in Latin America saw the first printing press set up in Mexico City in 1539 and the first universities established around the same time (Encyclopedia Britannica, 2023a), implying that a nontrivial number of books in Spanish produced in Latin America became available not before the late 16^{th} century. Our results are consistent when excluding Spain from our *Ngram*-based analysis, however (see columns 3 and 4 in Table E2). The most populated English colonies in New England had 280,000 inhabitants in 1700 (McEvedy et al., 1978, p. 286) compared to London with about twice this number alone (Harding, 1990). In fact, London has been shown to be the only major literary cluster in the UK and Ireland in 1700 to 1925 (Mitchell, 2019). In summary, literary and book production in the five languages under consideration was low outside the mainland.

data are summarized in the final columns of Table 1. Results are consistent if we alternatively calculate $\frac{\%\, religious\, terminology}{\%scientific\, terminology}$, for example (see Table E2).

3.2 Religious Birth Names

For our second proxy of religiosity, we extend recent scholarship proposing naming patterns as contemporary barometers of culture (Lieberson, 2000; Fryer Jr and Levitt, 2004; Abramitzky et al., 2018). For example, Fouka (2019, 2020) studies the naming choices of German-origin parents for their children in the US during and after World War I.

In our case, we access data from *FamilySearch* (FamilySearch, 2022), the largest free genealogical resource, holding information for more than 6.3 billion historical records (Top Ten Reviews, 2023). Data availability and the necessity to assign a precise birthplace to pre-Enlightenment state boundaries allow us to derive data from the year 1500 to 1714 for (i) England (497,473 names; 178 of 197 years available), (ii) Scotland (218,683 names; 140 of 143 years), (iii) Denmark (82,657 names; all 96 years), (iv) Switzerland (74,086 names; all 165 years), (v) France (63,894 names; 165 of 211 years), (vi) Spain (41,386 names; 171 of 208 years), (vii) the Netherlands (41,338 names; 104 of 108 years), and $(viii)$ Ireland (16,814 names; 89 of 94 years). Appendix C details our data collection process. In our main analysis, we only incorporate state-year observations with at least ten available names, although results are consistent if we raise that threshold to 20, 30, or 40 names, for example (see Table E3).

With these names, we then calculate the share of babies born in a particular state and year who carry a distinctly Christian first name, since Christianity constituted the dominant religion in these states and times. We posit parents' naming choices, specifically whether they choose distinctly Christian names, reflect their contemporary degree of religiosity (e.g., see Hacker, 1999), especially when accounting for dyad- and year-fixed effects. For an objective and comprehensive list of Christian first names, we access Hanks et al. (2006) before translating all the included Christian names into the respective languages. Table 2 and Figure C1 show summary statistics and state-specific developments over time. The average share of Christian first names ranges from 7% and 8% in France and Denmark to as high as 42%, 43%, and 44% in Ireland, Spain, and England. In additional specifications, we also incorporate name variants, producing consistent (and statistically more precise) estimates.

Table 2: Summary Statistics for state-level religiosity measure based on birth names (from FamilySearch, 2022) for the period 1500-1714.

	FamilySearch coverage		% religious birth names	
State	Available years[a]	Mean births/year (median)	Mean (Std. dev.)	Min. (Max.)
England	178 of 197	2,795 (3,152)	43.698 (9.502)	16.667 (69.767)
Scotland	140 of 143	1,562 (1,882)	23.238 (3.989)	12.909 (30.092)
Denmark	96 of 96	861 (784)	7.968 (2.128)	0 (13.374)
Switzerland	165 of 165	449 (504)	18.204 (4.062)	7.143 (27.317)
The Netherlands	104 of 108	397 (419)	10.592 (3.980)	0 (29.032)
France	165 of 211	387 (388)	6.865 (3.678)	0 (25.000)
Spain	171 of 208	242 (253)	42.779 (5.941)	18.182 (55.497)
Ireland	89 of 94	189 (119)	41.697 (9.885)	21.212 (81.818)

Notes: [a]We only incorporate a state-year observation if FamilySearch (2022) reports at least ten names in that location and year. Results are consistent if we expand this threshold to 20, 30, or 40 names (see Table E3). Appendix C details the data collection process.

Figure 1 visualizes the correlation between the shares of religious terminology captured in *Google Ngram* and Christian baby names from *FamilySearch* for those 507 state-year observations where data for both are available. We observe a positive and statistically significant correlation for the raw data ($p < 0.001$) and also when controlling for state- and year-fixed effects ($p = 0.040$). This pattern provides confidence that these independently derived measures of religiosity indeed capture meaningful elements of the prevalent level of religiosity in the respective states and years.

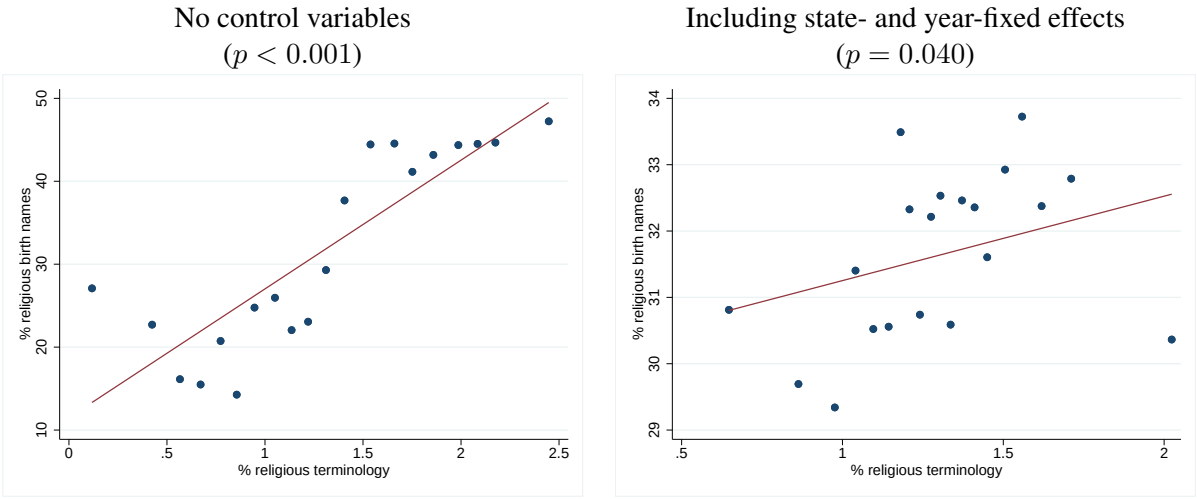

Figure 1: Binned scatterplots correlating the percentage of religious terminology on *Google Ngram* (*x*-axis) with the percentage of religious birth names (*y*-axis) between the years 1500 and 1714. Regressions include all 507 state-year observations for which both variables are available (i.e., from England, France, and Spain).

3.3 Data on Interstate Warfare

To connect these religiosity measures with their states' warring efforts, we access data from Brecke (2012a,b), which constitutes the benchmark list of interstate wars for the late Middle Ages and the Early Modern Period (circa 1400-1800).[28] Brecke's (2012b) data begin in the year 1400, but data availability from *Google Ngram* and *FamilySearch* restricts the start of our full empirical analysis to the early 1500s. Nevertheless, we are able to reach back to the year 1400 when exploring the reduced form relationship

[28]For example, Pinker (2011, l.6335) writes "Brecke discovered at least three times as many conflicts as had been listed in all the previous datasets combined." Other recent usages of Brecke's (2012b) data can be found in Iyigun (2008), Iyigun et al. (2017), and Benzell and Cooke (2021), for example.

between solar eclipses and warfare.

Since Brecke (2012a,b) lists the aggressor as the first state(s) in his database, we are able to distinguish between attack wars and defense wars. We generate a dyad-year-level panel database that includes every dyad in which the first-listed state conducted at least one attack war against the respective second-listed state between the years 1400 and 1714. During that timeframe and for each dyad, we include every year in which both states existed. Appendix D provides further detail on our coding rules.

Table 3 reports summary statistics of the dyadic databases, where Panel A considers the sample resulting from the availability of *Google Ngram*, while Panel B does the same for the availability of *FamilySearch* data. Both samples produce approximately 21,000 dyad-year-level observations. For the *Google Ngram*-based measure of religiosity, this translates to 198 dyads for the five attacking states; for the *FamilySearch*-based measure, we count 233 dyads for the eight attacking states.

On average, a state attacked their dyadic counterpart approximately every 100^{th} year. Finally, Panel C turns to the full dyad-year-level data that are not restricted by data availability of the religiosity measures, which we will access for reduced form regressions of attack war onset on preceding solar eclipses. This produces a sample of 1,277 dyads and 156 attacking states.

3.4 Data on Local Solar Eclipse Visibility

To derive information on the local visibility of solar eclipses in the respective state capitals, we access data from Jubier (2020). Using latitude and longitude, we first download all solar eclipses for each state capital from 1400 onwards. An important aspect of any solar eclipse – whether they be total, annular, partial, or hybrid (NASA, 2023a) – constitutes their degree of visibility. For example, Mostert (1989) conclude that even "a small partial eclipse is visible with the naked eye." Yet, even a total solar eclipse, defined by the moon completely blocking the sun, could remain entirely undetected by a local populace if it happened before local sunrise or after local sunset. Further, the eclipse's obscuration rate (i.e., how much of the sun's visible surface is at most covered by the moon) determines whether a local population becomes witness to this extraordinary event or whether it passes unnoticed. In particular, when clouds cover the sky and the sun, a higher obscuration rate is needed for a solar eclipse to be noticeable, everything else equal.

Table 3: Summary Statistics for dyad-year-level database.

Variable	Mean	(Std. dev.)	Min.	(Max.)	Source
Panel A: Sample of *Google Ngram* coverage; $n = 21,313$, from 1500-1714					
Attack war onset	0.009	(0.092)	0	(2)	Brecke (2012b)
% religious terminology	1.130	(0.642)	0	(3.022)	Michel et al. (2011) and Pennebaker et al. (2015)
$\frac{\%\, religious\ terminology}{\%\, religious + \%scientific\ terminology}$	0.350	(0.161)	0	(1)	Michel et al. (2011) and Pennebaker et al. (2015)
Solar eclipses in capital	0.065	(0.257)	0	(2)	Jubier (2020)
Panel B: Sample of birth name coverage; $n = 20,913$, from 1500-1714					
Attack war onset	0.010	(0.103)	0	(2)	Brecke (2012b)
% religious birth names	24.159	(18.001)	0	(81.818)	FamilySearch (2022) and Hanks et al. (2006)
Solar eclipses in capital	0.073	(0.270)	0	(2)	Jubier (2020)
Panel C: Full Brecke (2012b) data; $n = 172,589$, from 1400-1714					
Attack war onset	0.007	(0.083)	0	(2)	Brecke (2012b)
Solar eclipses in capital	0.062	(0.243)	0	(2)	Jubier (2020)

Each eclipse shadow consists of three areas (Bikos, 2023): the *umbra* (i.e., the shadow's dark center portion), the *penumbra* (i.e., the lighter outer part of the shadow), and the *antumbra* (i.e., the lighter part of the shadow that begins where the umbra tapers to a point). These areas refer to different types of solar eclipses: (i) the moon's umbra causes *total* solar eclipses (because the moon is relatively near to earth, observers on earth see the moon covering the entire sun); (ii) the moon's penumbra causes *partial* solar eclipses; (iii) the moon's antumbra causes *annular* solar eclipses (because the moon is relatively far from earth, it appears small to observers on earth and can obscure only the central part of the sun with an unobscured *ring of fire* around it (this is not to be confused with a *corona* that is visible during a total eclipse).[29]

Since every solar eclipse follows a unique path across the earth, the appearance and degree of each solar eclipse varies by location. For our main definition of a visible solar eclipse in a particular state capital, we select those with a local obscuration rate of at least 75%, following Hamacher and Norris (2011) and Querejeta (2011). We select that threshold, as it has been shown that animals seemingly notice something to be different at that level (Backus et al., 1965; Murdin, 2001; Nilsson et al., 2018; Hartstone-Rose et al., 2020; NASA, 2023b).[30] Nevertheless, results are consistent if we select thresholds of 80% or 100%, for example (see Figure 5). Table 3 documents how a solar eclipse appears approximately every 14^{th}-15^{th} year, on average.

As an example of how a solar eclipse can affect relatively nearby locations differently, it is worth comparing Paris and London – major European capitals less than 500 km apart. Employing our main solar eclipse definition, from 1400 to 1714, Paris experienced 20 solar eclipses, while London experienced 21. Out of these, two were only visible in London but not in Paris (1453 and 1654); one was visible in Paris but not in London (1614).

To provide a broad overview, Figure 2 visualizes the share of capitals in the full database that ex-

[29] Annular eclipses are often difficult to detect because of the bright sunlight blinding observers, which explains why there are relatively few historical records of these eclipses (Stephenson, 1997; Mozaffari, 2013).

[30] Founda et al. (2007) provide interesting insights into the role of local weather conditions during a solar eclipse in Greece in 2006. Despite an obscuration rate of only 75%, Thessaloniki experienced a temperature drop by 3.9°C compared to only 2.3°C in Kastelorizo (100% obscuration). This can be explained by clouds in Thessaloniki, the island location of Kastelorizo (which led to a more influential effect of the eclipse on wind gustiness), and other factors. With substantially lower obscuration rates, uncertainties resulting from weather conditions can be expected to increase to levels that will be difficult to control, providing another reason for choosing the 75% threshold.

perienced a solar eclipse in a given year. The total number of states and capitals in Brecke; Brecke's (2012b) database that conducted at least one attack war from 1400-1714 ranges from 93 (in 1400) to 114 (in 1707). Figure 2 shows the corresponding share of capitals with a locally visible solar eclipse ranges from zero to 56% with a mean of 6%. In sum, there is substantial spatial variation in whether a given solar eclipse is visible from state capitals.

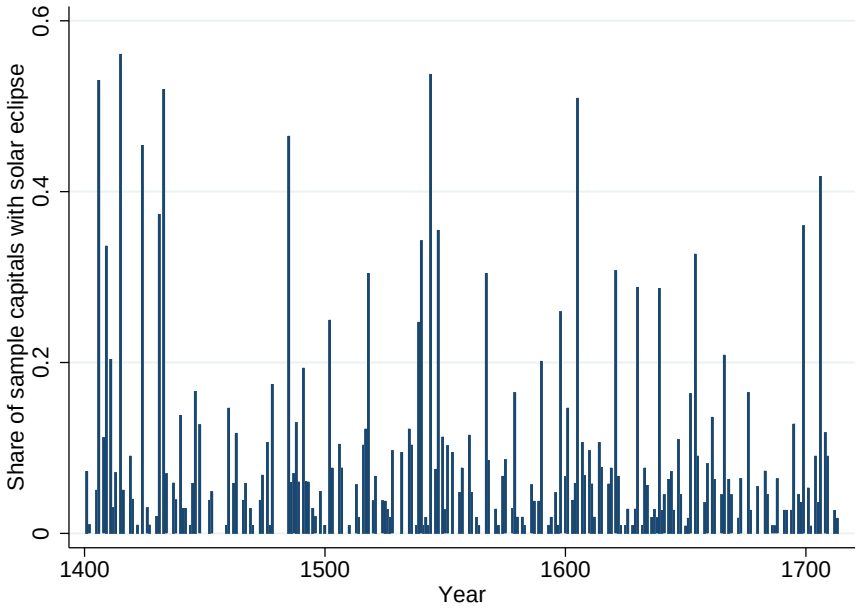

Figure 2: Share of sample capitals with a solar eclipse by year, using the full data from 1400-1714.

4 Empirical Strategy

4.1 Correlating Religiosity and Attack War Onsets

We begin with a basic OLS analysis to predict the number of wars state i initiates against state j in year t. For each religiosity measure, we estimate

$$\big(Attack\ war\ onsets\big)_{i-j,t} = \beta\big(Religiosity\big)_{i,t-1} + \gamma_{i-j} + \theta_t + \epsilon_{i-j,t}, \tag{1}$$

where $\left(Religiosity\right)_{i,t-1}$ constitutes the share of religious terminology employed in books (by itself or relative to scientific terminology) or, alternatively, the share of religious baby names given in state i and year $t-1$. The coefficient β captures the correlation between the extent of religiosity, as measured by our proxies, and state i launching attack wars against state j.

All regressions account for dyad- and year-fixed effects (γ_{i-j} and θ_t) to hold constant unobservable factors that vary across dyads and over time. Dyad-fixed effects control away each dyad's unique history, their relative geographies and fundamental cultural similarities and differences, as well as any other dyad-specific factors that do not change (or only change slowly) over time. Year-fixed effects filter out contemporary global developments that may independently affect warfare and religiosity, such as the Little Ice Age (1600-1850; e.g., see Parker, 2013 and Waldinger, 2022). In additional analyses, we also incorporate dyad-specific time trends, where we observe consistent estimates (see Table E2). Finally, $\epsilon_{i-j,t}$ denotes the conventional error term, and we cluster at the dyad level.

4.2 Alleviating Endogeneity: Locally Visible Solar Eclipses

To alleviate endogeneity concerns in equation (1), we are in need of a plausibly exogenous factor to render religiosity salient, yet without the attribute of affecting warfare through another channel. We propose locally visible solar eclipses in i's state capital as an exogenous primer of religiosity that remains unrelated to any other anthropoid or natural dynamics. As opposed to natural disasters, for example, solar eclipses cause no damage to harvests, infrastructure, climate, or other factors that could by themselves influence war-related developments. The only documented effects of solar eclipses constitute a temporary drop in temperatures (Fernández et al., 1993; Anderson, 1999; Founda et al., 2007), as well as unusual and confused behavior by animals who have been observed as preparing for sleep during an eclipse, assuming it to be nighttime (Backus et al., 1965; Murdin, 2001; Nilsson et al., 2018; Hartstone-Rose et al., 2020; NASA, 2023b). In a time before systematic scientific inquiry into the origins of solar eclipses, such an event would, we posit, only leave one explanation: That supernatural forces are at work. Figure 3 visualizes our identification strategy.

Econometrically, we implement a two-stage-least-squares (2SLS) specification that, before estimat-

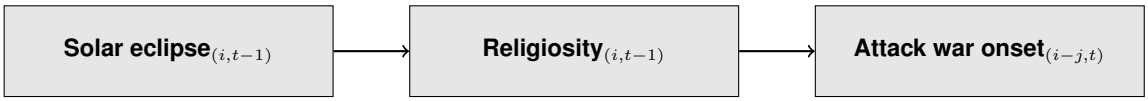

Figure 3: Solar eclipses, religiosity, and interstate warfare.

ing equation (1), predicts the corresponding religiosity measure with

$$\big(Religiosity\big)_{i,t-1} = \alpha\big(Solar\ eclipses\big)_{i,t-1} + \gamma_{i-j} + \theta_{t-1} + \delta_{i-j,t-1}. \tag{2}$$

Connecting solar eclipses to religious terminology in books published in the same year assumes a relatively quick turnaround of book writing and production. We employ this structure for several reasons. First, while book production was generally a slow process in the Middle Ages, the printing press (invented around 1436) both facilitated turnaround substantially and increased the number of books that could be produced and distributed.[31] Early printing presses were able to produce 250 sheets per hour and, within the first 50 years after the invention of the printing press, the number of books increased from a few thousand to nine million by 1500, just before our main sample period (Encyclopedia Britannica, 2023c,b). Second, a solar eclipse may also affect an author's writing of an ongoing book. For example, an author may have been working on a book for some time, but a salient religiosity primer (such as a solar eclipse) could affect the final chapters or even last-minute edits to a book that is scheduled to be published. Third, from a statistical perspective, if the frequency of religious terminology employed in books would not change within the timeframe suggested in equation (2), then our estimated α would simply be weak in statistical terms. Finally, these considerations should be less relevant for our naming-based religiosity measure since naming decisions are made by new parents and do not require substantial preparations.

In the second stage, we then employ the predicted values of $\big(\widehat{Religiosity}\big)_{i,t-1}$ in equation (1). If both the predictive power of α and the exclusion restriction are valid, then the corresponding β coefficient derived from that 2SLS specification allows us to draw causal inferences between i's degree of religiosity and their propensity to attack j in the subsequent year. Notably, this identification strategy is then also able to overcome issues related to attenuation bias (e.g., see Wooldridge, 2015), yielding a more accurate

[31] The rapid spread of the Protestant Reformation is an explicit example of this (e.g., see Urquhart and Heyer, 2018).

quantitative estimate. Nevertheless, this identification strategy naturally leaves us a with a *local* (rather than a *global*) average treatment effect – something we explore carefully in Section 6.1.

5 Main Empirical Findings

5.1 Religiosity and Attack War Onsets

Table 4 reports our benchmark results. Columns (1)-(3) document estimates from OLS specifications, while columns (4)-(6) turn to the corresponding IV results. All regressions account for dyad- and year-fixed effects. To facilitate readability and the quantitative comparison of estimates, all religiosity measures are standardized.

In column (1), we observe a positive and moderately statistically significant coefficient associated with the share of religious terminology expressed in books to predict subsequent attack war onset ($p = 0.058$). Column (2) turns to religious relative to scientific terminology, similarly yielding a positive estimate that is weakly statistically different from zero ($p = 0.097$). Employing the share of Christian baby names as a proxy for religiosity in column (3) produces yet another weak positive association ($p = 0.086$). Aside from sign and statistical significance, it is useful to consider implied magnitudes: A one standard deviation increase in the respective religiosity measures would be associated with 0.0016, 0.0011, or 0.0054 additional war onsets in columns (1)-(3), respectively. Taken together, these results produce tentative correlational evidence about a systematic relationship between religiosity, as elicited by these three proxies, and a state beginning a war.

However, these conclusions become much firmer once we instrument religiosity with solar eclipses. First-stage estimates in Panel B underscore the predictive power of these solar eclipses, and Panel C reports common statistics along those lines, suggesting a statistically powerful instrumentation strategy across the board. The respective second-stage estimates associated with all three religiosity measures produce positive and precisely estimated coefficients, with p-values of 0.011, 0.013, and 0.006.

