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Modernization Before Industrialization: Cultural Roots of the Demographic Transition in France

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Abstract

This research identifies the origins of the early demographic transition in eighteenth-century France. Before the French Revolution and more than a hundred years before the rest of Europe, this event remains one of the “big questions of history” in part because of limited data availability. I first document an important process of dechristianization with never-before-used data on religious beliefs across time and space. Using standard econometric methods and machine learning with census data, I find large, significant, and robust results suggesting that secularization accounts for the bulk of the decline in fertility. Finally, I draw on a novel dataset crowdsourced from publicly available genealogies in order to study individuals at the time and to establish a causal interpretation. I control for time-varying unobservables with fixed effects, study the effect of religiosity before and after secularization with difference-in-differences, and exploit the choices of second-generation migrants to account for unobserved institutional factors. These findings reveal that changes in preferences and the transition away from tradition may shape development.

JEL codes: N33, O10, Z12

Keywords: fertility, development, secularization

And the race of man cannot, by any efforts of reason, escape from it.

—Thomas Malthus, *An Essay on the Principle of Population* (1798)

1 INTRODUCTION

In the eighteenth and nineteenth centuries, the transition to sustained economic growth triggered dramatic upheavals when parts of the world escaped the Malthusian stagnation that characterized most of human history because demographic expansion offset increases

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in income. In particular, a shift towards modernity and away from tradition took place. Did industrialization and development come first, followed by a wave of institutional, demographic, and cultural changes? Or did these changes pave the way for income per capita to rise above subsistence level?

This paper argues that secularization, not development, brought about the demographic transition in eighteenth-century France; modernization materialized before industrialization. Why the historical fertility transition started in France first, more than a century before the rest of the world, is a mystery.¹ It is one of “the big questions of history” (Darnton, 1978) and, according to Sauvy (1962) “the most important fact of her [France] entire history”. While the rest of Europe went through the demographic transition in the late nineteenth century, after the Industrial Revolution, the onset of the decline in fertility in France is dated to the second half of the eighteenth century, between 1760 and 1776.² Because it took place so long ago, there is a lack of available data and the roots of the decline are still not understood.

In many ways, France was a developing country in the eighteenth century. In 1750, literacy in France was half that of England and Wales. France attained the GDP per capita of 1750 England and Wales, the cradle of the Industrial Revolution, only in the aftermath of World War I, and it took more than two centuries to achieve the rate of urbanization of 1750 England: only in 1950 did the urban population begin to outnumber the rural population in France. In the process of development and through the transition to modern growth, the demographic transition played a major part with the Industrial Revolution (Galor and Weil, 2000; Hansen and Prescott, 2002; Kremer, 1993).³ For that reason, France is an exceptional case for studying the effect of social norms on economic outcomes.

Also before any other country, dechristianization took hold in eighteenth-century France with an important loosening of traditional religious moral constraints (Chartier, 1991; Van Kley, 1996; Vovelle, 1982). Braudel (1986*b*) evokes “the liberation of Frenchmen from the teachings, the restrictions, and the yoke of the Catholic Church”. The weakening of the moral authority of the Roman Catholic Church left a profound and lasting impact on France. Secular beliefs spread “in a veritable flood” (Tackett, 1986, p. 252) and “irreligion was able to become a general and dominant passion” (de Tocqueville, 1856, Book 3, Chapter 2). In some regions the move away from religion took place exceptionally early, in the first half of the eighteenth century (Vovelle, 1973).

Using a variety of standard, recently developed, and rigorous empirical methods with census data, and a novel individual-level dataset crowdsourced from publicly available genealogies, I establish that places that remained more religious have higher fertility, suggesting that the wave of secularization played a significant role in the demographic transition.

¹See, among many others, Coale and Watkins (1986); Cummins (2012); Henry (1972*a,b*, 1978); Henry and Houdaille (1973); Knodel and Van de Walle (1979); Murphy (2015); Weir (1994); Wrigley (1985*a,b*).

²More details on the timing in Blanc (2020).

³“We all agree that the escape from the Malthusian trap is the most important event in world history” (McCloskey, 2008, Chapter 23).

I exploit variation in the intensity of religious beliefs after secularization, proxied by the population-weighted share of refractory clergy in 1791. The 1790 Civil Constitution of the Clergy required all clergymen to take an oath of allegiance to the secular state, which had to be taken “on a Sunday at the conclusion of the mass” (Decree on the clerical oath). The share of refractory clergy is a standard measure of devotion and loosening attachment to religion (Franck and Johnson, 2016; Squicciarini, 2020; Tackett, 1986), as suggested by the fact that it is highly correlated with all other available measures of religiosity. The data is available at the *département* and district levels.

In order to capture the extent of secularization and not pre-existing differences, I control for proxies for religiosity before secularization in most regressions. Additionally, I leverage novel and detailed micro-level data on secular beliefs across time and space in the region of Provence from 1690 to 1789 (Vovelle, 1973) in order to measure dechristianization. Using spatial variation, I show that the oath reflects not only the devotion of laypeople before the French Revolution but is also the product of the rise in secular attitudes over the previous hundred years. These results suggest that the main independent variable, the population-weighted share of refractory clergy, captures not only religiosity in 1791 but also dechristianization in the eighteenth century, rather than pre-existing differences.