In terms of magnitude, in column (4), a one standard deviation increase in religious terminology translates to a rise in the number of attack wars against state j by 0.08 units or one additional war every 12.5 years. Similarly, a one standard deviation increase in terms of religious versus scientific language

Table 4: Main regression results, predicting attack war onset of state i against state j in year t. To facilitate readability and interpretation of coefficients, the religiosity variables are standardized. All regressions control for dyad- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method:		OLS			IV	
Mean of dep. var.:	0.008	0.008	0.010	0.008	0.008	0.010
Panel A: Predicting attack war onset$_{i-j,t}$						
% religious terminology$_{i,t-1}$	0.0016*			0.0817**		
	(0.0009)			(0.0323)		
$\left(\frac{\%\ religious\ terminology}{\%\ religious\ +\ \%scientific\ terminology}\right)_{i,t-1}$		0.0011*			0.0600**	
		(0.0007)			(0.0241)	
% religious baby names$_{i,t-1}$			0.0054*			0.3804***
			(0.0031)			(0.1380)
Panel B: 1st stage results						
Solar eclipses in capital$_{i,t-1}$				0.1532***	0.2026***	0.0426***
				(0.0249)	(0.0310)	(0.0097)
Panel C: Statistical properties						
F-test insignificance of IV				37.878***	42.629***	19.404***
Stock-Wright S statistics (p-value)[a]				0.009***	0.012**	0.002***
Weak IV test (Wald, p-value)[b]				0.011**	0.013**	0.006***
Kleibergen-Paap rk LM statistic (p-value)[c]				0.000***	0.000***	0.000***
N	21,313	20,523	20,913	21,313	20,523	20,913

Notes: Standard errors clustered at the dyad level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a]Following Stock and Wright (2000). [b]Following Magnusson (2010) and Finlay et al. (2013), we apply the *weakiv* command in Stata to test for weak instruments. [c]Following Kleibergen and Paap (2006), we present results from under-identification tests.

employed in books in column (5) translates to an increase of 0.06 wars. Finally, in column (6), a one standard deviation increase in the share of Christian baby names is associated with an additional war every 2.6 years.

These IV results remain robust in a range of alternative specifications. Beginning with the *Google Ngram*-based religiosity measure, Table E2 reports results from excluding Prussia and the Kingdom of Sardinia because assigning German and Italian writings entirely to these states may be less accurate, as these languages were employed in other states as well at the time. We also derive estimates from alternative measures of religious terminology, first exploring the percentage *change* in the frequency of religious terminology from the previous year and, second, implementing $\frac{\%\ religious\ terminology}{\%\ scientific\ terminology}$. Table E2 also displays estimates from IV specifications that control for dyad-specific time trends. Further, results are consistent if we employ a binary measure of solar eclipses, rather than a count variable (see Table E3). Next, for the religiosity measure based on baby names, we implement alternative cutoff values for the number of observations above which we include a state-year observation with 20, 30, and 40 names (see Table E3). Adding name variants in each language further solidifies our conclusions (see Table E4), and extending our sample to the years 1720 or 1730, as alternative starting dates for the Enlightenment, also yields consistent estimates (Table E4).

5.2 Solar Eclipses and Warfare: Reduced Form Results and Placebos

We now turn to the reduced form relationship between solar eclipses and subsequent warfare. If solar eclipses indeed made religiosity salient, which in turn raised a society's appetite for war, then we should observe a positive link between solar eclipses in year $t-1$ and the number of attack wars against state j in year t. However, we should not see any anomalies in terms of attack wars *before* an eclipse.

Figure 4 visualizes results from an event study-type regression, where we predict attack war onset with the 11 solar eclipse variables from $t-5$ until $t+5$, in addition to dyad- and year-fixed effects. The corresponding estimates are consistent with our narrative: In the years leading up to a solar eclipse, we observe no unusual developments related to attack war onset. However, the number of attack war onsets rises sharply, by more than a standard deviation, in the year after i's capital experiences a solar eclipse ($p = 0.003$). After that, from year $t+2$ until $t+5$, the derived coefficients again become

indistinguishable from zero in statistical terms and noticeably diminish in magnitude.

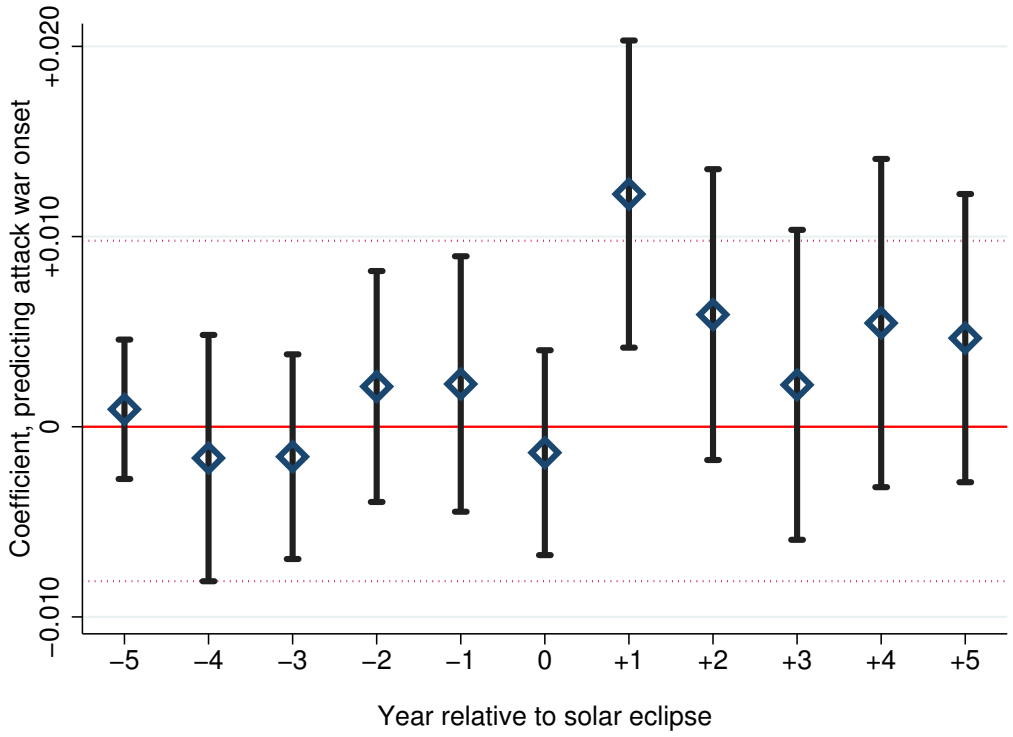

Figure 4: Reduced form estimates in event-study-type format, predicting attack war onset with lags and leads of solar eclipses. The regression controls for dyad- and year-fixed effects. The dotted lines indicate a one standard deviation change in the probability of attack war onset as a quantitative reference point. Two-sided 95 percent confidence intervals are displayed.

Figure 5 continues with the reduced form relationship between solar eclipses and warfare, displaying results from seven regressions that connect solar eclipse occurrences in $t-1$ with warfare measures in year t. Since we are not restricted by data availability for our religiosity measures in this case, we expand our sample towards the full list of dyads from 1400-1714 (since Brecke's, 2012b data begin in 1400). Here, we observe a positive and statistically significant link between a solar eclipse in $t-1$ and state i's propensity to start warring in year t ($p = 0.031$). Next, we re-estimate that same specification but define a solar eclipse by having produced a local obscuration rate of at least 80%, as opposed to 75% in our baseline measure. Similarly, for the third specification, we raise that threshold to 100%. In both cases, we derive consistent results with a positive coefficient that is statistically significant at the 5% level ($p = 0.010$ and $p = 0.024$). Notably, as the number of captured solar eclipses decreases with higher

obscuration rate thresholds, statistical precision diminishes, as indicated by inflated confidence intervals.

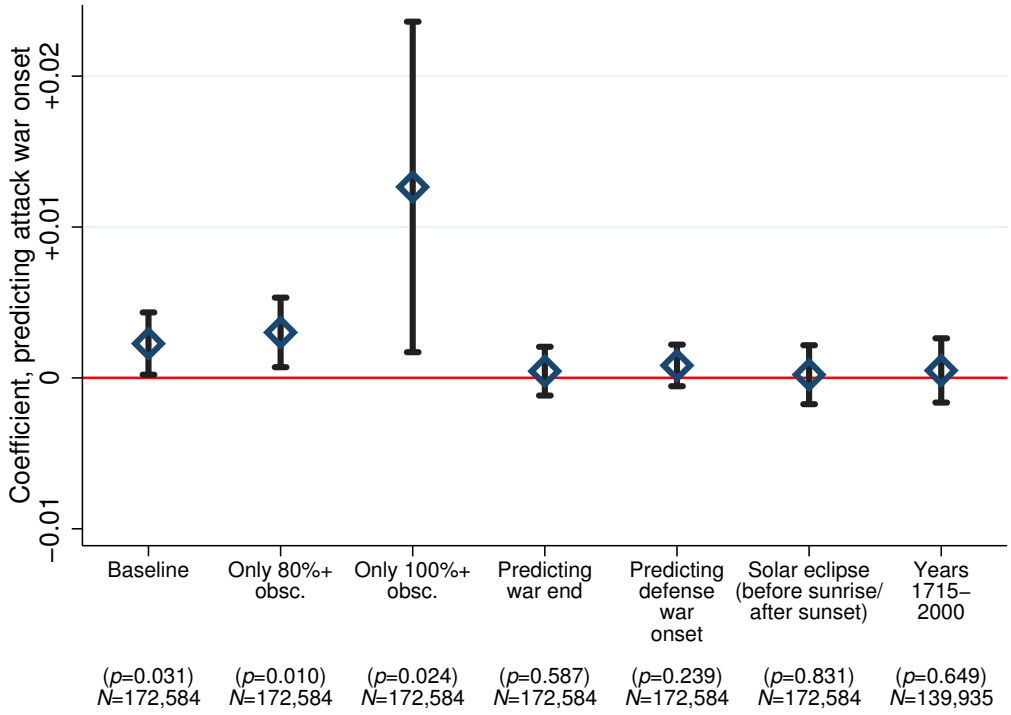

Figure 5: Estimates from seven reduced form regressions, predicting warfare characteristics in year t with solar eclipses in year $t-1$. The first six regressions consider the years 1400-1714, while the final regression studies the years 1715-2000. All regressions control for dyad- and year-fixed effects. Two-sided 95 percent confidence intervals are displayed.

For the fourth specification, we return to our baseline measure of solar eclipses but change the outcome variable to measuring the number of attack wars *ending*, rather than starting. This tests whether solar eclipses generally elicit a change in the warfare status quo with state j or whether the effects are specific to war *onset*. We derive a marginally positive coefficient that remains, however, firmly statistically insignificant at conventional levels ($p = 0.587$). Comparing magnitudes, the estimate also comes in at approximately one sixth of the main coefficient at the left end of Figure 5 with 0.0004 versus 0.0023. Thus, we find no evidence to suggest solar eclipses predict attack war *terminations*.

The fifth specification again changes the outcome variable, this time towards predicting *defense* war onsets as a placebo. Intuitively, we should not see more or fewer attacks of state j against state i after

a solar eclipse in i's capital. Indeed, this is the case as we derive a statistically irrelevant coefficient ($p = 0.239$).

For the penultimate specification of Figure 5, we pursue another placebo regression, this time by measuring solar eclipses that either occurred before sunrise or after sunset in i's capital. Naturally, these would remain invisible to the local population. As predicted, we identify a precisely estimated null relationship with subsequent attack war onsets ($p = 0.831$).

The final coefficient reported in Figure 5 comes from re-estimating the reduced form specification but changing the time period to 1715-2000. If solar eclipses were indeed explainable for the masses through scientific inquiry, and if our baseline channel operated through religiosity, as we suggest, then their predictability of subsequent attack warfare should seize or at least weaken in these recent centuries. That is indeed what the respective estimate suggests with a much smaller coefficient of 0.0005 that remains statistically indiscernible from zero ($p = 0.649$).

6 Religious Ingroups versus Religious Outgroups

6.1 Solar Eclipses and Types of Religious Terminology

How can we explain our results that suggest religiosity, as measured by our three proxies, enhances a society's propensity to start warring? As with any IV, our identification strategy is characterized by a *l*ocal *a*verage *t*reatment *e*ffect (*LATE*; Angrist and Pischke, 2008), i.e., results are driven by those changes in religiosity that are induced by solar eclipses. To better understand these developments, Table 5 lists those religiosity words and stems that are particularly frequently used in solar eclipse years. We first standardize each individual word's and stem's frequency over the entire pre-1715 time period in *Google Ngram*. Table 5 then reports those words and stems for which the average value in solar eclipse years is highest. In other words, this compares each word's and stem's usage to itself over the entire time period and reports those for which the deviation from its mean usage is most positive in solar eclipse years.

A stark pattern across Table 5 concerns the extraordinary frequency of explicitly *non*-Christian terminology (highlighted in bold). In German, for example, the words *Sunnit* (*Sunni* in English), *Kippur*, and *Juden* (*Jews*) rank among the top ten. In Italian, the word *musulmana* (*Muslim*) tops the list, while

Table 5: List of 35 words that are more frequently used in solar eclipse years, compared to their usage in non-solar eclipse years (1500-1714). Explicitly non-Christian words are highlighted in bold, stems are marked with an asterisk, and English translations are provided in parentheses.

Rank	Spanish	French	German	British English	Italian
#1	misericordioso* (compassionate)	aumonier (chaplain)	episkopal* (episcopal)	satanic	**musulmana (muslim)**
#2	misionar* (mission)	condamner* (damn)	pietismus (pietism)	amish	profetizzata (prophesied)
#3	misionero* (missionary)	pèlerin (pilgrim)	**sunnit (sunni)**	**kippur**	benedire* (bless)
#4	**mahometano* (mohammedan)**	mausolée (mausoleum)	predigen* (preaching)	biblically	**rabbino (rabbi)**
#5	pío* (pious)	temple (temple)	spiritus (spirit)	demonic	profetizzato (prophesied)
#6	angélico* (angelic)	clémence (clemency)	gnädig* (gracious)	evangelism	ciarlatano (charlatan)
#7	luterano* (lutheran)	prophétique (prophetic)	**kippur (kippur)**	**zen**	angelicato (angelic)
#8	diablesco* (devilish)	**juif* (jewish)**	engel (angel)	pentecostal	bigotto (bigot)
#9	**sionistas (zionists)**	orthodoxe* (orthodox)	**juden (jews)**	monastic	protestantesimo (protestantism)
#10	apiadar* (pity)	évangélisation (evangelization)	prophezeiung (prophecy)	prophetic	chiesastico (churchy)
#11	congregación (congregation)	**paganisme (paganism)**	geistlichkeit (clergy)	**muslim**	**rabbinico (rabbinic)**
#12	prestes (lend)	baptiser* (baptize)	**islamisch* (islamic)**	holiest	paradisiaco (heavenly)
#13	baptisterios (baptisteries)	protestantisme (protestantism)	**sabbat (sabbath)**	**jew**	rosari (rosaries)
#14	monjía (nun)	sanctuaire (sanctuary)	satanisch* (satanic)	methodist	anabattista (anabaptist)
#15	frailes (friars)	pieux (pious)	göttlich (divine)	saints	riti (rites)
#16	pontífice (pontiff)	**sion (zion)**	konventionen (conventions)	immorality	**corano (koran)**
#17	mortificación (mortification)	autel (altar)	taufe (baptism)	church*	luteranismo (lutheranism)
#18	protestante (protestant)	jésuite (jesuit)	**jüdinnen (jewish women)**	evangelicals	agnosticismo (agnosticism)
#19	celestial (heavenly)	missionnaire (missionary)	gottesdienst (church service)	biblical	confessionalmente (confessionally)
#20	fraile (friar)	démoniaque (demonic)	seminar (seminar)	satan	ortodossamente (orthodox)
#21	predicaciónes (preachings)	mennonite (mennonite)	jesus (jesus)	spirit	**rabbini (rabbis)**
#22	**hebraísmo (hebraism)**	foi (faith)	christus (christ)	sinful	condannare* (condemn)
#23	jesús (jesus)	**juifs (jews)**	ewig* (eternal)	pray*	destinato (fated)
#24	vaticano* (vatican)	culte (cult)	bekennen* (confess)	sect	evangelismo (evangelism)
#25	paraíso (paradise)	impitoyablement (ruthlessly)	glaube (believe)	**passover**	predicatorio (preachy)
#26	peregrinación (pilgrimage)	bénédicion (blessing)	versündigung (sin)	**veil***	gesuitico (jesuit)
#27	novicia (novice)	prophétie (prophecy)	glauben (believe)	catholic	evangelico (evangelical)
#28	**mahometizar (mahometize)**	méditer* (meditate)	**judentum (judaism)**	protestantism	meditatamente (thoughtfully)
#29	moralista (moralist)	soeur (sister)	beten* (pray)	divinity	**giudaico (jewish)**
#30	alabancias (praises)	baptême (baptism)	priesterin (priestess)	meditation	salmo (psalm)
#31	caritativo* (charitable)	ange (angel)	gottesdienst	gentiles	peccatore (sinner)
#32	diablura (devilry)	impie (impious)	**jüdin (jewess)**	evangelical	pellegrinare* (pilgrimage)
#33	**chií* (shiite)**	bénir* (bless)	bibel (bible)	immoral	ministeriale (ministerial)
#34	celestiales (heavenlies)	expier* (expiate)	**jude (jew)**	clergy*	inno (hymn)
#35	penitenciales (penitential)	séraphins (seraphim)	fegefeuer (purgatory)	**muslims**	**giuda (judah)**

the term *rabbino* (*Rabbi*) enters at number four.

Further, some non-highlighted words also reveal interesting information. In a time when Catholicism constituted the mainstream religion in these states (at least in Spain, France, and Italy), religious terminology specific to non-Catholic Christian branches also feature prominently in Table 5, such as references to the *Amish*, *Protestantism*, and *Luther* (the seminal figure of the Protestant Reformation).

To systematically test for a pattern, we run state-year-level regressions to predict the percentage of explicitly non-Christian religious terminology in *Google Ngram* with the occurrence of solar eclipses in the respective capital cities, conditional on state- and year-fixed effects. The results, displayed in column (1) of Table 6, suggest a positive and statistically significant relationship ($p = 0.027$). In terms of magnitude, a solar eclipse corresponds to a rise of non-Christian religious terminology equivalent to 32% of a standard deviation.

In column (2), we predict the share of the remaining religious terminology, i.e., those religious words and stems that are *not* explicitly non-Christian. In this case, we derive a coefficient that remains statistically and quantitatively insignificant, where a solar eclipse would translate to a rise of only 10% of a standard deviation ($p = 0.459$) or only about a third of the magnitude of column (1). In columns (3) and (4), we re-estimate columns (1) and (2) for a broader definition of non-Christian religious terminology by further defining words and stems that are explicitly non-Catholic as non-Christian (including, for example, terms related to *Amish*, *Protestantism*, and *Luther*). This produces a consistent pattern.

Table 6: Results from state-year-level regressions, predicting different types of religious language with the occurrence of solar eclipses in the respective state capitals. To facilitate readability and interpretation of coefficients, dependent variables are standardized. All regressions control for state- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	% non-Christian religious terminology$_{i,t}$	% *not* non-Christian religious terminology$_{i,t}$	% non-Catholic religious terminology$_{i,t}$	% *not* non-Catholic religious terminology$_{i,t}$	% Judaism-specific religious terminology$_{i,t}$	% Islam-specific religious terminology$_{i,t}$
Solar eclipses in capital$_{i,t}$	0.319**	0.097	0.335**	0.097	0.350**	0.051
	(0.103)	(0.121)	(0.102)	(0.121)	(0.125)	(0.036)
N	987	987	987	987	987	987

Notes: Standard errors clustered at the state level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Next, we further distinguish non-Christian religious language between Judaism- and Islam-specific terminology (see highlighted words and stems in Appendix A). The corresponding results, reported in columns (5) and (6), imply Judaism-specific language is particularly responsive to the occurrence of solar eclipses ($p = 0.038$), while Islam-specific language are less predictive with solar eclipses, although still display the expected positive sign ($p = 0.217$). In sum, the *LATE* of solar eclipses may make religious identity salient through a heightened emphasis on religious outgroups.

6.2 Types of Religious Terminology and Attack Warfare

We now turn to delineating types of religious terminology to predict attack war onset, our primary outcome variable. Table 7 lists the top 35 words that are unusually frequently used in the year before dyadic attack war onsets, relative to their frequency in all other years. Here again, explicitly non-Christian terms are standing out, such as *musulmán* (*Muslim*), *kippur*, *jew(s)*, and *Muhammad*.

Motivated by this observation, we return to our IV strategy, this time (i) focusing on Muslim opposition states (as the main interstate case of a religious outgroup at the time) and (ii) employing the outgroup-specific religious sub-dictionaries. Table 8 reports the corresponding results, where all religiosity variables are again standardized. In column (1), we re-estimate our main specification of column (4) in Table 4 but only include those dyad-year observations that include a Muslim counterpart to the Christian states of Spain, France, Prussia, England, and the Kingdom of Sardinia (the sample available for *Google Ngram* data).[32] Again, the observed estimate is positive and statistically significant ($p = 0.045$) – however, the magnitude increases by 235% to 0.1927, as opposed to the full-sample estimate of 0.0817. Thus, solar eclipses as religious primers translate particularly into attack wars against Islamic states.

In column (2), we return to the full sample of all (not just Muslim) opposition states but employ the explicitly non-Christian religious terminology as our main *x*-variable, instrumented by solar eclipses in i's capital. In column (3), we repeat that specification but again focus exclusively on the Islamic opposition states. Contrasting the derived estimates – that are both positive and statistically significant ($p = 0.009$ and $p = 0.026$) – again shows a substantially larger effect for Islamic target states, with

[32]These opposing states include the Ottoman Empire (785 observations), Algiers (609), Morocco (603), Tunis (495), the Tuareg People (210), Syria (203), Bengal (192), Molucca (9), Iran (6), Kano (6), Oman (6), and Zanzibar (6).

Table 7: List of 35 words that are more frequently used in a year before attack war onset (1500-1714). Explicitly non-Christian words are highlighted in bold, stems are marked with an asterisk, and English translations are provided in parentheses. Italian words are not reported because the state had no attack war onset in that timeframe.

Rank	Spanish	French	German	British English
#1	**musulmán* (muslim)**	prêcher (preach)	**kippur (kippur)**	baptize*
#2	clero (clergy)	crucifié (crucified)	pietismus (pietism)	bless*
#3	santurrón* (sanctimonious)	sainteté (holiness)	dämonischer (demonic)	soul
#4	pastores (shepherds)	angélique (angelic)	**rabbinisch* (rabbinic)**	gentile
#5	salmodiar* (psalm)	méditer* (meditate)	orthodox* (orthodox)	immoral
#6	sagrario (sanctuary)	mausolée (mausoleum)	konventionen (conventions)	salvation
#7	cristianismo (christianity)	pèleriner* (pilgrim)	fegefeuer (purgatory)	sinners
#8	cristiano* (christian)	pontifical (papal)	versündigung (sin)	piety
#9	**mahometano* (mohammedan)**	croyance* (belief)	pilger (pilgrim)	spirits
#10	diabólico* (diabolical)	**voile (veil)**	hölle (hell)	**judah**
#11	plegarias (prayers)	coutumes (customs)	ungeist (unspiritual)	worship*
#12	rezaderas (praying pads)	immortel* (immortal)	seelen (souls)	**zion**
#13	bautizar* (baptize)	démons (demons)	bibel (bible)	**jews**
#14	espiritualismo (spiritualism)	temple (temple)	rosenkränze (rosaries)	**passover**
#15	baptizador (baptizer)	bénédicité (grace)	beichten* (confess)	moral
#16	santificador* (sanctifier)	orthodoxe* (orthodox)	frömmigkeit (piety)	devil*
#17	obispales (bishops)	coutume (custom)	**rabbi (rabbi)**	sin*
#18	**buda (buddha)**	crucifiement (crucifixion)	**jude (jew)**	evangelists
#19	menonitas (mennonites)	christianisme (christianity)	seeligkeit (bliss)	demons
#20	amish (amish)	**judaïquement (judaically)**	verhängnis (doom)	mercy
#21	ultratumba (afterlife)	immortellement (immortality)	moral (moral)	baptism
#22	bautisterios (baptisteries)	sacrifice (sacrifice)	untergang (demise)	spirit
#23	espiritualización (spiritualization)	impitoyablement (ruthlessly)	gnade (grace)	heaven
#24	himnodia (hymnody)	impie (mpious)	theologisch* (theological)	ritual
#25	**alá (allah)**	pécher* (sin)	gnädig* (gracious)	**kippur**
#26	peregrinajes (pilgrimages)	**mahométan (mohammedan)**	himmel (heaven)	biblically
#27	herejías (heresies)	divin (divine)	presbyterianer (presbyterian)	divinity
#28	cristianidad (christendom)	**paganisme (paganism)**	engel* (angel)	souls
#29	iglesia (church)	spirituel (spiritual)	moralität (morality)	**muhammad**
#30	ritual (ritual)	**hindu (hindu)**	andacht (prayer)	sinner
#31	**sabbat (sabbath)**	satanisme (satanism)	gebet (prayer)	morals
#32	satanismo (satanism)	banc (bench)	**ramadan (ramadan)**	**judaism**
#33	**hebraico* (hebraic)**	sacré (sacred)	**jüdinnen (jewish women)**	psalm
#34	monasterio (monastery)	pécheur (sinner)	sündigen* (sin)	evangelism
#35	**paganía (pagany)**	autel (altar)	geistliche (spiritual)	demonic

Table 8: Results from additional IV regressions, predicting attack war onset of state i against state j in year t. To facilitate readability and interpretation of coefficients, the religiosity variables are standardized. All regressions control for dyad- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)
Sample:	Only Islamic opponents	Full	Only Islamic opponents	Full	Only Islamic opponents
Mean of dep. var.	0.011	0.008	0.011	0.008	0.011
Panel A: Predicting attack war onset$_{i-j,t}$					
% religious terminology$_{i,t-1}$	0.1927**				
	(0.0963)				
% non-Christian religious terminology$_{i,t-1}$		0.0304***	0.0808**		
		(0.0116)	(0.0363)		
% Islam-specific religious terminology$_{i,t-1}$				0.0603***	0.1662*
				(0.0234)	(0.0877)
Panel B: 1^{st} stage results					
Solar eclipses in capital$_{i,t-1}$	0.173**	0.411***	0.412***	0.207***	0.200***
	(0.078)	(0.021)	(0.069)	(0.021)	(0.070)
Panel C: Statistical properties					
F-test insignificance of IV	4.851**	382.926***	35.579***	101.214***	8.146***
N	3,130	21,313	3,130	21,313	3,130

Notes: Standard errors clustered at the dyad level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

the estimate increasing by 266%, from 0.0304 to 0.0808. Finally, columns (4) and (5) re-estimate those specifications for the respective samples, this time employing Islam-specific religiosity language, rather than the more general non-Christian terminology. This produces an even more pronounced difference in magnitudes of 276%, from 0.0603 to 0.1662.

6.3 City-Level Jewish Persecutions

To test these patterns of religious ingroups versus religious outgroups beyond interstate warfare, our penultimate set of specifications turns to Jewish persecutions at the city level. Accessing data from Anderson et al. (2017) and their respective sources, we again derive a database from the years 1400 to 1714 (see Table E5 for summary statistics and references). From Jubier (2020), we then code city-level solar eclipses into that same database, employing the same solar eclipse definitions as in our main specifications (see Section 3.4). The aim of our regressions is to check whether solar eclipses in city i and year $t-1$ can predict Jewish persecutions in city i and year t. Throughout, we control for city- and year-fixed effects, while clustering standard errors at the city level.

Panel A of Table 9 reports the corresponding results from predicting Jewish persecutions overall in columns (1) and (2). Columns (3)-(6) split up the dependent variable into pogroms and expulsions. The even-numbered columns also include the benchmark set of covariates employed by Anderson et al. (2017) pertaining to population density, temperature, and capital protection (see Table E5 for summary statistics).

The regressions in columns (1) and (2) produce estimates that are positive, statistically significant, and sizeable in terms of magnitude ($p = 0.001$ and $p < 0.001$). A solar eclipse raises the number of Jewish persecutions by a fifth of a standard deviation (with the standard deviation of the dependent variable being 0.07). Delineating by types of persecutions in the remaining columns of Table 9 reveals a locally visible solar eclipse systematically predicts an expulsion of a city's Jewish populace.

Panel B of Table 9 reports estimates from further controlling for city-specific time trends. These specifications produce consistent results in that Jewish persecutions, and specifically expulsions, are significantly more likely after a locally visible solar eclipse. Finally, columns (2), (4), and (6) document estimates from placebo regressions, where we measure those solar eclipses that occurred either before

Table 9: Predicting Jewish persecutions in city i and year t with solar eclipses visible in city i and year $t-1$. Data range from 1400-1714 and include 864 European cities. All regressions control for city- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Jewish persecutions$_{i,t}$		Jewish pogrom$_{i,t}$		Jewish expulsion$_{i,t}$	
Mean of dep. var.	0.0052	0.0053	0.0018	0.0016	0.0037	0.0040
Panel A: Main results						
Solar eclipses$_{i,t-1}$	0.0140***	0.0172***	0.0038	0.0037	0.0127***	0.0161***
	(0.0040)	(0.0042)	(0.0029)	(0.0030)	(0.0039)	(0.0042)
Control variables[a]		✓		✓		✓
N	134,926	119,287	134,926	119,287	134,926	119,287
Panel B: Extensions and placebos						
Solar eclipses$_{i,t-1}$	0.0149***		0.0034		0.0137***	
	(0.0041)		(0.0028)		(0.0040)	
Placebo solar eclipses$_{i,t-1}$ (before sunrise or after sunset)		-0.0002		0.0000		-0.0003
		(0.0012)		(0.0007)		(0.0010)
Control variables[a]	✓	✓	✓	✓	✓	✓
City-specific time trends	✓	✓	✓	✓	✓	✓
N	119,287	119,287	119,287	119,287	119,287	119,287

Notes: Standard errors clustered at the city level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a]Includes measures of population density, temperature, and capital protection (see Anderson et al., 2017 and Table E5).

local sunrise or after local sunset, i.e., solar eclipses that should not be noticeable to the local populace. As expected, we do not derive statistically or quantitatively relevant patterns in these cases.

6.4 Witch Trials

In our final exploration of a potential ingroup-outgroup dynamic associated with religiosity (as primed by locally visible solar eclipses) and systematic outgroup-targeted violence, we turn to city-year-level witch trials. Studying data for 836 European cities from 1300-1714 (see Table E6 for summary statistics and sources), Table 10 documents regression results from using the visibility of solar eclipses in city i and year $t-1$ to predict whether there are any witch trials in city i and year t, as well as, alternatively, the *number* of witch trials (maximum and average), as reported by various sources (see Leeson and Russ, 2018). As before, we also conduct placebo regressions, i.e., employing those solar eclipses that must have been unnoticeable because they occurred either before sunrise or after sunset. As in all our empirical specifications, results in Table 10 account for city- and year-fixed effects throughout. If a society was indeed more likely to turn against outgroups as the result of a salient religiosity primer, it is possible that we also witness a systematic rise in witch trials. Columns (1), (3), and (5) of Table 10 display coefficients from the main regressions, while columns (2), (4), and (6) are reserved for results from placebo specifications.

Table 10: Predicting witch trials in city i and year t with solar eclipses visible in city i and year $t-1$. Data range from 1300-1714 and include 836 European cities. All regressions control for city- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Witch trial$_{i,t}$ (0/1)		Max. # of witch trials$_{i,t}$		Avg. # of witch trials$_{i,t}$	
Mean of dep. var.	0.0129	0.0129	0.1619	0.1619	0.0380	0.0380
Solar eclipses$_{i,t-1}$	0.0143**		0.1453**		0.0367***	
	(0.0061)		(0.0602)		(0.0117)	
Placebo solar eclipses$_{i,t-1}$ (before sunrise or after sunset)		-0.0000		0.0659		0.0113
		(0.0020)		(0.1182)		(0.0149)
N	307,567	307,567	307,567	307,567	307,567	307,567

Notes: Standard errors clustered at the city level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The corresponding results are, again, remarkably consistent with an ingroup-outgroup mechanism. In column (1), we find a solar eclipse more than doubles the likelihood of a witch trial taking place in a given city, from a mean of 1.3% to 2.7% ($p = 0.019$). Columns (3) and (5) imply similarly-sized effects when considering the maximum reported or the average reported number of witch trials ($p = 0.016$ and $p = 0.002$, respectively). Finally, the placebo regressions of the even-numbered columns produce precisely estimated null effects ($p = 0.986$, $p = 0.577$, and $p = 0.446$, respectively).

7 Conclusion

This paper aims to make three contributions to our understanding of how religiosity can inform large-scale organized violence, expressed in the form of interstate attack wars and intrastate persecution of religious outgroups and outsiders. First, we present two independent state-year thermometers of religiosity for the two centuries preceding the Age of Enlightenment. These measures are based on the frequency of religious terminology employed in books and the share of distinctly Christian names selected by parents for their babies in the respective state and year.

Second, to explore potentially causal relationships between religiosity and interstate warfare, we exploit the occurrence of locally visible solar eclipses as a salient primer of religiosity in an era preceding modern-day systematic scientific inquiry into and understanding of the origin of solar eclipses. Results from 2SLS and reduced form specifications collectively support the hypothesis that increased religiosity increases the occurrence of a state starting a war against their dyadic counterpart.

Third, we pursue potential mechanisms and find the *type* of religious language that spikes both in solar eclipse years and before a state goes to war is explicit to religious outgroups. Specifically, if religious terminology unique to Islam increases, so does the state's likelihood to wage war in the subsequent year – but particularly against Islamic states. These results are consistent with the hypothesis of a salient ingroup-outgroup demarcation along religious dimensions preceding large-scale organized violence. Finally, to test for this hypothesis when it comes to intrastate violence, we access pre-Enlightenment city-year-level data of (i) Jewish persecutions and (ii) witch trials. Indeed, we find locally visible solar eclipses are strongly predictive of both Jewish expulsions from a given city and witch trials in the fol-

lowing year.

Overall, we hope these findings enrich our understanding of whether, how, and when religiosity can causally inform large-scale organized violence at the societal level.

References

Abramitzky, R., Boustan, L. P., and Eriksson, K. (2018). Cultural assimilation during the two ages of mass migration. Technical report, Working paper.

Acemoglu, D., Hassan, T. A., and Robinson, J. A. (2011). Social structure and development: A legacy of the Holocaust in Russia. *The Quarterly Journal of Economics*, 126(2):895–946.

Acemoglu, D., Johnson, S., and Robinson, J. (2005). The rise of Europe: Atlantic trade, institutional change, and economic growth. *American Economic Review*, 95(3):546–579.

Andersen, L. H. and Bentzen, J. (2022). In the Name of God! Religiosity and the Transition to Modern Growth.

Anderson, J. (1999). Meteorological changes during a solar eclipse. *Weather*, 54(7):207–215.

Anderson, R. W., Johnson, N. D., and Koyama, M. (2017). Jewish persecutions and weather shocks: 1100–1800. *The Economic Journal*, 127(602):924–958.

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.

Arias Guillén, F. (2013). A kingdom without a capital? Itineration and spaces of royal power in Castile, c. 1252–1350. *Journal of Medieval History*, 39(4):456–476.

Asbridge, T. (2012). *The Crusades: The war for the Holy Land*. Simon and Schuster.

Atran, S. (2016). The devoted actor: Unconditional commitment and intractable conflict across cultures. *Current Anthropology*, 57(S13):S192–S203.

Atran, S. and Ginges, J. (2012). Religious and sacred imperatives in human conflict. *Science*, 336(6083):855–857.

Ayres, R. U. and Ayres, R. U. (2020). The Age of Enlightenment: 1585–1789. *On Capitalism and Inequality: Progress and Poverty Revisited*, pages 27–39.

Backus, R. H., Clark, R. C., and Wing, A. S. (1965). Behaviour of certain marine organisms during the solar eclipse of July 20, 1963. *Nature*, 205:989–991.

Baldwin, M. W. and Setton, K. M. (2016). *A History of the Crusades, Volume 1: The First Hundred Years*, volume 1. University of Pennsylvania Press.

Barro, R. J. and McCleary, R. M. (2003). Religion and economic growth across countries. *American Sociological Review*, 68(5):760–781.

Bartlett, R. (2008). *The natural and the supernatural in the Middle Ages: the Wiles lectures given at the Queen's University of Belfast, 2006*. Cambridge Univ. Press.

Basedau, M., Gobien, S., and Prediger, S. (2018). The multidimensional effects of religion on socioeconomic development: A review of the empirical literature. *Journal of Economic Surveys*, 32(4):1106–1133.

Basedau, M., Pfeiffer, B., and Vüllers, J. (2016). Bad religion? Religion, collective action, and the onset of armed conflict in developing countries. *Journal of Conflict Resolution*, 60(2):226–255.

Bastian, J. (2020). The rise of working mothers and the 1975 earned income tax credit. *American Economic Journal: Economic Policy*, 12(3):44–75.

Bazzi, S., Fiszbein, M., and Gebresilasse, M. (2020). Frontier culture: The roots and persistence of "rugged individualism" in the United States. *Econometrica*, 88(6):2329–2368.

Beach, B. and Hanlon, W. W. (2022). Culture and the historical fertility transition. *The Review of Economic Studies*, 90(4):1669–1700.

Becker, S. O. and Pascali, L. (2019). Religion, division of labor, and conflict: Anti-Semitism in Germany over 600 years. *American Economic Review*, 109(5):1764–1804.

Becker, S. O., Rubin, J., and Woessmann, L. (2021). Religion in economic history: A survey. *The Handbook of Historical Economics*, pages 585–639.

Belloc, M., Drago, F., and Galbiati, R. (2016). Earthquakes, religion, and transition to self-government in Italian cities. *The Quarterly Journal of Economics*, 131(4):1875–1926.

Bénabou, R., Ticchi, D., and Vindigni, A. (2022). Forbidden fruits: The political economy of science, religion, and growth. *The Review of Economic Studies*, 89(4):1785–1832.

Benzell, S. G. and Cooke, K. (2021). A Network of Thrones: Kinship and Conflict in Europe, 1495-1918. *American Economic Journal: Applied Economics*, 13:102–133.

Bikos, K. (2023). Eclipses: What Is the Umbra? Available under `https://www.timeanddate.com/eclipse/umbra-shadow.html`.

Boerner, L., Rubin, J., and Severgnini, B. (2021). A time to print, a time to reform. *European Economic Review*, 138:103826.

Boerner, L. and Severgnini, B. (2015). Time for growth. *LSE Economic History Working Paper No. 222/2015*.

Bosker, M., Buringh, E., and Van Zanden, J. L. (2013). From Baghdad to London: Unraveling urban development in Europe, the Middle East, and North Africa, 800–1800. *Review of Economics and Statistics*, 95(4):1418–1437.

Braun, R. (2016). Religious minorities and resistance to genocide: The collective rescue of Jews in the Netherlands during the Holocaust. *American Political Science Review*, 110(1):127–147.

Brecke, P. (2012a). Notes regarding the Conflict Catalog. In *Hosted on Peter Brecke's website*.

Brecke, P. (2012b). Conflict Catalog (Violent Conflicts 1400 A.D. to the Present in Different Regions of the World). In *Centre for Global Economic History*.

Brewer, K. (2016). *Wonder and skepticism in the Middle Ages*. Routledge.

Bryan, G., Choi, J. J., and Karlan, D. (2021). Randomizing religion: the impact of Protestant evangelism on economic outcomes. *The Quarterly Journal of Economics*, 136(1):293–380.

Buc, P. (2023). Christianity's stamp: Of hybrids, traitors, false peace, massacres and other horrors. *History and Anthropology*, 34(1):123–144.

Bushman, B. J., Ridge, R. D., Das, E., Key, C. W., and Busath, G. L. (2007). When God sanctions killing: Effect of scriptural violence on aggression. *Psychological Science*, 18(3):204–207.

Caluori, N., Jackson, J. C., Gray, K., and Gelfand, M. (2020). Conflict changes how people view God. *Psychological Science*, 31(3):280–292.

Campante, F. and Yanagizawa-Drott, D. (2015). Does religion affect economic growth and happiness? Evidence from Ramadan. *The Quarterly Journal of Economics*, 130(2):615–658.

Campion, N. (2012). *Astrology and Cosmology in the World's Religions*. NYU Press.

Cesur, R., Freidman, T., and Sabia, J. J. (2020). War, traumatic health shocks, and religiosity. *Journal of Economic Behavior & Organization*, 179:475–502.

Chen, M. K. (2013). The effect of language on economic behavior: Evidence from savings rates, health behaviors, and retirement assets. *American Economic Review*, 103(2):690–731.

Clingingsmith, D., Khwaja, A. I., and Kremer, M. (2009). Estimating the impact of the Hajj: Religion and tolerance in Islam's global gathering. *The Quarterly Journal of Economics*, 124(3):1133–1170.

Contreras, J. and Henningsen, G. (1986). Forty-four thousand cases of the Spanish Inquisition (1540–1700): analysis of a historical data bank. *The Inquisition in Early Modern Europe: Studies on Sources and Methods*, pages 100–129.

Couprie, D. (2004). How Thales Was Able to "Predict" a Solar Eclipse Without the Help of Alleged Mesopotamian Wisdom. *Early Science and Medicine*, 9(4):321–337.

Cunnison, I. (1961). Kazembe and the Portuguese 1798–1832. *The Journal of African History*, 2(1):61–76.

D'Acunto, F., Prokopczuk, M., and Weber, M. (2019). Historical antisemitism, ethnic specialization, and financial development. *The Review of Economic Studies*, 86(3):1170–1206.

Dawkins, R. and Ward, L. (2006). *The god delusion*. Houghton Mifflin Company Boston.

Ducarme, F. and Couvet, D. (2020). What does 'nature' mean? *Palgrave Communications*, 6(1):1–8.

Dunnell, R. W., Elliott, M. C., Foret, P., and Millward, J. A. (2004). *New Qing Imperial History: The Making of Inner Asian Empire at Qing Chengde*. Routledge.

Durlauf, S. N., Kourtellos, A., and Tan, C. M. (2012). Is God in the details? A reexamination of the role of religion in economic growth. *Journal of Applied Econometrics*, 27(7):1059–1075.

Encyclopedia Britannica (2023a). Latin American literature.

Encyclopedia Britannica (2023b). Printing Press.

Encyclopedia Britannica (2023c). History of publishing.

Encyclopedia Judaica (2007). *Encyclopaedia Judaica, 2nd edition*. Keter Publishing House.

Enke, B. (2020). Moral values and voting. *Journal of Political Economy*, 128(10):3679–3729.

FamilySearch (2022). FamilySearch.org. Available under https://www.familysearch.org/.

Fernández, W., Castro, V., and Hidalgo, H. (1993). Air temperature and wind changes in Costa Rica during the total solar eclipse of July 11, 1991. *Earth, Moon, and Planets*, 63(2):133–147.

Finlay, K., Magnusson, L., and Schaffer, M. (2013). weakiv: Weak-instrument-robust tests and confidence intervals for instrumental-variable (IV) estimation of linear, probit and tobit models. *Published on REPEC*.

Finley, T. and Koyama, M. (2018). Plague, politics, and pogroms: The Black Death, the rule of law, and the persecution of Jews in the Holy Roman Empire. *The Journal of Law and Economics*, 61(2):253–277.

Fouka, V. (2019). How do immigrants respond to discrimination? The case of Germans in the US during World War I. *American Political Science Review*, 113(2):405–422.

Fouka, V. (2020). Backlash: The unintended effects of language prohibition in US schools after World War I. *The Review of Economic Studies*, 87(1):204–239.

Founda, D., Melas, D., Lykoudis, S., Lisaridis, I., Gerasopoulos, E., Kouvarakis, G., Petrakis, M., and Zerefos, C. (2007). The effect of the total solar eclipse of 29 March 2006 on meteorological variables in Greece. *Atmospheric Chemistry and Physics*, 7(21):5543–5553.

Fryer Jr, R. G. and Levitt, S. D. (2004). The causes and consequences of distinctively black names. *The Quarterly Journal of Economics*, 119(3):767–805.

Gennaro, G. and Ash, E. (2022). Emotion and reason in political language. *The Economic Journal*, 132(643):1037–1059.

Giorcelli, M., Lacetera, N., and Marinoni, A. (2022). How does scientific progress affect cultural changes? A digital text analysis. *Journal of Economic Growth*, 27(3):415–452.

Gorodnichenko, Y. and Roland, G. (2011). Which dimensions of culture matter for long-run growth? *American Economic Review*, 101(3):492–498.

Graham, J., Haidt, J., and Nosek, B. A. (2009). Liberals and conservatives rely on different sets of moral foundations. *Journal of Personality and Social Psychology*, 96(5):1029.

Grosfeld, I., Sakalli, S. O., and Zhuravskaya, E. (2020). Middleman minorities and ethnic violence: Anti-Jewish pogroms in the Russian Empire. *The Review of Economic Studies*, 87(1):289–342.

Guiot, J., Corona, C., and members, E. (2010). Growing season temperatures in Europe and climate forcings over the past 1400 years. *PloS one*, 5(4):e9972.

Guiso, L., Sapienza, P., and Zingales, L. (2003). People's opium? Religion and economic attitudes. *Journal of Monetary Economics*, 50(1):225–282.

Hacker, J. D. (1999). Child naming, religion, and the decline of marital fertility in nineteenth-century America. *The History of the Family*, 4(3):339–365.

Hamacher, D. W. and Norris, R. P. (2011). Eclipses in Australian aboriginal astronomy. *arXiv preprint arXiv:1105.2635*.

Hanks, P., Hodges, F., and Hardcastle, K. (2006). *A dictionary of first names*. Oxford University Press.

Harding, V. (1990). The population of London, 1550–1700: A review of the published evidence. *The London Journal*, 15(2):111–128.

Hartstone-Rose, A., Dickinson, E., Paciulli, L. M., Deutsch, A. R., Tran, L., Jones, G., and Leonard, K. C. (2020). Total Eclipse of the Zoo: Animal Behavior during a Total Solar Eclipse. *Animals*, 10(4):587.

Henrich, J., Bauer, M., Cassar, A., Chytilová, J., and Purzycki, B. G. (2019). War increases religiosity. *Nature Human Behaviour*, 3(2):129–135.

Hoffman, M. (2011). Does higher income make you more altruistic? Evidence from the Holocaust. *Review of Economics and Statistics*, 93(3):876–887.

Hucker, C. O. (1958). Governmental organization of the Ming dynasty. *Harvard Journal of Asiatic Studies*, 21:1–66.

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

International Biblical Association (2023). The Bible – bilingual.

Isaqzadeh, M. (2021). Reassessing the Relationship Between Religiosity and Political Violence: Evidence from Afghanistan. Technical report, Working Paper.

Iyer, S. (2016). The new economics of religion. *Journal of Economic Literature*, 54(2):395–441.

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

Iyigun, M., Nunn, N., and Qian, N. (2017). Winter is coming: The long-run effects of climate change on conflict, 1400-1900. Technical report, National Bureau of Economic Research.

Jackson, J. C., Gelfand, M., De, S., and Fox, A. (2019). The loosening of American culture over 200 years is associated with a creativity-order trade-off. *Nature Human Behaviour*, 3(3):244–250.

Jedwab, R., Johnson, N. D., and Koyama, M. (2019). Negative shocks and mass persecutions: Evidence from the Black Death. *Journal of Economic Growth*, 24:345–395.

Jenkins, P. (2014). *The Great and Holy War: How World War I Became a Religious Crusade*. Harper Collins.

Johnson, D. and Krüger, O. (2004). The good of wrath: Supernatural punishment and the evolution of cooperation. *Political Theology*, 5(2):159–176.

Jubier, X. M. (2020). Five Millennium (−1999 to +3000) Canon of Solar Eclipses Database. In *Retrieved online in March 2020*.

Kaplan, B. J. (2007). *Divided by faith: Religious conflict and the practice of toleration in early modern Europe*. Harvard University Press.

Kivikangas, J. M., Fernández-Castilla, B., Järvelä, S., Ravaja, N., and Lönnqvist, J.-E. (2021). Moral foundations and political orientation: Systematic review and meta-analysis. *Psychological Bulletin*, 147(1):55.

Kleibergen, F. and Paap, R. (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of Econometrics*, 133(1):97–126.

Kowalska-Pietrzak, A. (2007). History of Poland During the Middle Ages. *Poland: History, Culture and Society. Lodz: Wydawnictwo Uniwersytetu Łódzkiego*.

Landry, A. P., Orr, R. I., and Mere, K. (2022). Dehumanization and mass violence: A study of mental state language in Nazi propaganda (1927–1945). *PLoS one*, 17(11):e0274957.

Leeson, P. T. and Russ, J. W. (2018). Witch trials. *The Economic Journal*, 128(613):2066–2105.

Leetaru, K. (2011). Culturomics 2.0: Forecasting large-scale human behavior using global news media tone in time and space. *First Monday*.

Lieberson, S. (2000). *A matter of taste: How names, fashions, and culture change*. Yale University Press.

Litina, A. and Fernández, È. R. (2020). Celestial enlightenment: Eclipses, curiosity and economic development among pre-modern ethnic groups. *Working Paper*.

Magness, P. W. and Makovi, M. (2023). The Mainstreaming of Marx: Measuring the effect of the Russian Revolution on Karl Marx's influence. *Journal of Political Economy*, 131(6):000–000.

Magnusson, L. M. (2010). Inference in limited dependent variable models robust to weak identification. *The Econometrics Journal*, 13(3):S56–S79.

Martin, D. (2006). *Does Christianity cause war?* Regent College Publishing.

McCleary, R. M. and Barro, R. J. (2006). Religion and economy. *Journal of Economic Perspectives*, 20(2):49–72.

McCluskey, S. C. (2000). *Astronomies and cultures in early medieval Europe*. Cambridge University Press.

McEvedy, C., Jones, R., et al. (1978). *Atlas of world population history*. Penguin Books Ltd, Harmondsworth, Middlesex, England.

McNamara, R. A., Norenzayan, A., and Henrich, J. (2016). Supernatural punishment, in-group biases, and material insecurity: Experiments and ethnography from Yasawa, Fiji. *Religion, Brain & Behavior*, 6(1):34–55.

Michel, J.-B., Shen, Y. K., Aiden, A. P., Veres, A., Gray, M. K., Pickett, J. P., Hoiberg, D., Clancy, D., Norvig, P., and Orwant, J. (2011). Quantitative analysis of culture using millions of digitized books. *Science*, 331(6014):176–182.

Miguel, E. (2005). Poverty and witch killing. *The Review of Economic Studies*, 72(4):1153–1172.

Mitchell, S. (2019). London calling? Agglomeration economies in literature since 1700. *Journal of Urban Economics*, 112:16–32.

Morrison, L. and Stephenson, F. R. (2001). Historical eclipses and the variability of the Earth's rotation. *Journal of Geodynamics*, 32(1-2):247–265.

Mostert, R. (1989). On the naked-eye visibility of a partial eclipse. *Quarterly Journal of the Royal Astronomical Society*, 30:113.

Mozaffari, S. M. (2013). Historical annular solar eclipses. *Journal of the British Astronomical Association*, 123(1):33–37.

Murdin, P. (2001). Effects of the 2001 total solar eclipse on African wildlife. *Astronomy & Geophysics*, 42(4):4–4.

Naidu, S., Hwang, S.-H., and Bowles, S. (2017). The evolution of egalitarian sociolinguistic conventions. *American Economic Review*, 107(5):572–577.

NASA (2023a). Types of Solar Eclipses. Available under `https://solarsystem.nasa.gov/eclipses/about-eclipses/types/`.

NASA (2023b). Questions Frequently Asked by the Public About Eclipses. Available under `https://sunearthday.nasa.gov/2006/faq.php`.

New World Encyclopedia (2020). Transylvania — New World Encyclopedia. [Online; accessed 18-November-2021].

Nexon, D. H. (2009). *The struggle for power in early modern Europe: religious conflict, dynastic empires, and international change*. Princeton University Press.

Nilsson, C., Horton, K. G., Dokter, A. M., Van Doren, B. M., and Farnsworth, A. (2018). Aeroecology of a solar eclipse. *Biology Letters*, 14(11):20180485.

Norenzayan, A. (2013). *Big gods: How religion transformed cooperation and conflict*. Princeton University Press.

Norenzayan, A. and Shariff, A. F. (2008). The origin and evolution of religious prosociality. *Science*, 322(5898):58–62.

Norenzayan, A., Shariff, A. F., Gervais, W. M., Willard, A. K., McNamara, R. A., Slingerland, E., and Henrich, J. (2016). The cultural evolution of prosocial religions. *Behavioral and Brain Sciences*, 39:e1.

Oster, E. (2004). Witchcraft, weather and economic growth in Renaissance Europe. *Journal of Economic Perspectives*, 18(1):215–228.

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

Pasachoff, J. M. (1999). Halley as an eclipse pioneer: his maps and observations of the total solar eclipses of 1715 and 1724. *Journal of Astronomical History and Heritage*, 2(1):39–54.

Pasachoff, J. M. (2009). Solar eclipses as an astrophysical laboratory. *Nature*, 459(7248):789–795.

Pennebaker, J. W., Boyd, R. L., Jordan, K., and Blackburn, K. (2015). The development and psychometric properties of LIWC2015. Technical report.

Pinker, S. (2011). *The better angels of our nature: The decline of violence in history and its causes*. Penguin UK.

Purzycki, B. G., Apicella, C., Atkinson, Q. D., Cohen, E., McNamara, R. A., Willard, A. K., Xygalatas, D., Norenzayan, A., and Henrich, J. (2016). Moralistic gods, supernatural punishment and the expansion of human sociality. *Nature*, 530(7590):327–330.

Querejeta, M. (2011). On the eclipse of Thales, cycles and probabilities. *Culture and Cosmos*, 15(1):5–16.

Riley-Smith, J. and Throop, S. A. (2022). *The crusades: A history*. Bloomsbury Publishing.

Roes, F. L. and Raymond, M. (2003). Belief in moralizing gods. *Evolution and Human Behavior*, 24(2):126–135.

Roozen, B. and Shulman, H. C. (2014). Tuning in to the RTLM: Tracking the evolution of language alongside the Rwandan genocide using social identity theory. *Journal of Language and Social Psychology*, 33(2):165–182.

Saler, B. (1977). Supernatural as a Western category. *Ethos*, 5(1):31–53.

Shahbazi, A. S. and Bosworth, C. E. (1990). Capital cities.

Sinopoli, C. M. (1994). Monumentality and mobility in Mughal capitals. *Asian Perspectives*, pages 293–308.

Skali, A. (2017). Moralizing gods and armed conflict. *Journal of Economic Psychology*, 63:184–198.

Smith, A. (1982). Essays on philosophical subjects [EPS][Edited by WPD Wightman and JC Bryce]. *Indianapolis, IN: Liberty Fund (Original work published in 1980)*.

Squicciarini, M. P. (2020). Devotion and development: Religiosity, education, and economic progress in nineteenth-century France. *American Economic Review*, 110(11):3454–91.

Steele, J. M. (1998). Observations and predictions of eclipse times by astronomers in the pre-telescopic period.

Stephenson, F. R. (1997). *Historical eclipses and Earth's rotation*, volume 64. Cambridge University Press Cambridge.

Stifter, A. and Holland, J. (2015). The Solar Eclipse on July 8th, 1842. *Configurations*, 23(2):253–258.

Stock, J. H. and Wright, J. H. (2000). GMM with weak identification. *Econometrica*, 68(5):1055–1096.

Tabellini, G. (2008). Institutions and culture. *Journal of the European Economic Association*, 6(2-3):255–294.

Tausczik, Y. R. and Pennebaker, J. W. (2010). The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology*, 29(1):24–54.

Top Ten Reviews (2023). Best genealogy sites 2023.

Transcripture International (2023). The Bible – bilingual.

Turmunkh, U., Van den Assem, M. J., and Van Dolder, D. (2019). Malleable lies: Communication and cooperation in a high stakes TV game show. *Management Science*, 65(10):4795–4812.

Tyerman, C. (2013). *The Debate on the Crusades, 1099–2010*. Manchester University Press.

Urquhart, P. and Heyer, P. (2018). *Communication in history: Stone age symbols to social media*. Routledge.

Voigtländer, N. and Voth, H.-J. (2012). Persecution perpetuated: The medieval origins of anti-Semitic violence in Nazi Germany. *The Quarterly Journal of Economics*, 127(3):1339–1392.

Voigtländer, N. and Voth, H.-J. (2013). Gifts of Mars: Warfare and Europe's early rise to riches. *Journal of Economic Perspectives*, 27(4):165–186.

Voigtländer, N. and Voth, H.-J. (2015). Nazi indoctrination and anti-Semitic beliefs in Germany. *Proceedings of the National Academy of Sciences*, 112(26):7931–7936.

Waldinger, M. (2022). The economic effects of long-term climate change: evidence from the Little Ice Age. *Journal of Political Economy*, 130(9):2275–2314.

Waldron, J. (2012). *The harm in hate speech*. Harvard University Press.

Walters, A. N. (1999). Ephemeral events: English broadsides of early eighteenth-century solar eclipses. *History of Science*, 37(1):1–43.

Waytz, A., Iyer, R., Young, L., Haidt, J., and Graham, J. (2019). Ideological differences in the expanse of the moral circle. *Nature Communications*, 10(1):1–12.

Woodberry, R. D. (2012). The missionary roots of liberal democracy. *American Political Science Review*, 106(2):244–274.

Wooldridge, J. M. (2015). *Introductory econometrics: A modern approach*. Cengage learning.

Younes, N. and Reips, U.-D. (2019). Guideline for improving the reliability of Google Ngram studies: Evidence from religious terms. *PloS One*, 14(3):e0213554.

Young, C. (2009). Model uncertainty in sociological research: An application to religion and economic growth. *American Sociological Review*, 74(3):380–397.

Appendix A: Religiosity Dictionaries and Frequencies

Judaism-specific terminology is highlighted in *italics*, Islam-specific terminology is highlighted in **bold**, and stems are indicated with an asterisk.

A1: Original English

afterlife, agnostic*, **alla**, **allah**, altar, amen, amish, angel, angelic, angels, baptism, baptisms, baptise*, baptize*, belief, beliefs, bible, biblical, biblically, bishop, bless*, buddha, buddhist, buddhistic, buddhism, catholic, catholicism, chapel*, chaplain*, christ, christen*, christian, christmas*, church*, clergy*, confess*, convent*, crucify*, crucifix, crucifixion, crusade*, crusader*, demon, demonic, devil*, divine, divinity, doom*, doomsday, episcopal, episcopalian, evangelical, evangelicals, evangelist, evangelists, evangelism, faith, faiths, faithful, fundamentalist, fundamentalists, fundamentalism, gentile, gentiles, god, gods, goddess, goddesses, gospel*, *hashanah*, heaven, heavens, hell, hellish, hells, hindu, hinduism, holier, holiest, holy, hymn, hymns, **imam**, **imams**, immoral, immorality, immortal, immortality, **islam**, jesuit, jesuits, jesus, *jew*, *jewish*, *jews*, **jihad**, **jihadi**, *judah*, *judas*, *judaism*, karma, *kippur*, **koran**, *kosher*, krishna, krisna, lord, lutheran, lutherans, **mecca**, meditate*, meditation, mennonite, mennonites, merciful, mercifully, mercy, methodist, methodists, minister, ministers, ministry, ministries, missionary, *mitzvah*, **mohammad**, monastic, monastery, monasticism, monk, monks, moral, morality, morals, mormon, mormons, mormonism, **mosque**, **mosques**, **muhammad**, **mujahid**, **mujahideen**, **muslim**, **muslims**, nun, nuns, orthodox, pagan, papal, paradise, *passover*, pastor, pastoral, pastoralism, pastoralist, penance, pentecost, pentecostal, pentecostalism, pew, pews, piety, pilgrim, pilgrims, pilgrimage, pious, pope, pray*, prayer, prayers, preach*, preacher, preachers, presbyterian, presbyterianism, priest, priests, prophet, prophets, prophetic, protestant, protestants, protestantism, psalm, psalms, purgatorial, purgatory, puritan, puritans, puritanical, puritanism, **quran**, *rabbi*, *rabbis*, *rabbinical*, **ramadan**, religion, religious, religiosity, rite, rites, ritual, rituals, ritualistic, rosary, rosaries, *sabbath*, sacred, sacrifice*, sacrificial, saint, saints, salvation, satan, satanic, scripture, scriptures, sect, sects, sectarian, seminary, **shiite**, **shia**, shrine, sikh, sin*, sinful, sinner, sinners, soul, souls, spirit, spirits, spiritual, spirituals, spiritualistic, **sunni**, **sunnis**, temple, temples, testament, theology, theologian, theologist, theological, *torah*, vatican, **veil***, worship*, *yiddish*, zen, *zion*, *zionist*, *zionism*, *zionic*

A2: Spanish

agnóstico*, altar*, monaguillo*, angelito*, ultratumba, agnosticismo, **alá**, retablo, presbiterio, palia, sabanilla, angelizar*, angélico*, angelical*, luminaria, cirio, amén, amish, ángel, arcángel, angelote, serafín*, querubín*, angelología, angelicalmente, ángeles, arcángeles, angelotes, bautizar*, baptizar*, creer*, biblíco*, bautismo*, bautizo*, bautismal*, bautista*, bautisterio*, baptismal*, baptismo*, baptista*, baptisterio*, baptizador*, creencia*, creyente*, biblia, biblista*, obispo*, obispar*, bendecir*, bendecidor*, obispado*, obispal*, obispalía*, arzobispo*, arzobispado*, arzobispal*, episcopal*, episcopado*, episcopalismo, bendición*, consagración*, consagramiento*, buda, budismo, budista*, consagrar*, consagratorio*, católico*, catolicismo, catolicidad, católicamente, capilla*, oratorio*, capillero*, ermitaño*, cristianar*, cristiano*, ermita*, capilleta, eremita*, eremitorio*, capellán*, capellanía*, cristo, jesucristo, cristianería, cristianizar*, cristianego*, navideño*, eclesiástico*, feligrés*, cristiandad, cristianismo, cristianerías, cristianización, navidad*, nochebuena, villancico*, iglesia*, templo*, parroquia*, congregación*, ecclesial*, eclesiásticamente, practicante*, clero, clerecía, clerical*, clerófobo*, confesar*, clérigo*, clericalismo, clericato*, clericatura*, clerizón*, clerizonte*, clerigalla, cleriguicia, an-

ticlerical*, anticlericalismo, clerofobia, confesión*, confessional*, confesionario*, confesante*, confesionalidad*, confesionalismo, confesionista*, confesuría, convento*, conventual*, confesor*, crucificar*, demonio*, demonizar*, abadía*, conventualidad, crucifijo*, cruz, cruces, crucifixión*, cruciferario*, crucifixor*, cruzada*, cruzado*, demontre*, demonche*, demonismo, demonización*, demonolatría, demonólatra*, endemoniar*, demonológico*, demonólogo*, demonología, demonomancia, demonomanía, demonial*, diabla, demoníaco*, diablo*, diabólico*, satanás, lucifer, belcebú, mefistófeles, belial, diablos, diablada*, diabólicamente, diablura*, diantre*, endiablar*, diablear*, diablillo*, diablesco*, divino*, divinizar*, divinizador*, divinidad*, divinal*, divinamente, divinización, condenación, condenar*, evangelizar*, evangelizador*, pagano*, condenable*, episcolapismo*, episcopio*, episcopologio*, arquiepiscopal*, evangelio*, evangelista*, evangelización, evangeliario*, evangelistero*, fe, fiel*, fidelidad, fundamentalismo*, fundamentalista*, gentil*, deidad*, *judío**, dios*, gospel, cielo, paraíso, celestial*, celeste*, celestialmente, infierno*, infernal*, hinduismo, infernar*, inferno*, averno*, hinduista*, santísimo, santísima, sacral*, santurrón*, sagrado*, santo*, sacralizar*, **islámico***, **islamizar***, sacralidad*, sacralización*, sacramente, sagradamente, sagrario, himno*, himnario*, himnodia*, salve*, salterio*, cantico*, cantoral*, **imán***, inmoral*, inmoralidad*, amoral*, amoralidad*, amoralismo, inmortal*, inmortalidad, inmortalmente, islamista*, islamismo, **islam**, **islamita**, **islamólogo***, jesuítico*, jesuitina*, islamitas, **islamización**, **islamología**, jesuita*, jesuitismo, jesús, *hebreo**, *judaizar**, *hebraizar**, *judaico**, *judaísmo*, *judaización*, *judaizante**, *hebraísmo*, *hebraizante**, *hebraísta**, **yihad**, **yihadista***, *hebraico**, kármico*, **coránico***, **yihadismo**, *judá*, karma, *kippur*, corán, *kosher*, luterano*, meditar*, meditativo*, meditador*, krishna, krishnaísmo, krisná, krisnaísmo, krisnaísta*, luteranismo, **meca**, meditación*, menonita*, mennón, misericorde, misericordioso*, apiadar*, apiadarse*, misericordes, misericordiosamente, píamente, piadosamente, misericordia, piedad, caridad, pío*, piadoso*, caritativo*, ministrar*, merced, metodista*, metodismo, ministro*, ministril*, ministerial*, pastor*, apostolado, misional*, *mitzva*, **mahoma**, misionero*, misionar*, **mahometano***, **mahomético***, **mohammed**, **mahometismo**, **mahometista***, monasterio*, monacato, **mahometizar***, monástico*, ético*, ascetismo, monasterial*, monje*, fraile*, monacal*, monjía, moral*, virtud*, ética, moralista*, moralismo, moralmente, moralizar*, moralizador*, mormón*, mormónico*, moralizante*, moralidad, valores, principios, moralina, mormonismo, **mezquita***, **aljama***, **muyahid**, **musulmán***, ortodoxo*, **muyahidín**, monja*, abadesa*, novicia*, monjerío*, monjil*, monjío, noviciado, novitiate, ortodoxia, paganismo, paganía, paganización*, paganizar*, hereje*, paradisíaco*, edénico*, herejía*, papal*, pontifical*, edén, pascua, sacerdote*, penitenciar*, penitenciario*, peregrino*, cura*, párroco*, pastoral*, pastoralista*, pastoralmente, penitencia*, mortificación*, arrepentimiento*, penitencial*, penitente*, pentecostés, pentecostal*, religiosidad, devoción*, pietista*, pietismo, devocional*, devocionario*, devotería, peregrinación*, peregrinar*, devoto*, pío*, peregrinaje*, peregrinidad, papas, papisa*, pontificio*, papado*, pontífice*, pontificador*, orar*, pontificado*, pontificación*, pontificalmente, pontificial*, oración*, rezo*, plegaria*, alabar*, rezador*, oracionero*, jaculatoria*, ruego*, alabado*, rezado*, rezadera*, orante*, oracional*, predicar*, sermonear*, predicador*, predicación*, predicante*, predicatorio*, prédica, presbiteriano*, profeta*, profético*, prédicas, presbiterianismo, preste*, sacerdotal*, sacerdocio*, parroquial*, profecía*, profetismo, protestante*, protestantismo, salmo*, salmista, profetizar*, profetizador*, salmear*, salmodiar*, salmistas, salmodia*, purgatorio, puritanismo, *rabí*, puritano*, *rabínico**, *rabíes*, *rabino**, *rabinismo*, *rabinista**, **ramadán**, religioso*, religionario*, ritualizar*, rosariero*, religión*, religiosamente, religiosidad, rito*, ritual*, ritualidad, ritualismo, ritualista*, rosario*, *hashaná*, *sabbat*, *shabat*, sacrificio*, sacrificar*, inmolar*, sacrificial, inmolación*, ofrenda*, santidad, santero*, santificar*, santificador*, santería, santamente, santificable*, santificación, santificante*, salvador*, satánico*, salvación, salvacionista*, satán, satanismo, satanización, escritura*,

secta*, sectarismo, satanizar*, sectario*, sectador*, pecar*, seminario*, seminarista*, **chií***, **chiita***, **chiismo**, santuario*, sagrarios, sanctasanctórum, relicario*, humilladero*, sij, sijismo, pecado*, pecable*, pecaminosidad, pecante*, pecatriz*, pecaminoso*, pecador*, pecadorizo*, espiritualizar*, templario*, teólogo*, teológico*, alma*, ánima*, espíritu*, espiritual*, espiritualidad, espiritualismo, espiritualista*, espiritualización, espiritualmente, **suni***, **sunita***, testamento*, teología, teologismo, teologal*, teológicamente, *torá*, vaticanismo, vaticanista*, teologizar*, vaticano*, velar*, velo*, velación*, alabanza*, adorar*, venerar*, adoración*, culto*, adorable*, adorante*, adoratorio, venerador*, alabador*, venerable*, venerablemente, veneración*, alabamiento*, alabancia*, *yiddish*, *yidish*, *yidis*, zen, *sión*, *sionismo*, *sionista**, rezar*, rogar*, adorador*

A3: French

l'après-vie, l'au-delà, outre-tombe, agnostique, agnosticime, agnostiquement, angélique*, baptiser*, croire*, croyance*, **allah**, autel, amen, amish, ange, séraphin, séraphique, angéliquement, séraphiquement, anges, séraphins, baptême, foi, conviction, bible*, biblique*, bénir*, croyant, évangile, évangélique, êvêque, bénédiction, bénédicité, bouddha, confesser*, crucifier*, diable*, condamner*, bouddhisme, bouddhiste, catholique, catholisme, catholiquement, chapelle, aumonier, chapelain, christ, chrétien, chrétienté, christianisme, noël, église, clergé, confession, confessional, confessable, couvent, couvents, crucifix, crucifixion, crucifiement, crucifié, croisade, croisé, démon, démoniaque, démoniaquement, démons, diabolique, diaboliquement, divin, divinité, divinement, destin, destinée, fatalité, épiscopal, évangélisation, évangéliser*, hymne*, immoral*, évangéliste, épiscopalien, principes, fondamentaux, fondamentaliste, fondamentalisation, gentil, dieu, déesse, gospel, *hachana*, *hashānāh*, paradis, paradisiaque, enfer, infernal, enfers, hindu, hindouiste, hindou, hindouisme, sainteté, sacré, saint, hymnique, **imam**, **imamique**, immoralité, immoralisme, immoraliste, immoralement, immortel*, *juif**, **djihad***, méditer*, immortellement, **islam**, **islamiste**, **islamique**, **islamiquement**, jésuite, jésus, *judaïque*, *judaïsme*, *judaïquement*, **djihadisme**, **djihadiste**, *juda*, karma, *kippur*, *kippour*, **coran**, *kasher*, *casher*, krishna, seigneur, luthérien, luthéranisme, **mecque**, méditation, mennonite, missionner*, mormon*, orthodoxe*, mennonisme, impitoyable, impitoyablement, pitié, miséricorde, clémence, méthodisme, méthodiste, pasteur, pastoral, pastoralement, missionnaire, *mitzvah*, **mahomet**, **muhammad**, **mohammed**, **mahométisme**, **mahométan**, monastère, moine, moral, moralement, moralité, moraux, mormonisme, **mosquée**, **mujahid**, **moudjahid**, **moudjahidine**, **musulman**, **musulmanisme**, nonne, religieuse, nonnes, soeur, soeurs, religieuses, orthodoxie, paganisme, impie, païennement, païen*, pèleriner*, prier*, papal, *pessa'h*, pénitence, contrition, mortification, pentecôte, banc, bancs, piété, pieux, pèlerin, pèlerinage, religieux, dévot, pape, papauté, pontife, prière, prieur, prêcheur, prêche, pontifical, prêcher*, prêtre*, purger*, expier*, presbytère, presbytérianisme, presbytérien, curé, abbé, desservant, officiant, prophétie, prophète, prophétique, prophétiquement, protestant, protestantisme, psaume, purgatoire, expiation, purification, purgatif, puritanisme, puritain, sacrifier*, pécher*, testamenter*, voiler*, **coranique**, *rabbin*, *rabbinique*, *rabbins*, **ramadan**, religion, religieusement, rite, coutume, rites, coutumes, rituel, ritualité, rituellement, chapelets, rosaires, chapelet, rosaire, sabbat, shabbat, chabbat, sabbatique, consacré, sacrifice, abnégation, sacrifiable, sainement, salut, satan, satanisme, satanique, sataniquement, scriptural, secte, sectaire, sectarisme, sectes, séminaire, **shi'ism**, **shi'a**, **chiisme**, **shiite**, **chiite**, sanctuaire, mausolée, sikh, sikhe, sikhisme, pécheur, péchés, âme, esprit, âmes, esprits, spirituel, spirituellement, **sunnite***, temple, testament, testamentaire, théologie, théologien, théologique, théologiquement, *torah*, *torahique*, vatican, voile, culte, adoration, yiddish, adorer*, vénérer*, célébrer*, zen, *zion*, *sion*, *sionisme*, *sioniste*

A4: German

nachleben*, agnostisch*, altar*, engel*, agnostizismus, agnostiker, agnostikerin, **allah**, amen, amish, engelhaft, taufen*, glauben*, bibel*, taufe, baptist, glaube, überzeugung, biblisch, bischof, segnen*, bekennen*, beichten*, kreuzigen*, bischöfe, bistum, segen, buddhist, buddhismus, buddha, katholisch, katholizismus, katholik, katholiken, katholizität, kapelle, kapellen, kaplan, kapläne, seelsorge, geistlicher, geistliche, pfarrer, christus, jesus, christenheit, christ, christin, christlich, weihnachten, heiligabend, weihnachtsbaum, kirche, kirchen, kirchlich, gottesdienst, geistlichkeit, klerus, kloster, konvent, nonnenkloster, frauenkloster, konvention, konventionell, konventionen, klöster, göttlich*, bischöflich*, episkopal*, kruzifix, kreuzigung, kreuz, kreuzzug, kreuzritter, kreuzzüge, missionsfeldzug, dämon, dämonen, teufel, ungeist, dämonisch, dämonische, dämonischer, teuflisch, teuflische, teuflischer, teuflisches, gottheit, untergang, schicksal, verhängnis, verderben, evangelist, evangelion, fundamentalist, fundamentalismus, evangelisch*, nichtjüdisch*, nichtmormonisch*, nichtjude, heide, nichtmormone, gott, götze, gottes, göttin, höllisch*, hinduistisch*, heilig*, *hashanah*, himmel, hölle, hindu, hymne, **imam**, **islam**, geweiht*, gottgefällig*, unsterblich*, unvergänglich*, ewig*, unmoralisch*, unsittlich*, amoralisch*, sittenlos*, **islamisch***, **mohammedaner**, jesuit, jesuiten, *jude*, *jüdin*, *juden*, *jüdinnen*, jesuitisch*, *jüdisch**, lutherisch*, meditieren*, **dschihad**, *judentum*, *judas*, *judenpriester*, karma, *kippur*, **koran**, *koscher*, krishna, lord, lutheraner, luthertum, **mekka**, meditation, mennoniten, barmherzigkeit, gnade, erbarmen, methodist, methodistin, barmherzig*, gnädig*, methodistisch*, moralisch*, sittlich*, mormonisch*, rechtgläubig*, pastor, missionar, missionare, *mizwa*, mönch, mönche, ordensbruder, ordensbrüder, moral, sittlichkeit, moralität, ethik, moralismus, sitten, moralvorstellungen, moralvorstellung, mormone, mormonen, **moschee**, **moscheen**, **mujahed**, **muslim**, **muslime**, nonne, nonnen, ordensschwester, ordensschwestern, heidin, orthodox*, heidnisch*, päpstlich*, paradies, *passah*, pastorin, pastorinnen, pastoren, seelsorger, seelsorgerin, papistisch*, fromm*, pilgern*, andächtig*, seelenhirte, seelenhirt, seelenhirten, buße, pfingsten, erntefest, pfingstkirche, kirchenbank, kirchenbänke, frömmigkeit, pietät, pietismus, pilger, wallfahrer, andacht, pietätvoll, papst, päpste, gebet, prediger, beten*, predigen*, presbyterianisch*, prophezeien*, protestantisch*, predigt, presbyterianer, priester, priesterin, priestertum, prophet, prophezeiung, puritanisch*, *rabbinisch**, religiös*, protestant, psalm, psalmen, fegefeuer, puritaner, puritanerin, *rabbi*, *rabbiner*, **ramadan**, religion, religionen, kult, ritus, rituell*, opfern*, aufopfern*, zeremonie, riten, ritual, rituale, rosenkranz, rosenkränze, *sabbat*, *sabbattag*, heiligkeit, opfer, opfergabe, sankt, erlösung, seeligkeit, satanisch*, sektiererisch*, konfessionell*, satan, satanismus, sekte, sekten, seminar, schrein, grab, **schiitisch***, sündigen*, testamentarisch*, grabstätte, grabaltar, grabkapelle, heiligtum, sikh, sünde, schuld, versündigung, frevel, sünder, sünden, seele, seelen, geist, spiritus, **sunni**, **sunnit**, tempel, gotteshaus, bethaus, testament, theologe, theologin, *tora*, vatikan, vatikanstadt, **schleier**, theologisch*, verschleiern*, *jiddisch**, anbetung, zen, *zion* nachleben*, agnostisch*, altar*, engel*, agnostizismus, agnostiker, agnostikerin, **allah**, amen, amish, engelhaft, taufen*, glauben*, bibel*, taufe, baptist, glaube, überzeugung, biblisch, bischof, segnen*, bekennen*, beichten*, kreuzigen*, bischöfe, bistum, segen, buddhist, buddhismus, buddha, katholisch, katholizismus, katholik, katholiken, katholizität, kapelle, kapellen, kaplan, kapläne, seelsorge, geistlicher, geistliche, pfarrer, christus, jesus, christenheit, christ, christin, christlich, weihnachten, heiligabend, weihnachtsbaum, kirche, kirchen, kirchlich, gottesdienst, geistlichkeit, klerus, kloster, konvent, nonnenkloster, frauenkloster, konvention, konventionell, konventionen, klöster, göttlich*, bischöflich*, episkopal*, kruzifix, kreuzigung, kreuz, kreuzzug, kreuzritter, kreuzzüge, missionsfeldzug, dämon, dämonen, teufel, ungeist, dämonisch, dämonische, dämonischer, teuflisch, teuflische, teuflischer, teuflisches, gottheit, untergang, schicksal, verhängnis, verderben, evangelist, evangelion, fundamentalist, fundamentalismus, evangelisch*, nichtjüdisch*, nicht-

mormonisch*, nichtjude, heide, nichtmormone, gott, götze, gottes, göttin, höllisch*, hinduistisch*, heilig*, *hashanah*, himmel, hölle, hindu, hymne, **imam**, **islam**, geweiht*, gottgefällig*, unsterblich*, unvergänglich*, ewig*, unmoralisch*, unsittlich*, amoralisch*, sittenlos*, **islamisch***, **mohammedaner**, jesuit, jesuiten, *jude*, *jüdin*, *juden*, *jüdinnen*, jesuitisch*, *jüdisch**, lutherisch*, meditieren*, **dschihad**, *judentum*, *judas*, *judenpriester*, karma, *kippur*, **koran**, *koscher*, krishna, lord, lutheraner, luthertum, **mekka**, meditation, mennoniten, barmherzigkeit, gnade, erbarmen, methodist, methodistin, barmherzig*, gnädig*, methodistisch*, moralisch*, sittlich*, mormonisch*, rechtgläubig*, pastor, missionar, missionare, *mizwa*, mönch, mönche, ordensbruder, ordensbrüder, moral, sittlichkeit, moralität, ethik, moralismus, sitten, moralvorstellungen, moralvorstellung, mormone, mormonen, **moschee**, **moscheen**, **mujahed**, **muslim**, **muslime**, nonne, nonnen, ordensschwester, ordensschwestern, heidin, orthodox*, heidnisch*, päpstlich*, paradies, *passah*, pastorin, pastorinnen, pastoren, seelsorger, seelsorgerin, papistisch*, fromm*, pilgern*, andächtig*, seelenhirte, seelenhirt, seelenhirten, buße, pfingsten, erntefest, pfingstkirche, kirchenbank, kirchenbänke, frömmigkeit, pietät, pietismus, pilger, wallfahrer, andacht, pietätvoll, papst, päpste, gebet, prediger, beten*, predigen*, presbyterianisch*, prophezeien*, protestantisch*, predigt, presbyterianer, priester, priesterin, priestertum, prophet, prophezeiung, puritanisch*, *rabbinisch**, religiös*, protestant, psalm, psalmen, fegefeuer, puritaner, puritanerin, *rabbi*, *rabbiner*, **ramadan**, religion, religionen, kult, ritus, rituell*, opfern*, aufopfern*, zeremonie, riten, ritual, rituale, rosenkranz, rosenkränze, *sabbat*, *sabbattag*, heiligkeit, opfer, opfergabe, sankt, erlösung, seeligkeit, satanisch*, sektiererisch*, konfessionell*, satan, satanismus, sekte, sekten, seminar, schrein, grab, **schiitisch***, sündigen*, testamentarisch*, grabstätte, grabaltar, grabkapelle, heiligtum, sikh, sünde, schuld, versündigung, frevel, sünder, sünden, seele, seelen, geist, spiritus, **sunni**, **sunnit**, tempel, gotteshaus, bethaus, testament, theologe, theologin, *tora*, vatikan, vatikanstadt, **schleier**, theologisch*, verschleiern*, *jiddisch**, anbetung, zen, *zion* nachleben*, agnostisch*, altar*, engel*, agnostizismus, agnostiker, agnostikerin, **allah**, amen, amish, engelhaft, taufen*, glauben*, bibel*, taufe, baptist, glaube, überzeugung, biblisch, bischof, segnen*, bekennen*, beichten*, kreuzigen*, bischöfe, bistum, segen, buddhist, buddhismus, buddha, katholisch, katholizismus, katholik, katholiken, katholizität, kapelle, kapellen, kaplan, kapläne, seelsorge, geistlicher, geistliche, pfarrer, christus, jesus, christenheit, christ, christin, christlich, weihnachten, heiligabend, weihnachtsbaum, kirche, kirchen, kirchlich, gottesdienst, geistlichkeit, klerus, kloster, konvent, nonnenkloster, frauenkloster, konvention, konventionell, konventionen, klöster, göttlich*, bischöflich*, episkopal*, kruzifix, kreuzigung, kreuz, kreuzzug, kreuzritter, kreuzzüge, missionsfeldzug, dämon, dämonen, teufel, ungeist, dämonisch, dämonische, dämonischer, teuflisch, teuflische, teuflischer, teuflisches, gottheit, untergang, schicksal, verhängnis, verderben, evangelist, evangelion, fundamentalist, fundamentalismus, evangelisch*, nichtjüdisch*, nichtmormonisch*, nichtjude, heide, nichtmormone, gott, götze, gottes, göttin, höllisch*, hinduistisch*, heilig*, *hashanah*, himmel, hölle, hindu, hymne, **imam**, **islam**, geweiht*, gottgefällig*, unsterblich*, unvergänglich*, ewig*, unmoralisch*, unsittlich*, amoralisch*, sittenlos*, **islamisch***, **mohammedaner**, jesuit, jesuiten, *jude*, *jüdin*, *juden*, *jüdinnen*, jesuitisch*, *jüdisch**, lutherisch*, meditieren*, **dschihad**, *judentum*, *judas*, *judenpriester*, karma, *kippur*, **koran**, *koscher*, krishna, lord, lutheraner, luthertum, **mekka**, meditation, mennoniten, barmherzigkeit, gnade, erbarmen, methodist, methodistin, barmherzig*, gnädig*, methodistisch*, moralisch*, sittlich*, mormonisch*, rechtgläubig*, pastor, missionar, missionare, *mizwa*, mönch, mönche, ordensbruder, ordensbrüder, moral, sittlichkeit, moralität, ethik, moralismus, sitten, moralvorstellungen, moralvorstellung, mormone, mormonen, **moschee**, **moscheen**, **mujahed**, **muslim**, **muslime**, nonne, nonnen, ordensschwester, ordensschwestern, heidin, orthodox*, heidnisch*, päpstlich*, paradies, *passah*, pastorin, pastorinnen, pastoren, seelsorger, seelsorgerin, papistisch*, fromm*, pilgern*, andächtig*, seelenhirte, seelenhirt, seelenhirten, buße, pfingsten, erntefest, pfingstkirche, kirchenbank, kirchenbänke, frömmigkeit, pietät, pietismus,

pilger, wallfahrer, andacht, pietätvoll, papst, päpste, gebet, prediger, beten*, predigen*, presbyterianisch*, prophezeien*, protestantisch*, predigt, presbyterianer, priester, priesterin, priestertum, prophet, prophezeiung, puritanisch*, *rabbinisch**, religiös*, protestant, psalm, psalmen, fegefeuer, puritaner, puritanerin, *rabbi*, *rabbiner*, **ramadan**, religion, religionen, kult, ritus, rituell*, opfern*, aufopfern*, zeremonie, riten, ritual, rituale, rosenkranz, rosenkränze, *sabbat*, *sabbattag*, heiligkeit, opfer, opfergabe, sankt, erlösung, seeligkeit, satanisch*, sektiererisch*, konfessionell*, satan, satanismus, sekte, sekten, seminar, schrein, grab, **schiitisch***, sündigen*, testamentarisch*, grabstätte, grabaltar, grabkapelle, heiligtum, sikh, sünde, schuld, versündigung, frevel, sünder, sünden, seele, seelen, geist, spiritus, **sunni**, **sunnit**, tempel, gotteshaus, bethaus, testament, theologe, theologin, *tora*, vatikan, vatikanstadt, **schleier**, theologisch*, verschleiern*, *jiddisch**, anbetung, zen, *zion*

A5: Italian

battezzare*, benedire*, agnostico, agnostica, agnosticamente, agnosticismo, **allah**, altare, chierichetto, amen, amish, angelo, angelico, angelica, angelicale, angelicato, angelicata, angelicamente, angeli, battesimo, battesimale, battista, battisterio, battistero, battezzabile, battezzamento, battezzatore, credenza, convinzione, convinzioni, credo, bibbia, biblico, biblica, biblicamente, biblicismo, biblicista, vescovo, vescovado, beatamente, beatitudine, beatore, beatrice, benedizione, budda, buddha, bodhi, buddismo, buddhismo, buddista, buddhista, buddistico, buddhistico, teologia, cattolico, cattolica, universale, cattolicamente, patriarcato, cattolicizzazione, cattolicesimo, cattolicismo, cattolicità, patriarca, katholicos, cattolicizzarsi*, confessare*, cappella, cappellano, cappellanato, cristo, cristianità, battezzante, natale, natalizio, chiesa, ecclesiastico, chiericato, praticante, ecclesiasticità, ecclesiasticamente, sacrestano, sagrestano, sagrestana, chiesastico, clero, confessabile, penitente, confessato, confessata, confesso, confessa, crocifiggere*, crucifiggere*, divinare*, divinizzare*, confessatamente, confessione, confessionale, confessionalismo, confessionalista, confessionalistico, confessionalmente, confessore, confessorato, convento, conventi, crocifero, crocifera, crocifisso, crocifissa, crucifisso, crucifissa, crocifissione, crociata, demone, demonio, demoniaco, demoniaca, demoni, diavolo, demonocrazia, diabolico, diabolica, diavolesco, diavolesca, diabolicamente, diavolescamente, demonicamente, diabolicità, demonialità, demonolatria, diavoleria, divinazione, divinatore, divinatorio, divinatoria, divino, divina, divinizzazione, divinità, rovina, rovinato, rovinata, destinato, destinata, catastrofista, destinare*, condannare*, evangelizzare*, apocalittico, apocalittica, catastrofico, catastrofica, catastroficamente, catastrofismo, apocalisse, episcopale, episcopaliano, episcopalismo, episcopalmente, vangelo, evangelista, evangeliario, evangelico, evangelica, zelante, evangelicalismo, evangelismo, evangelicamente, evangelizzato, evangelizzata, evangelizzatore, evangelizzatrice, fede, immortalare*, **islamizzare***, gesuitare*, fedele, fedelmente, fedeltà, infedele, sfiduciato, sfiduciata, miscredente, infedelmente, sfiduciatamente, infedeltà, sfiducia, incredulità, fondamentalismo, fondamentalista, fondamentalistico, fondamentalistica, gentile, pagano, dio, dea, gospel, *ha-shanah*, paradiso, cielo, paradisiaco, paradisiaca, inferno, inferni, indù, induismo, santissimo, santissima, santo, santa, salmo, inno, innico, innica, salmi, salmodiante, salmodiatore, salmodiatrice, salmista, **imam**, **imano**, **imamato**, **imanato**, **imamita**, immorale, immoralismo, immoralista, immoralità, immoralmente, immortale, immortalità, immortalmente, **islam**, **islamico**, **islamica**, **islamitico**, **islamitica**, **islamista**, **islamizzazione**, **islamismo**, **islamita**, gesuita, gesuitico, gesuitesco, gesuiticamente, gesuitescamente, gesuitismo, gesuiteria, *giudaizzare**, *ebraizzare**, signore, gesù, *ebreo*, *ebraico*, *ebraica*, *giudaico*, *giudaica*, *ebrei*, **jihad**, **jihadisti**, **jihadi**, **jihadismo**, **jihadista**, *giuda*, *giudea*, *giudeo*, *giudaicamente*, *giudaizzazione*, *ebraismo*, *giudaismo*, karma, karman, *kippur*, **corano**, *kasher*, *kosher*, krishna, luterano, luterana, luteranesimo, luteranismo, **mecca**, meditato, med-

itata, meditatamente, meditazione, meditare*, paganizzare*, paganizzarsi*, pellegrinare*, meditativo, meditabondo, meditativamente, meditatore, meditante, anabattista, anabattismo, misericordioso, misericordiosa, misericordiosamente, misericordia, pietà, metodismo, metodista, metodistico, metodistica, metodisticamente, ministro, ministero, ministeriale, ministrante, officiante, ministrazione, ministrativo, ministrativa, amministrativo, amministrativa, assistenziale, ministra, missionario, missionaria, *mitzvah*, *mitzva*, **maometto**, **muhammad**, **maomettano**, **maomettana**, **maomettanesimo**, **maomettismo**, monasteriale, monastero, monastico, monastica, monasticamente, monasticismo, monaco, monachesimo, monaci, morale, moralità, mormone, mormonico, mormonismo, **moschea**, **mujahiddin**, **mujaheddin**, **mujahedin**, **musulmano**, **musulmana**, **musulmanesimo**, suora, suore, ortodosso, ortodossa, ortodossamente, pagana, paganità, paganizzazione, paganizzato, paganizzata, paganico, paganesimo, papale, pasqua, *pesach*, pastore, pastorale, pastorate, penitenza, pentecoste, pentecostale, pentecostalismo, pieta, pietas, pellegrino, pellegrina, pellegrinaggio, pellegrinante, pio, pia, papa (only upper case), pregare*, preghiera*, predicare*, papato, pontificato, episcopato, papasso, pregato, pregata, predicabile, predicatore, predicatrice, predicatorio, presbiteriano, presbiteriana, presbiterianesimo, pronosticare*, protestantizzare*, salmodiare*, presbiterianismo, prete, sacerdote, presbiterale, sacerdotessa, sacerdozio, presbiterato, profezia, ciarlatano, ciarlatana, profetizzabile, profetizzato, profetizzata, pronosticatore, profetizzare, profeta, profetessa, profetico, profetica, protestante, protestantesimo, salmistico, salmodico, salmodia, salmodo, purgatoriale, purgatorio, purgatoria, purgatorialmente, puritano, puritana, puritanesco, puritanamente, puritanesimo, puritanizzare, puritanismo, coranico, *rabbino*, *rabbinico*, *rabbini*, **ramadan**, religione, religionario, religionaria, religionismo, religionista, religioso, religiosamente, religiosità, bigotto, bigotta, rito, riti, ritual, ritualizzazione, ritualizzato, ritualizzata, ritualismo, ritualista, ritualistico, ritualistica, ritualizzare*, sacrificare*, sataneggiare*, peccare*, ritualisticamente, ritualità, ritualmente, rosari, rosario, sabato, *shabbat*, sacro, sacra, sacrificio, sacrificale, salvazione, satana, satanico, satanica, satanicamente, satanismo, satanista, scritturale, scritturalismo, scritturalista, setta, settario, settaria, sette, seminario, **sciismo**, **sciita**, **sciiti**, sacrario, sepolcro, santuario, reliquiario, sikh, sikhismo, peccato, peccatore, peccatrice, peccati, spiritualizzare*, teologizzare*, onorare*, anima, anime, spirito, spirituale, spiritual, spiritualizzazione, spiritualismo, spiritualista, spiritualistico, spiritualistica, spiritualisticamente, spiritualità, **sunnita**, **sunniti**, tempio, testamento, testamentale, testamentariamente, testamentario, teologo, teologa, teologale, teologico, teologica, *torah*, *pentateuco*, vaticano, vaticanismo, vaticanista, **velo**, **velato**, **velata**, adorazione, devozione, adorare*, devoto, devota, *yiddish*, zen, *sion*, *sionismo*, *sionista*, *sionistico*, beare*, cattolicizzare*

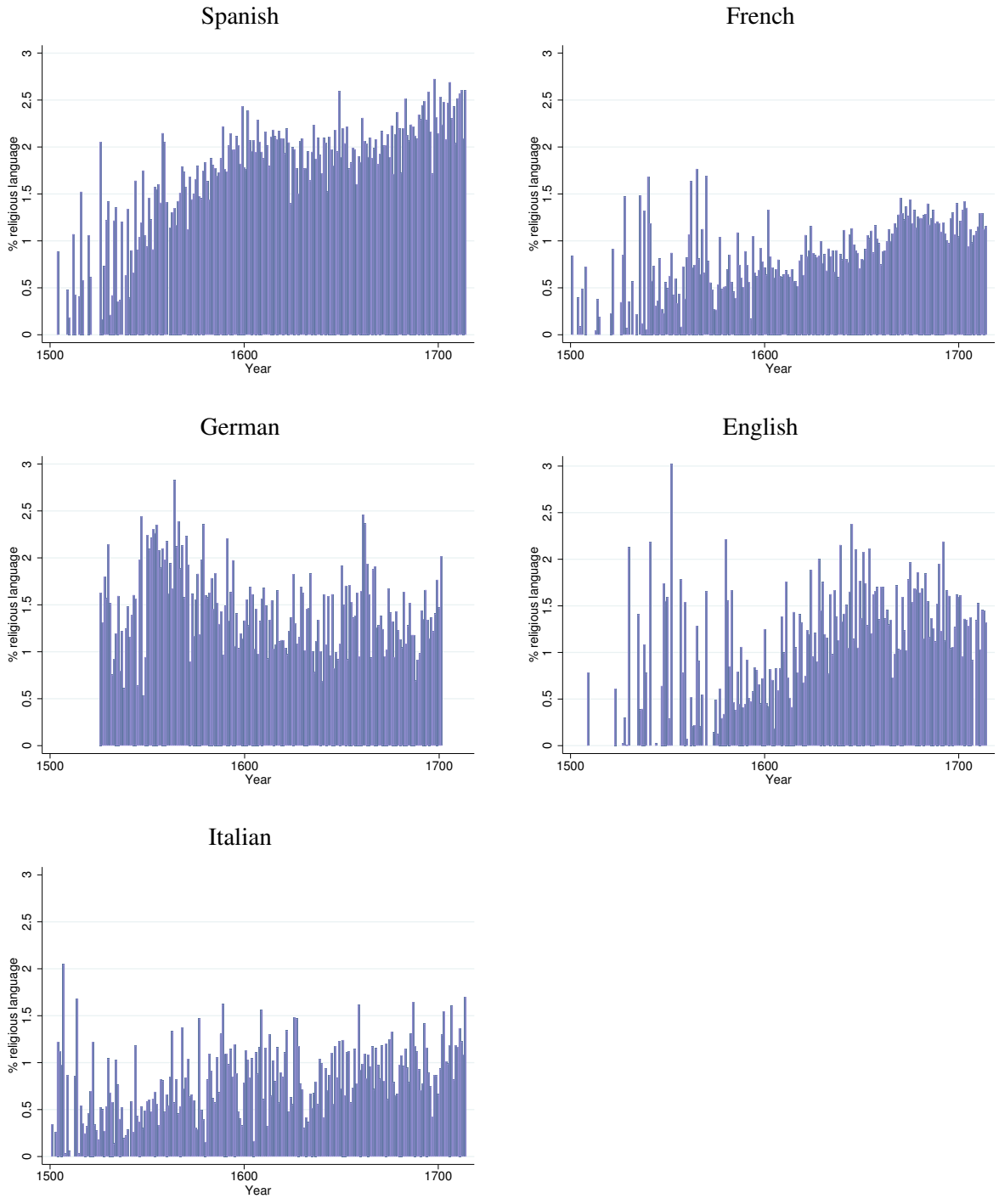

Figure A1: Share of religious terminology in *Google Ngram* from 1500 to 1714.

Table A1: List of 10 most frequent religiosity words/stems on *Google Ngram* for each language from 1500 to 1714.

Rank	Spanish	French	German	British English	Italian
#1	fe	dieu	gott	god	dio
#2	dios*	seigneur	gottes	lord	signore
#3	santo*	saint	heilig*	church*	papa
#4	alma	esprit	glauben*	faith	fede
#5	pecar*	croire*	christus	christ	santo
#6	cielo	christ	glauben	holy	cielo
#7	virtud	pape	kirchen	gods	santa
#8	orar*	religion	ewig*	spirit	peccare*
#9	creer*	prier*	geist	religion	chiesa
#10	templo	religieux	göttlich*	pray*	religione

Appendix B: Reason Dictionaries

Stems are indicated with an asterisk.

B1: Original English

activate*, affect, affected, affecting, affects, aggravate*, allow*, attribute*, basis, bc, because, bosses, cause*, causation, change, changed, changes, changing, compel*, compliance, compliant, complied, complies, comply*, consequent, consequence, control*, cos, coz, create, created, creates, creating, creation, creations, creative, creativity, cuz, deceive*, deduce*, deduction, depend, depended, depending, depends, effect*, elicit*, elicitation, enable*, enact*, experiment, factor, force*, founded, generate*, generating, generator*, hence, how'd , how're, how's, howd, howre, hows, ignite*, ignition, implication, implicate*, imply*, independent*, induce*, induction, infer, infers, influence, influential, initiate*, initiation, intend*, intent*, intention, justify*, justification, launch*, lead, leading, leads, led, made, make, maker*, makes, making, manipulate*, manipulation, mislead*, motivate*, motive, obedience, obedient, obediently, obey, obeyed, obeying, obeys, origin, originate*, origins, outcome*, permit*, pick, picked, picking , picks, produce*, production, provoke*, purpose*, rational, rationality, rationale, rationally, react*, reaction, reason*, response*, result*, root*, since, solution*, solve, solved, solves, solving, source*, stimulate*, stimulation, therefore, thus, trigger*, use, used, uses, using, whereby, wherefore, why, whyever

B2: Spanish

activar*, accionar*, movilizar*, activador*, actividad, activación, activismo, activamente, accionamiento, permisivamente, porque, activista*, accionable*, movilizador*, movilización*, afectar*, afectante*, afectador*, agravar*, agravación*, agravante*, agravador*, agravatorio*, agravamiento*, empeorar*, empeoramiento*, permitir*, permiso*, permisibilidad*, permisible*, permisión*, permisionario*, permisividad*, permisivo*, permisor*, permitividad*, permitidor*, dejar*, conceder*, concedente*, concesible*, concesivo*, acceder*, consentir*, consentidor*, atribuir*, atribuible*, atribución*, atributo*, achacar*, achacable*, basar*, basado*, fundamentar*, fundamental*, base*, fundamento*, criterio*, jefe*, gerente*, mandar*, pues, por, obligamiento, obligatoriedad, presión, forzadamente, forzosamente, dirigir*, causa*, origen*, razón*, causal*, causación*, causalidad*, causador*, causante*, causativo*, motivar*, motivo*, motivación*, motivador*, motivante*, producir*, producto*, producción*, producible*, producidor*, productor*, provocar*, provocador*, provocación*, provocante*, cambiar*, modificar*, variar*, mutar*, distinto*, cambio*, modificación*, transformación*, transformamiento*, variación*, variabilidad*, mutación*, mutabilidad*, cambiante*, cambiable*, modificable*, modificador*, modificante*, modificativo*, modificatorio*, transformable*, transformador*, transformativo*, variable*, mutable*, compeler*, compelir*, forzar*, presionante*, forzoso*, forzosidad, forzamiento, conformidad, docilidad, obediencia, consecuentemente, entonces, forzador*, acatamiento*, cumplimiento*, obedecimiento*, conforme*, obediente*, cumplidor*, acatar*, consiguiente*, control*, controlar*, consiguientemente, creación, criatura, creaciones, criaturas, creatividad, engañabobos, controlador*, controlable*, controlabilidad*, dominar*, dominio*, dominante*, dominable*, dominación*, dominador*, dominativo*, mandato*, mandamiento*, mandación*, mandador*, mandamás*, mandante*, mandatorio*, crear*, creador*, creable*, creativo*, engañar*, engaño*, engañanecios, engañosamente, engatusamiento, posiblemente, experimentalmente, inclusive, incluso, engañador*, engañifa*, engañoso*,

engatusar*, engatusador*, embaucar*, embaucador*, embaucamiento*, deducir*, deducible*, deductor*, deducción*, deducibilidad*, deductible*, deductivo*, deductibilidad*, inferir*, inferencia*, depender*, dependiente*, dependencia*, efecto*, efectuación*, sacar*, desencadenar*, desencadenante*, desencadenamiento*, obtener*, obtención*, obtenible*, posibilitar*, posible*, posibilidad*, posibilitador*, posibilitación*, autorizar*, promulgar*, promulgación*, promulgador*, experiencia*, experimentación*, experimental*, probar*, prueba*, probador*, probadura*, incluir*, inclusión*, considerar*, incluyente, considerablemente, fuerza, cómo, implícitamente, independientemente, inicialmente, consideración*, considerable*, considerador*, considerativo*, imponer*, coerción*, coercitivo*, coercer*, coercible*, generar*, generación*, generable*, generador*, generativo*, encender*, prender*, arrancar*, arranque*, encendedor*, mecha*, detonador*, detonante*, implicar*, implícito*, implicación*, implicancia*, implicatorio*, involucrar*, involucración*, involucramiento*, tácito*, sobreentendimiento*, significar*, significación*, significador*, suponer*, suposición*, suponedor*, supositivo*, sobreentender*, independiente*, independencia*, independizar*, independización*, inducir*, inducidor*, inducimiento*, inducción*, inductivo*, inductor*, influir*, influencia*, influenciable*, influyente*, iniciar*, iniciador*, iniciativa*, inicial*, inicio*, iniciación*, iniciático*, iniciativo*, justificadamente, confusamente, erróneamente, obedientemente, originalmente, originariamente, producibilidad, intención*, propósito*, empeño*, tentativa*, justificar*, justificable*, justificación*, justificador*, justificante*, justificativo*, pretextar*, pretexto*, lanzar*, lanzamiento*, guiar*, conducir*, liderazgo*, líder*, dirigente*, importante*, fabricar*, hacedor*, ejecutor*, fabricante*, fabricación*, manipular*, manipulador*, manipulación*, manipulativo*, manejar*, manejable*, confundir*, confusión*, confundidor*, confundimiento*, confundible*, falsear*, falseador*, falseamiento*, desorientar*, desorientación*, desorientador*, erróneo*, móvil*, incitar*, incentivo*, incitador*, incitación*, incitamento*, incitante*, incitativo*, obedecible*, ascendencia*, originar*, original*, originalidad*, originario*, desarrollar*, desarrollo*, desarrollable*, producimiento*, productible*, productividad*, autorizadamente, escogidamente, recolección, adrede, deliberadamente, aposta, intencionadament, productivo*, procedencia*, desenlace*, autoridad*, autoritario*, autorizable*, autorización*, autorizador*, autorizamiento*, escoger*, elegir*, recolectar*, elector*, electivo*, electividad*, elección*, escogencia*, escogimiento*, recolecta*, provocativo*, finalidad*, objetivo*, meta*, fin*, proponerse*, intencionalidad*, lógica, razonablemente, razonadamente, racionalidad, racionalismo, racionalmente, resolución*, resoluto*, significante*, significativo*, racional*, lógico*, razonable*, congruente*, cuerdo*, juicioso*, sensato*, razonar*, racionalizar*, razonabilidad*, razonador*, razonamiento*, razonante*, racionalista*, racionalización*, reaccionar*, reacción*, reactivo*, reaccional*, reaccionario*, reactividad*, motive*, cordura*, responder*, respuesta*, resultar*, raíz*, enraizar*, desde, así, luego, enraizamiento*, arraigar*, arraigamiento*, proceder*, procedente*, solución*, solucionar*, resolver*, solucionador*, resolvente*, resolviente*, fuente*, estimular*, estímulo*, estimulante*, estimulación*, estimulador*, estimuloso*, animar*, animador*, animación*, incentivar*, incentivador*, incentivación*, detonar*, disparar*, disparador*, usar*, utilizer*, sentido*, utilización*, utilizable*, empleo*, cual*, uso*, usanza*, recoger*, escogedor*, hacer*, liderar*, ignición*, experimentar*, experimento*, efectuar*, engañadizo*, obedecer*, consecuencia*, acatable*, cumplir*, obligación*, obligar*, presionar*, transformar*, causar*, fundamentación*, consentimiento*, concesión*

B3: French

affecter*, activer*, atteindre*, affliger*, activateur, activable, activement, effet, incidence, aggravation, aggravement, concerner*, toucher*, impacter*, aggraver*, empirer*, exacerber*, autoriser*, permet-

tre*, attribuer*, imputer*, exacerbation, autorisation, autorisant, permission, attribution, imputation, attribuable, baser*, imputable, base, fondement, car, patron, chef, employeur, dirigeant, causalité, raison, motif, causale, causable, causalement, changement, modification, changements, modifications, contrainte, obligation, modifier*, contraindre*, astreindre*, obliger*, forcer*, conformer*, soumettre*, conséquence*, contrôler*, imposition, exigeance, contraignant, conformité, conformation, conforme, conformément, conséquent, conséquemment, contrôle, contrôlable, création, concevant, créant, créer*, provoquer*, décevoir*, tromper*, berner*, conception, créations, conceptions, créatif, inventif, créativité, inventivité, créativement, déduction, conclusion, compréhension, déductible, compréhensible, déduire*, conclure*, comprendre*, dépendre*, effectuer*, susciter*, dépendance, corrélation, selon, impact, effectif, effectivement, suscitation, suscitement, déclenchement, attisement, déclenchable, déclencher*, attiser*, promulguer*, adopter*, activation, actif, permis, promulgation, promulguant, adoption, adoptant, décrétant, adoptable, décréter*, experimenter*, tester*, expérience, test, expérimentalement, facteur, force, obligeance, contraint, forcément, obligeamment, génération, fonder*, établir*, générer*, produire*, générateur*, producteur*, enflammer*, production, générant, donc, ainsi, comment, implication, impliquer*, insinuer*, implicite*, suggérer*, indépendant*, induire*, tacite, allusion, insinuation, implicitement, indépendance, autonome, indépendamment, indubitable, indubitablement, influence, inciter*, découvrir*, inférer*, influencer*, initier*, pouvoir, influençable, puissant, initiable, initialement, intention, intentionellement, intenter*, justifier*, prétexter*, objectif, projet, vocation, justificatif, justification, prétexte, explication, expliquer*, alléguer*, allégation, justifiable, justifiabilité, prétextable, explicable, lancement, publication, publier*, sortir*, sortie, lançable, publiable, sortable, meneur, leader, mener*, fabriquer*, guide, fabricant, réalisateu, créateur, constructeur, fabricable, faire*, construire*, manipuler*, duper*, flouer*, réalisable, créable, constructible, productible, manipulation, manipulateur, manipulable, trompeur, dupeur, motivation, stimulation, stimulant, motivant, obédience, motiver*, stimuler*, obéir*, sujétion, obédient, obéissance, obéissant, docile, origine, provenance, s'inféoder*, obtempérer*, écouter*, originaire*, originairement, originalement, origines, aboutissement, répercution, résultat*, laisser*, choisir*, séléctionner*, permissif, autorisable, choix, séléction, choisissant, décidant, amener*, procurer*, sélectionnant, produit, productivité, déclencheur, productif, agacer*, irriter*, procurable, productivement, provocation, provocateur, provoquant, rationaliser*, rationnel*, réagir*, répondre*, agacement, irritation, irritabilité, provocatif, provocable, agaçant, irritable, irritant, but, intentionel, objectivement, logique, rationnellement, logiquement, réaction, rebondissement, réactif, rebondir*, raisonner*, réactivement, argumentation, raisonnable, raisonnablement, argumenter*, résulter*, racine*, solutionner*, réponse, riposte, résultant, solution, résolution, résolvant, élucidant, démêlant, germe, résoudre*, élucider*, démêler*, source*, encourager*, éveiller*, provenance, encouragement, stimulable, encourageable, alors, désormais, dorénavant, entraîner*, amorce, utilisant, employant, où, pour, pourquoi, quoi, employer*, quelle, quoique, sous-entendre, amorcer*, utiliser*, réaliser*, conduire*, guider*, lancer*, concevoir*, imposer*, exiger*, causer*, changer*

B4: German

aktivieren*, aktivierung*, betätigen*, betätigung*, beeinflussen*, betreffen*, berühren*, affekt, befallen*, verschlimmern*, verschärfen*, erschweren*, erlauben*, ermöglichen*, zulassen*, gestatten*, dürfen*, zulässig*, zuschreiben*, zurechnen*, attribut, zuschreibung, basierend, basis, grundlage, grundstock, weil, denn, ursache, grund, anlass, verursachen*, bewirken*, hervorrufen*, veranlassen*, veranlassung*, kausal*, kausalität, veränderung, änderung, wechsel, wandel, abwechslung, wechseln*, ändern*, verändern*, zwingen*, erzwingen*, nötigen*, nachgiebigkeit, fügsamkeit, konform*, nachgiebig*, einge-

halten, entspricht, einhalten*, einhaltung*, einwilligung*, einwilligen*, folge, konsequenz, ergebnis*, auswirkung, auswirken*, folglich*, konsequent*, kontrollieren*, kontrolle*, steuern*, steuerung*, erstellen*, schaffen*, schaffung*, erzeugung*, kreation*, kreativ*, schöpferisch*, täuschen*, betrügen*, hintergehen*, trügen*, ableiten*, ableitung*, folgern*, erschließen*, abhängen*, abhängig*, erzielen*, wirkung, effekt, einwirkung, entlocken*, befähigen*, erlassen*, experimentieren*, experiment, experimente, faktor, faktoren, macht, kraft, gewalt, gegründet*, generieren*, erzeugen*, generator, daher, also, deshalb, wie, woher, wodurch, entzünden*, zünden*, anzünden*, entflammen*, zündung*, implizieren*, implikation*, verwickeln*, bedeuten*, bedeutung*, andeuten*, unabhängig*, selbständig*, selbstständig*, induzieren*, induktion*, bewegen*, herbeiführen*, bringen*, einleiten*, schlussfolgern*, schlussfolgerung*, inferenz, inferentiell*, einfluss, geltung, initiieren*, beginnen*, eröffnen*, wollen*, beabsichtigen*, absicht, vorhaben*, bestimmen*, vorsatz, intention, rechtfertigen*, begründen*, rechtfertigung*, starten*, lancieren*, start, einführung, gründung, eröffnung, gründen*, führen*, leiten*, führung*, leitung*, machen*, tun*, herstellen*, hersteller*, schöpfer*, schöpfen*, zubereiten*, zubereitung*, manipulieren*, handhaben*, bedienen*, bedienung*, manipulation*, , irreführen*, verleiten*, motivieren*, motivation*, motiv, gehorsam*, folgsam*, fügsam*, gefügig*, gehorchen*, befolgen*, folgen*, herkunft*, ursprung*, entstehung*, entstehen*, abstammung*, resultat, erfolg*, erlaubnis*, zulassung*, dulden*, genehmigen*, genehmigung*, wählen*, auswählen*, aussuchen*, auswahl*, produzieren*, ergeben*, hervorbringen*, herstellung*, produktion*, fertigen*, fertigung*, provozieren*, provokation*, reizen*, erregen*, herausfordern*, zweck, ziel, aufgabe, zielgerichtet*, gezielt*, entschliessen*, absichtlich*, zielbewusst*, rational*, vernünftig*, vernunft*, sinnvoll*, rationalität, vernünftigkeit*, reagieren*, reaktion*, begründung*, verstand*, argument*, argumentieren*, antworten*, antwort, resonanz, erwiderung, resultieren*, wurzel, da, lösung*, auflösung*, lösen*, auflösen*, aufklären*, quelle, stimulieren*, stimulation, anregen*, anregung*, fördern*, beleben*, reiz, anreiz, stimulus, darum, demnach, deswegen, so, somit, derart, folgendermaßen, auslösen*, auslöser, drücker, benutzen*, verwenden*, nutzen*, einsetzen*, anwenden*, anwendung*, benutzung*, gebrauchen*, verarbeitung, verwertung, mit, warum, weswegen, wieso, wozu, wofür

B5: Italian

attivare*, interessare*, condizionare*, influire*, attivazione, attivatore, emozionante, impressionante, aggravante, aggravamento, aggravio, colpire*, aggravarsi*, scocciare*, liceità, lecito, deducibile, lecitudine, lecitamente, assegno, rendita, concedere*, consentire*, indennità, concessione, detrazione, concedente, permessivamente, attributo, base, basato*, causato*, perché, capi, causa, causale, causalità, causalmente, cambiamento, cambiarsi*, scambiare*, cambio, coercibile, coercibilmente, costringente, forzatore, persuasore, convincente, indurre*, coercire*, ottemperare*, conformare*, probante, trascinante, affasciante, persuasivamente, ottemperanza, conformità, arrendevolezza, ottemperante, arrendevole, conseguenza, conseguenze, conseguente, consequenziale, conformarsi*, controllare*, creare*, creativo*, controllabilità, controllabile, controllore, creation, creazioni, creatività, ingannare*, dedurre*, detrarre*, ingannamento, ingannabile, ingannatore, ingannatrice, ingannevole, ingannevolmente, deduzione, deducibilità, detraibilità, detraibile, dipendere*, effettuare*, deduttivo, deduttiva, deduttivamente, dipendente, effetto, effettuabile, effettivo, effettiva, effettivamente, effettività, svelabile, svelamento, oppurtunità, agevolatore, ottenere*, svelare*, agevolare*, abilitare*, attuabile, promulgabile, rappresentabile, attuamento, promulgamento, rappresentazione, attuativo, attuare*, promulgare*, esperimentare*, forzare*, promulgativo, attuazione, promulgazione, attuatore, attuatrice, promulgatore, promulgatrice, interprete, esperimento, fattore, forza, forzatamente, estorcere*, generare*, incendiare*, forzatura, forte, gagliardo,

gagliarda, solido, solida, fortemente, gagliardamente, potenza, debole, fiacco, fiacca, generatore, generatrice, quindi, come, incendiabilità, incendiabile, accenditore, incendiarsi*, accendere*, implicare*, sottintendere*, ignizione, ignitore, accensione, implicazione, implicatore, implicito, implicitamente, insinuare*, implicitezza, indipendenza, indipendente, indipendentemente, incentivo, induttore, inducimento, introduzione, avviamento, induzione, inferenza, inferendo, desumendo, investire*, inferire*, inferente, inferenziale, inferenzialmente, desumibile, desumibilmente, influenza, influenzabile, influente, influenzando, inizio, principio, iniziazione, iniziativa, principiare*, intendere*, iniziatore, iniziatrice, iniziatico, iniziatica, inteso, intesa, designato, designata, destinato, destinata, destinatario, destinataria, prospettato, prospettata, intento, intenta, intenzione, intenzionale, intenzionalità, intenzionalmente, intenzionato, intenzionata, intentamente, intenza, intensità, giustificabile, giustificabilità, lanciare*, lanciarsi*, giustificabilmente, giustificazione, giustificativo, giustificatorio, lancio, lanciatore, lanciando, guida, vantaggio, indizio, principale, primo, prima, fatto, dirigere*, produttore, produttrice, creatore, creatrice, manipolabile, manipolato, manipolata, fabbricare*, manipolare*, fuorviare*, motivare*, manipolazione, manipolativo, manipolativa, manipolativamente, manipolatore, manipolatrice, manipolatorio, manipolatoria, corruttore, corruttrice, traviatore, traviatrice, fuorviante, fuorviamento, fuorviato, motivato, motivata, motivazione, motivazionale, motivante, motivatore, ubbidire*, obbedire*, originare*, motivatrice, motivo, immotivato, immotivatamente, immotivazione, ubbidienza, obbedienza, ubbidiente, obbediente, ubbidientemente, origine, originazione, originario, originaria, originarsi*, permettere*, originariamente, originatore, esito, permesso, permissione, permissionario, permissionaria, producimento, producibile, prodotto, producibilità, produzione, produttivamente, raccogliere*, rimuovere*, produttività, provocato, provocata, provocatore, provocatoriamente, scopo, proposito, risoluto, risoluta, significativo, significativa, risolutamente, significativamente, risolutezza, significatività, immotivata, razionale, razionalizzabile, razionalizzazione, razionalizzatore, razionalismo, razionalista, razionalistico, razionalisticamente, reagire*, ragionare*, razionalità, razionalmente, reagente, reazione, reazionario, reazionaria, reazionariamente, ragione, ragionevolezza, ragionevole, ragionevolmente, ragionato, ragionata, ragionatamente, ragionatore, ragionatrice, ragionamento, risposta, responso, disatteso, disattesa, ignorato, ignorata, inanimato, inanimata, risultato, risultante, fruttifero, fruttifera, improduttivo, improduttiva, improduttività, radice, radici, radicare*, risolvere*, radicato, radicata, radiciforme, radicamento, radicazione, radicoso, radicosa, da, soluzione, solvente, risolutivo, risolutiva, solutore, solutrice, fonte, sorgente, infondato, infondata, stimolabile, indicare*, stimolare*, stimolante, stimolando, stimolazione, stimolativo, stimolativa, stimolatore, stimolatrice, stimoli, stimolo, perciò, così, pertanto, finora, quiddità, siffatto, siffatta, grilletto, innesco, uso, laddove, innescare*, usare*, percome, scatenare*, procurare*, procurarsi*, risultare*, provocare*, razionalizzare*, scegliere*, fare*, produrre*, guidare*, condurre*, designare*, giustificare*, desumere*, iniziare*, suscitare*, scambiarsi*, costringere*, cambiare*, considerare*, attribuire*, fingere*, aggravare*

Appendix C: Collecting and Preparing *FamilySearch* Data

To systematically collect data from *FamilySearch* (FamilySearch, 2022), we employ a Python script and the *Selenium* module. The script logs into the website through three browsers and loops through a given set of locations for a given set of years. If any locations were detected, the script uses the download feature available on the website to download the shown files. If an error occurred on one of the browsers, the code would switch to a new browser and attempt the query again. If this failed, it is assumed that there are no results for the given query, and it is ignored.

FamilySearch limits the number of results available to users: Only the first 4,900 records for any given search query are accessible, regardless of the actual number of records available for a query. Thus, the maximum number of results for a given year and location is 4,900.

Once the script finished collecting the data, we used a second Python script with *Pandas* to collate and sort the data. This involved:

- Collating the data into a single spreadsheet
- Removing unnecessary rows, leaving name, birth date, christening date, gender, and location of birth. Any records without a birth location are removed.
- Separating location of birth into four values: country, city, county, and province.
- Removing all rows that feature neither a birth date nor a christening date. Christening date proved to be a good analogue for birth date which is why it is used in circumstances where birth date is not provided.

Both files and dependencies are listed on *GitHub*. In all, over 3GB of data were collected for this project, which, once sorted, provided 1,048,575 viable birth records.

To properly match records to their pre-1715 states, we assign a record to:

- England if the city or country indicates England, as well as if the county is listed as Middlesex, Essex, or Bristol.
- Scotland if the city is recorded as Scotland, Midlothian, Stirlingshire, or Haddingtonshire; or if the country is recorded as Scotland, Midlothian, Stirlingshire, or Haddingtonshire.
- Denmark if the city or country is listed as Copenhagen or if the country is listed as Denmark.
- Switzerland if the country is listed as Switzerland.
- the Netherlands if the country is listed as Netherlands.
- France if the city, county, province, or country is listed as Île-de-France or Paris.
- Spain if the country is listed as Spain.
- Ireland if the country if listed as Ireland.

To identify explicitly Christian names (because these eight states were predominantly Christian at the time), we access Hanks et al. (2006) for a comprehensive list of 209 English-language names. To capture the corresponding names in Danish, French, German, Italian, and Spanish, we consult Transcripture

International (2023) and International Biblical Association (2023). In addition, we google "[name] in Danish", for example.

The initial English-language names are Aaron, Abel, Abigail, Abishag, Abital, Abner, Abraham, Abram, Absalom, Adah, Adam, Adina, Adlai, Alexander, Amittai, Amnon, Amos, Andrew, Angel, Angela, Aram, Ariel, Artemas, Asa, Asaph, Asenath, Asher, Atarah, Azariah, Azriel, Balthazar, Barnabas, Bartholomew, Baruch, Bathsheba, Benjamin, Boaz, Caleb, Candace, Caspar, Chloe, Chloe, Damaris, Dan, Daniel, David, Deborah, Delilah, Dinah, Drusilla, Edom, Ehud, Eli, Elias, Eliezer, Elijah, Elisha, Elizabeth, Elkanah, Emmanuel, Enoch, Enos, Ephraim, Erastus, Esau, Esther, Ethan, Eunice, Eve, Ezekiel, Ezra, Gabriel, Gabrielle, Gamaliel, Gershom, Gershon, Gideon, Gomer, Guni, Habacuc, Hagar, Hannah, Heber, Hephzibah, Hillel, Hiram, Hulda, Ira, Isaac, Isaiah, Iscah, Ishmael, Israel, Issachar, Itamar, Jabez, Jacob, Jared, Jason, Jedidiah, Jehiel, Jehoram, Jehoshaphat, Jemima, Jeremiah, Jerome, Jesse, Jethro, Joanna, Job, Joel, John, Johoiachin, Jonah, Jonathan, Joseph, Joshua, Josiah, Judah, Judas, Judith, Keren, Keturah, Kezia, Lazarus, Leah, Lemuel, Levi, Lilith, Lois, Lucas, Lucius, Lydia, Magdalene, Malachi, Mara, Mark, Martha, Mary, Matthew, Matthias, Mehitabel, Melchior, Menahem, Meshulam, Michael, Michaela, Michal, Miriam, Mordecai, Moses, Nahum, Naomi, Naphtali, Nathan, Nathaniel, Nicodemus, Noah, Obadiah, Oded, Omar, Omri, Ophrah, Paul, Paula, Peleg, Persis, Phineas, Prisca, Rachel, Raphael, Rebecca, Reuben, Reuel, Rhoda, Ruth, Salome, Samson, Samuel, Sarah, Saul, Seth, Shelomit, Silas, Simeon, Simon, Solomon, Susanna, Tabitha, Talitha, Tamar, Thaddeus, Theophilus, Thomas, Tikvah, Timothy, Tobias, Uriah, Uriel, Uzziah, Uzziel, Yael, Zadok, Zebulun, Zechariah, Zedekiah, Zephaniah, Zillah, and Zipporah.

The corresponding Danish names are Aron, Abel, Abigajil, Abishag, Abital, Abner, Abraham, Absalom, Adam, Aleksander, Amittaj, Amnon, Amos, Andreas, Engle, Aram, Ariel, Artemas, Asa, Asaf, Asenat, Atara, Azarja, Azriel, Barnabas, Bartholom, Baruk, Batseba, Benjamin, Boaz, Kaleb, Kandake, Casper, Chloe, Damaris, Dan, Daniel, David, Debora, Dalila, Drusilla, Edom, Ehud, Eli, Elias, Eliezer, Elias, Elisa, Elisabeth, Elkana, Immanuel, Enosj, Efraim, Erastus, Esau, Ester, Etan, Eunike, Eva, Ezekiel, Ezra, Gabriel, Gabrielle, Gamaliel, Gerson, Gerson, Gideon, Gomer, Guni, Habakkuk, Hagar, Hanna, Hefziba, Hillel, Hiram, Hulda, Ira, Isak, Esajas, Jiska, Jisjmael, Israel, Issakar, Itamar, Jabez, Jakob, Jered, Jason, Jedidja, Jehiel, Joram, Josafat, Jemima, Jeremias, Jerome, Isaj, Jetro, Johanna, Job, Joel, Johannes, Jojakim, Jonas, Jonatan, Josef, Josua, Josia, Judas, Juda, Judit, Ketura, Kezia, Lazarus, Lea, Lemuel, Levi, Lilith, Lois, Lukas, Lukius, Lut, Magdalene, Malakiasi, Mara, Markus, Martha, Maria, Matth, Menahem, Mikael, Mikaela, Mikal, Mirjam, Mordokaj, Moses, Nahum, No'omi, Naftali, Natan, Jonatan, Nicodemus, Noa, Obadias, Oded, Omar, Omri, Ofra, Paulus, Paul, Peleg, Persis, Phineas, Priska, Rakel, Retael, Rebekka, Ruben, Reuel, Rode, Rut, Salome, Samson, Samuel, Sara, Saul, Set, Sjelomis, Silas, Simeon, Simon, Salomos, Susanna, Tabitha, Talitha, Tamar, Thadd, Theofilus, Thomas, Tikva, Timoteus, Tobija, Uria, Uriel, Uzzija, Uzziel, Jael, Zadok, Zebulon, Zakarias, Zedekia, Zefanias, Zilla, and Zippora.

The French names are Aaron, Abel, Abigaïl, Abisag, Abithal, Abner, Abraham, Abram, Absalom, Ada, Adam, Adina, Adlaï, Alexandre, Amitthaï, Amnon, Amos, André, Angel, Angela, Aram, Ariel, Artémas, Asa, Asaph, Asnath, Aser, Athara, Azarias, Azriel, Balthazar, Barnabé, Barthélemy, Baruch, Bethsabée, Benjamin, Boaz, Caleb, Candace, Gaspard, Chloé, Chloe, Damaris, Dan, Daniel, David, Débora, Dalila, Dinah, Drusille, Édom, Ehud, Éli, Élie, Éléazar, Élie, Élisée, Elisabeth, Elkana, Emmanuel, Hénoch, Énosh, Éphraïm, Éraste, Ésaü, Esther, Ethan, Eunice, Ève, Ézéchiel, Esdras, Gabriel, Gabrielle, Gamaliel, Gershom, Guershôn, Gédéon, Gomère, Guni, Habacuc, Agar, Anne, Haber, Hephzibah, Hillel, Hiram, Houldah, Ira, Isaac, Isaïe, Jisca, Ismaël, Israël, Issachar, Ithamar, Jaebets, Jacques, Yared, Jason, Jedidiah, Jehiel, Joram, Josaphat, Jemima, Jérémie, Jérôme, Jessé, Jéthro, Jeanne, Job,

Joël, Jean, Joachim, Jonas, Jonathan, Joseph, Josué, Josias, Juda, Judas, Judith, Kéren, Ketourah, Ketsia, Lazare, Léa, Lemuel, Lévi, Lilith, Loïs, Luc, Lucius, Lydie, Magdala, Malachie, Mara, Marc, Marthe, Marie, Mathieu, Matthias, Mehéthabeel, Melchior, Menahem, Meschullam, Michel, Michèle, Mikhal, Myriam, Mardochée, Moïse, Nahum, Noémie, Nephtali, Nathan, Nathanaël, Nicodème, Noé, Abdias, Oded, Omar, Omri, Ophra, Paul, Paule, Péleg, Perside, Phinées, Priscille, Rachel, Raphaël, Rébecca, Ruben, Reuel, Rhode, Salomé, Samson, Samuel, Sarah, Saül, Seth, Schelomith, Silas, Siméon, Simon, Salomon, Suzanne, Tabitha, Talitha, Tamar, Thaddée, Théophile, Thomas, Thikva, Timothée, Tobie, Urie, Uriel, Ozias, Ouzziel, Yaël, Sadoq, Zabulon, Zacharie, Sédécias, Sophonie, Tsillah, and Séphora.

The corresponding German names are Aaron, Abel, Abigajil, Abischag, Abital, Abner, Abraham, Abram, Abschalom, Ada, Adam, Adina, Adlai, Alexander, Amitthai, Amnon, Amos, Andreas, Angel, Angela, Aram, Ariel, Artemas, Asa, Asaf, Asenat, Ascher, Atara, Azaria, Asriel, Balthasar, Barnabas, Bartolomäus, Baruch, Batseba, Benjamin, Boas, Kaleb, Kandaze, Kaspar, Chloe, Damaris, Dan, Daniel, David, Debora, Delila, Dina, Drusilla, Edom, Ehud, Eli, Elias, Elieser, Elija, Elischa, Elisabeth, Elkana, Immanuel, Henoch, Enosch, Ephraim, Erastus, Esau, Ester, Etan, Eunike, Eva, Ezechiel, Esra, Gabriel, Gabriele, Gamaliel, Gershom, Gershon, Gideon, Gomer, Guni, Habakuk, Hagar, Hanna, Heber, Hephzibah, Hillel, Hiram, Hulda, Ira, Isaak, Jesaja, Jiska, Ismael, Israel, Issachar, Itamar, Jabez, Jakob, Jered, Jason, Jedidja, Jehiel, Joram, Joschafat, Jemima, Jeremia, Hieronymus, Isai, Jitro, Johanna, Ijob, Joel, Johann, Joachim, Jona, Jonathan, Josef, Josua, Joschija, Juda, Judas, Judit, Keren, Ketura, Kezia, Lazarus, Lea, Lemuel, Levi, Lilith, Lois, Lukas, Lucius, Lydia, Magdalena, Maleachi, Mara, Markus, Martha, Maria, Matthäus, Matthias, Mehetabeel, Melchior, Menahem, Mesullam, Michael, Michaela, Michal, Mirjam, Mordechai, Mose, Nahum, Noomi, Naftali, Natan, Nathanael, Nicodemus, Noah, Obadja, Oded, Omar, Omri, Ophra, Paul, Paula, Peleg, Persis, Pinchas, Priska, Rachel, Raphael, Rebekka, Ruben, Reguel, Rhode, Ruth, Salome, Simson, Samuel, Sara, Saul, Set, Selomith, Silas, Simeon, Simon, Salomo, Susanne, Tabitha, Talitha, Tamar, Thaddäus, Theophilus, Thomas, Thikwa, Timotheus, Tobias, Urija, Uriel, Usija, Usiël, Jaël, Zadok, Sebulon, Sacharja, Zedekia, Zefanja, Zilla, and Zippora.

Next, the Italian names are Aronne, Abele, Abigail, Abisag, Abital, Abner, Abrahamo, Abramo, Assalonne, Ada, Adamo, Adina, Adlai, Alessandro, Amittai, Amnon, Amos, Andrea, Angelo, Angela, Aram, Ariel, Artemas, Asa, Asaf, Asenat, Ascer, Atara, Azaria, Azriel, Baldassarre, Barnaba, Bartolomeo, Baruch, Betsabea, Beniamino, Booz, Caleb, Candace, Gaspare, Cloe, Cloe, Damaride, Dan, Daniele, Davide, Debora, Dalila, Dina, Drusilla, Edom, Eud, Eli, Ilja, Eleazaro, Elia, Eliseo, Elisabetta, Elkana, Emanuele, Enoch, Enos, Efrem, Erasto, Esaù, Ester, Ethan, Eunice, Eva, Ezechiele, Esdra, Gabriele, Gabriella, Gamaliel, Ghershom, Gherson, Gedeone, Gomer, Guni, Abacuc, Agar, Anna, Eber, Hephzibah, Hillel, Hiram, Culda, Ira, Isacco, Isaia, Isca, Ismaele, Israele, Issachar, Itamar, Jabets, Giacobbe, Iared, Giasone, Jedidiah, Jehiel, Ioram, Giosafat, Colomba, Geremia, Girolamo, Iesse, Ietro, Giovanna, Giobbe, Gioele, Giovanni, Gioacchino, Giona, Gionatan, Giuseppe, Giosué, Giosia, Giuda, Giuda, Giuditta, Argentea, Keturà, Cassia, Lazzaro, Lia, Lemuel, Levi, Lilith, Loide, Luca, Lucio, Lidia, Maddalena, Malachia, Mara, Marco, Marta, Maria, Matteo, Mattia, Mehetabeel, Melchiorre, Menachem, Meshullam, Michele, Micaela, Mikal, Miriam, Mardocheo, Mosè, Naum, Noemi, Neftali, Natan, Natanaele, Nicodemo, Noè, Abdia, Oded, Omar, Omri, Ophrah, Paolo, Paola, Peleg, Perside, Fineas, Priscilla, Rachele, Raffaele, Rebecca, Ruben, Reuel, Rode, Ruth, Salomé, Sansone, Samuele, Sara, Saul, Set, Scelomith, Sila, Simeone, Simone, Salomone, Susanna, Tabita, Talitha, Tamar, Taddeo, Teofilo, Tommaso, Tikva, Timoteo, Tobia, Uria, Uriele, Ozia, Uzziel, Giaele, Sadoc, Zabulon, Zaccaria, Sedecia, Sofonia, Tsillah, and Sefora.

The respective Spanish names are Aarún, Abel, Abigaíl, Abisag, Abital, Abner, Abraham, Abram, Absalún, Adá, Adán, Adina, Adlai, Alejandro, Amittai, Amnún, Amús, Andrés, Ángel, Ángela, Aram,

Ariel, Artemas, Asa, Asaf, Asenat, Aser, Atara, Azarías, Azriel, Baltasar, Bernabé, Bartolomé, Baruc, Betsabé, Benjamín, Booz, Caleb, Candace, Gaspar, Cloé, Chloe, Dámaris, Daniel, David, Débora, Dalila, Dina, Drusila, Edom, Aod, Eli, Elías, Eleazar, Elías, Eliseo, Isabel, Elcaná, Manuel, Enoc, Enús, Efrain, Erasto, Esaú, Ester, Ethán, Eunice, Eva, Ezequiel, Esdras, Gabriel, Gabriela, Gamaliel, Gersom, Gersún, Gedeún, Gomer, Guni, Habacuc, Agar, Ana, Heber, Hepsiba, Hillel, Hiram, Hulda, Ira, Isaac, Isaías, Isca, Ismael, Israel, Isacar, Itamar, Jabes, Jaime, Jared, Jasún, Jedidías, Jehiel, Joram, Josafat, Jemimah, Jeremías, Jerúnimo, Jesé, Jetrú, Juana, Job, Joel, Juan, Joaquin, Jonás, Jonatán, José, Josué, Josías, Judá, Judas, Judit, Keren, Cetura, Cesiah, Lázaro, Lea, Lemuel, Leví, Lilit, Loida, Lucas, Lucio, Lidia, Magdalena, Malaquías, Mara, Marcos, Marta, Maria, Mateo, Matías, Meetabel, Melchor, Menajem, Mesullam, Miguel, Micaela, Mical, Míriam, Mardoqueo, Moisés, Nahúm, Noemí, Neftalí, Natán, Natanael, Nicodemo, Noé, Abdías, Oded, Omar, Omri, Ophrah, Pablo, Paula, Peleg, Pérsida, Fineas, Priscila, Raquel, Rafael, Rebeca, Rubén, Rehuel, Rhode, Ruth, Salomé, Sansún, Samuel, Sara, Saúl, Set, Selomith, Silas, Simeún, Simún, Salomún, Susana, Tabita, Talitha, Tamar, Tadeo, Teofilo, Tomás, Ticva, Timoteo, Tobías, Urías, Uriel, Ozías, Uzziel, Yael, Sadoc, Zabulún, Zacarías, Sedecías, Sofonías, Sila, and Séfora.

In a robustness check (see columns 1 and 2 in Table E3), we also incorporate name variants in the respective languages. The English-language variants are Aron, Arron, Arun, Avishag, Avital, Avner, Avraham, Avrom, Absolon, Ada, Andreas, Artemus, Atara, Azaria, Azarias, Balthasar, Batsheva, Boas, Kaleb, Casper, Chloris, Danyal, Debora, Debrah, Debra, Debbra, Delila, Dina, Dine, Ellis, Eleazar, Eliyahu, Eliseo, Elisabeth, Emanuel, Enosh, Rastus, Hadassah, Eitan, Etan, Eva, Heskel, Haskel, Esdras, Habakkuk, Anne, Hepzibah, Huldah, Yitzhak, Jessica, Jesca, Jessika, Etamar, Isamar, Ithamar, James, Jered, Yered, Jarod, Jarrod, Yehiel, Yehoram, Jeremy, Johannes, Johanan, Joachim, Jonas, Jonathon, Johnathan, Yosef, Yehoshua, Yehuda, Yehudit, Juditha, Kerena, Keren-happuch, Keziah, Lea, Luke, Madeleine, Marcus, Maria, Miriam, Mathew, Mathias, Mehitable, Mehetabel, Melichior, Menachem, Meshullam, Micah, Miriamne, Ophra, Ofra, Pauline, Paulette, Pinhas, Pinchas, Phinehas, Priscilla, Rachelle, Racheal, Rebekah, Reuven, Raguel, Sampson, Shimshon, Shemuel, Sara, Zara, Shimeon, Shlomo, Suzanna, Susan, Dorcas, Tamara, Tikva, Tobiah, Urias, Uziah, Uziel, Jael, Zeb, Zachary, Zacharias, Zachariah, Zed, and Zeph.

The additional French-language name variants are Abishag, Absalon, Avshalom, Artémas, Azaria, Booz, Cloe, Dvora, Héli, Emanuel, Immanuel, Hadassah, Ezra, Guershom, Gideon, Gomer, Habaquq, Hephtsiba, Ésaïe, Jared, Jeremiah, Isaï, Yann, Kéren-Happuc, Ketura, Qetuwrah, Keziah, Ketzia, Lia, Madeleine, Menakhem, Michelle, Miriam, Mirjam, Miryam, Neftali, Pauline, Paulette, Phinée, Phinéas, Pinhas, Finéas, Priscilla, Prisca, Shimon, Dorcas, Urie, Ourias, Ouriel, Jaël, Jahel, Mathanias, Zillah, Tsippora, and Zéphora.

The additional erman-language variants are Absalom, Abischalom, Artemas, Asser, Azariah, Asarja, Kandake, Kasper, Elia, Elisa, Enoch, Esther, Eunice, Hesekiel, Jaebez, Iason, Jedediah, Jedidiah, Jeremias, Jesse, Hiob, Job, Johannes, Johan, Jochim, Jochem, Jochen, Jonas, Josia, Josias, Keren-Happuch, Leah, Lucas, Marthe, Miriam, Myriam, Moses, Naemi, Nathan, Noach, Priskilla, Priszilla, Rafael, Rut, Samson, Seth, Salomon, Tabita, Tabea, Dorcas, Talita, Theofilos, Theophilos, Yael, Secharja, and Zephania.

The additional Italian-language variants are Abshalom, Abishalom, Artemas, Atarah, Bartolommeo, Boaz, Elia, Eliezer, Enosh, Ezra, Heftsiba, Ulda, Hulda, Jared, Gerolamo, Geronimo, Jesse, Gianni, Gioachino, Lea, Menaem, Menahem, Menaham, Mical, Mordecai, Paula, Raffaello, Rut, Tabitah, Dorcas, Tadzio, Uria, Uriele, Sephora, and Zippora.

Finally, the additional Spanish-language variants are Andreu, Artemas, Asaph, Bathsheba, Elí, Enoch, Enoq, Henoc, Enosh, Hadassah, Hagar, Jacobo, Santiago, Isai, Joan, Xoán, Yehoshúa, Keren-happuch,

Cesia, Lia, Lluc, Marita, Mateu, Menahem, Manahem, Michal, Micol, Mikal, Finehas, Pricila, Prisila, Rebekah, Rivka, Rut, Shimon, Tabitha, Dorcas, Urías, Uzías, Jael, Sedequías, Zila, Silá, and Zipúra.

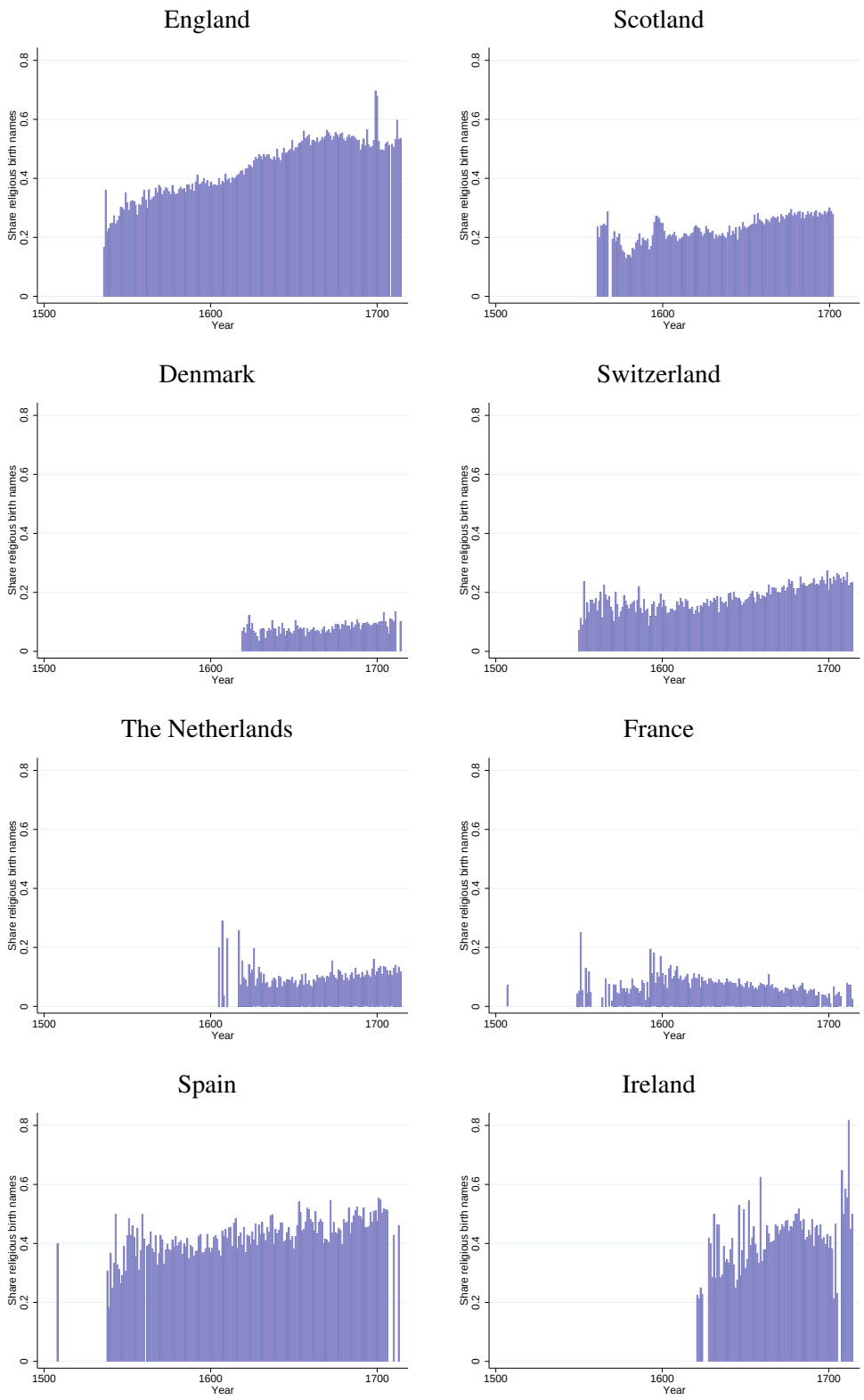

Figure C1: Share of religious birth names on FamilySearch (2022) from 1500 to 1714.

Appendix D: Preparing War Data

We use data compiled by Brecke (2012a,b) to derive a dyadic database of interstate warfare for the period 1400-2000. Brecke (2012a,b) delineates attacking parties (mentioned first) from defending parties (mentioned second) in each recorded historical conflict, and we start by matching these to historical states. We use the *Encyclopedia Britannica* to identify those parties that clearly correspond to historical states, supplementing this with data from the following sources: Hucker (1958), Cunnison (1961), Shahbazi and Bosworth (1990), Sinopoli (1994), Dunnell et al. (2004), Kowalska-Pietrzak (2007), Arias Guillén (2013), and New World Encyclopedia (2020). As our last resort, if no other credible records are available online, we draw on Wikipedia.

For the full 1400-2000 sample, of the 1,296 distinct party names which appear in Brecke's (2012a; 2012b) database, we match 851 with 429 defined states. For all states, we also code capital cities, as well as establishment and abolition dates to enable the subsequent coding of dyads and solar eclipses. This leaves 445 party names we are unable to match to states, which include non-state ethnic and tribal groups with no defined capital, as well as a few states without reliable historical records of capital cities, their establishment, and abolition dates.

We then code a dyad for each unique pair of one attacking and one defending state that appears in conflicts. This results in 1,277 dyads with 156 different attacking states. When considering attacking states in Europe, where the bulk of our specifications focus, we have 201 dyads with 11 different attacking states. Conflicts where at least one side (attacking or defending) does not include an identifiable state and conflicts listing one party only (often civil wars) are excluded from the analysis. Where Brecke (2012a,b) lists multiple attacking and/or defending states in a conflict, every possible combination is given its own dyad.

Appendix E: Additional Figures and Tables

Table E1: Solar eclipses and data availability for state i and year t.

	(1)	(2)
Dependent variable:	ln(# of books)$_{i,t}$	ln(# of names)$_{i,t}$
Source:	*Google Ngram*	*FamilySearch*
Solar eclipses$_{i,t}$	0.122	-0.209
	(0.183)	(0.166)
N	987	1,108

Notes: Standard errors clustered at the state level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E2: Robustness checks I, predicting attack war onset of state i against state j in year t in the standard 2SLS specification. To facilitate readability and interpretation of coefficients, the religiosity variables are standardized. All regressions control for dyad- and year-fixed effects.

	Excl. Prussia & Kingdom of Sardinia		Excl. Spain				Incl. dyad-specific time trends		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Displaying 2nd stage coefficient, predicting attack war onset$_{i-j,t}$									
% religious terminology$_{i,t-1}$	0.091**		0.056**				0.104**		
	(0.041)		(0.022)				(0.047)		
$\left(\frac{\%\ religious\ terminology}{\%\ religious + \%\ scientific\ terminology}\right)_{i,t-1}$		0.047**		0.130**				0.058**	
		(0.022)		(0.059)				(0.026)	
Change in % religious terminology$_{i,t-1}$					0.026***				
					(0.010)				
$\left(\frac{\%\ religious\ terminology}{\%\ scientific\ terminology}\right)_{i,t-1}$						0.296**			
						(0.115)			
% religious baby names$_{i,t-1}$									0.957**
									(0.408)
N	18,725	17,951	15,575	14,965	20,664	21,313	21,313	20,523	20,913

Notes: Standard errors clustered at the dyad level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E3: Robustness checks II, predicting attack war onset of state i against state j in year t in the standard 2SLS specification. To facilitate readability and interpretation of coefficients, the religiosity variables are standardized. All regressions control for dyad- and year-fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Displaying 2^{nd} stage coefficient, predicting attack war onset$_{i-j,t}$						
% religious terminology$_{i,t-1}$	0.129**					
	(0.056)					
$\left(\frac{\%\ religious\ terminology}{\%\ religious\ +\ \%\ scientific\ terminology}\right)_{i,t-1}$		0.126**				
		(0.050)				
% religious baby names$_{i,t-1}$			0.313***	0.275**	0.269**	0.264**
			(0.117)	(0.138)	(0.132)	(0.128)
Specification:	SE dummy^a	SE dummy^a	SE dummy^a	20+ names^b	30+ names^b	40+ names^b
N	21,313	20,523	20,913	19,967	19,536	19,127

Notes: Standard errors clustered at the dyad level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ^{a}Employs a binary indicator for a solar eclipse in capital city of state i in year $t-1$. ^{b}Only uses state-year observations for which at least 20, 30, or 40 names are available on *FamilySearch*, respectively.

Table E4: Robustness checks III, predicting attack war onset of state i against state j in year t. To facilitate readability and interpretation of coefficients, the religiosity variables are standardized. All regressions control for dyad- and year-fixed effects.

	Including name variants		Data until 1720			Data until 1730		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimation method:	OLS				IV			
Displaying 2nd stage coefficient, predicting attack war onset$_{i-j,t}$								
% religious baby names$_{i,t-1}$ (incl. name variants)	0.0003**	0.0078***						
	(0.0001)	(0.0025)						
% religious terminology$_{i,t-1}$			0.1233**			0.1512**		
			(0.0500)			(0.0631)		
$\left(\frac{\%\ religious\ terminology}{\%\ religious\ +\ \%scientific\ terminology}\right)_{i,t-1}$				0.3650**			0.3868**	
				(0.1503)			(0.1577)	
% religious baby names$_{i,t-1}$					0.0211***			0.0211***
					(0.0077)			(0.0077)
N	20,913	20,913	22,011	21,221	21,034	23,100	22,310	21,034

Notes: Standard errors clustered at the dyad level are displayed in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a]Employs a binary indicator for a solar eclipse in capital city of state i in year $t-1$. [b]Only uses state-year observations for which at least 20, 30, or 40 names are available on *FamilySearch*, respectively.

Table E5: Summary Statistics for city-year-level database on Jewish persecutions from 864 cities for the years 1400-1714.

Variable	Mean (Std. Dev.)	Min. (Max.)	N	Data source
Jewish persecution$_{i,t}$	0.0022 (0.0464)	0 (1)	336,735	Encyclopedia Judaica (2007); Anderson et al. (2017)
Jewish pogrom$_{i,t}$	0.0008 (0.0277)	0 (1)	336,735	Encyclopedia Judaica (2007); Anderson et al. (2017)
Jewish expulsion$_{i,t}$	0.0015 (0.0387)	0 (1)	336,735	Encyclopedia Judaica (2007); Anderson et al. (2017)
Solar eclipse$_{i,t-1}$	0.0531 (0.2242)	0 (1)	336,735	Jubier (2020)
Placebo solar eclipses$_{i,t-1}$ (before sunrise or after sunset)	0.0739 (0.2616)	0 (1)	336,735	Jubier (2020)
Population density$_{i,t}$	11.4046 (11.1489)	0 (256.5203)	294,840	Bosker et al. (2013); Anderson et al. (2017)
Temperature$_{i,t}$	-0.1759 (0.5434)	-3.5334 (1.7591)	336,735	Guiot et al. (2010); Anderson et al. (2017)
Low capital protection$_{i,t}$	1.5419 (0.8563)	1 (5)	336,735	Acemoglu et al. (2005); Anderson et al. (2017)

Table E6: Summary Statistics for city-year-level database on witch trials from 836 cities for the years 1300-1714.

Variable	Mean (Std. Dev.)	Min. (Max.)	N	Data source
Witch trial (0/1)$_{i,t}$	0.0129 (0.1128)	0 (1)	307,568	Leeson and Russ (2018)
Max. # of witch trials$_{i,t}$	0.1619 (2.8565)	0 (219)	307,568	Leeson and Russ (2018)
Avg. # of witch trials$_{i,t}$	0.0380 (0.6856)	0 (219)	307,568	Leeson and Russ (2018)
Solar eclipse$_{i,t-1}$	0.0505 (0.2189)	0 (1)	307,567	Jubier (2020)
Placebo solar eclipses$_{i,t-1}$ (before sunrise or after sunset)	0.0578 (0.2334)	0 (1)	307,567	Jubier (2020)