While the roots of the process of dechristianization are not understood, I find suggestive evidence that secularization hit poor and rural areas disproportionately and was a separate process from the spread of the Enlightenment, hence biasing estimates of the effect of religiosity toward zero. Historians have also rejected the idea that changing religious beliefs were linked to improved standards of living or to the spread of a bourgeois ideology from elites to peasants (Hoffman, 1984; Vovelle, 1973).⁴

In the empirical analysis at the *département* level, I evaluate the cross-sectional determinants of the transition to low fertility using census data from 1831 to 1961. I find that religiosity in 1791 explains both the timing of the transition and the level of marital fertility. Using ordinary least squares and maximum-likelihood in order to account for censoring with a Tobit model, I estimate remarkably strong, significant, and robust coefficients across specifications. Decreasing religiosity in 1791 from the 75th to the 25th percentile of the distribution predicts a delay in the year of transition of more than one standard deviation, and I show that no other variable has an impact nearly as important.

I provide different strategies to show the robustness of the results and to suggest a causal effect using this data. First, in order to flexibly estimate the determinants of transition date, I use lasso, a supervised machine-learning technique that relies on a selection-and-shrinkage algorithm to find the best available predictors (Tibshirani, 1996). No other variable is selected when religiosity in 1791 is included. Second, instead of selecting coefficients, I turn to sensitivity analysis and estimate bounds on the parameters of interest across all 131,072

⁴For example, Hoffman (1984) suggests that the ultimate roots of this process are likely to be found in the alliance of political, economic, and religious elites in Catholic France and in the strong opposition they met with the Third Estate, leading to important political and religious turmoil throughout the eighteenth century.

combinations of possible models (Brodeur, Cook and Heyes, 2020b; Leamer, 1983; Leamer and Leonard, 1983). Not a single specification returns a coefficient that would make religiosity in 1791 either statistically or economically insignificant. Last, I account for spatial correlation and omitted variables. I find that fixed effects remove the spatial dependence, and I compute Conley-adjusted standard errors at different cutoffs to improve the precision of the estimation. I run thousands of simulations by replacing the independent and dependent variables with spatially correlated noise (Kelly, 2019) and find that only a negligible portion of these regressions returns significant coefficients. In order to account for omitted variables, I account for variations in the R^2 with the addition of controls and I estimate coefficients adjusted for selection on unobservables, with standard errors bootstrapped over thousands of replications (Oster, 2016). The results suggest that the estimated coefficient on religiosity is biased downward, as expected.

Finally, I study ordinary individuals at the time of the decline in fertility by using a novel crowdsourced historical dataset spanning several centuries and containing all publicly available genealogies on geni.com (Blanc, 2020; Kaplanis et al., 2018). Individuals born all over France, in rural and urban areas, are included. I show that the dataset is a representative sample and that selection into the sample is limited from roughly 1680 to 1920. I find that individuals born in places with high religiosity have more children; the effect is large, statistically significant, and robust. I estimate the effect of religiosity on fertility with Poisson, OLS, overdispersed-Poisson, and negative-binomial regressions, and, using distribution regressions (Chernozhukov, Fernández-Val and Melly, 2013), I show that large families experienced the largest drop in fertility as religiosity declined.

I reach causal estimates with the aid of different strategies that I apply to this setting for the first time. First, I study individuals born in the same *départements* and account for time-varying *département*-level unobservables with *département*-by-decade fixed effects. Then, I apply a difference-in-differences estimation method to identify the causal effect of religiosity, using the onset of secularization in the mid-eighteenth century. I find that religiosity in 1791 was positively associated with fertility after secularization took place but had a null and insignificant effect before, which suggests again that dechristianization, and not unobservable pre-existing differences, is being captured. Last, I study second-generation migrants in order to control for unobserved institutional factors. This is the first research to implement this estimation strategy in a historical setting and at such a granular level. I compare individuals born in the same district but originating from different places. I find that religiosity in the district in which the parents were born had a large effect on fertility, which persisted for generations and through migrations.

This paper makes numerous contributions. I identify the change in preferences that caused the early demographic transition in France: dechristianization and the move away from the teachings of the Roman Catholic Church.⁵ Second, I contribute to a vibrant literature that

⁵I also contribute to a literature that has emphasized the role of secular forces, often in the nineteenth and

has documented the persistence of culture over the very long run (Ashraf and Galor, 2013; Spolaore and Wacziarg, 2013; Voigtländer and Voth, 2012), but I empirically establish that cultural change, not persistence, is a determinant of development. Third, I contribute to a literature that has documented profound changes in religious beliefs in eighteenth-century France (Van Kley, 1996; Vovelle, 1973) that had important consequences (Le Bras, 1942-5; Todd and Le Bras, 1981). Fourth, this is the first research to exploit crowdsourced genealogies in order to study ordinary individuals in the past and the spatial determinants of fertility at the time of the demographic transition. Finally, the paper contributes to a large literature on the cultural and religious origins of the transition to sustained growth (Bénabou, Ticchi and Vindigni, 2015; McCloskey, 2016; Mokyr, 2016; Schulz et al., 2019; Squicciarini, 2020; Squicciarini and Voigtländer, 2015).

2 HISTORICAL BACKGROUND AND LITERATURE

2.1 Demographic transition and development

In every respect, eighteenth-century France lagged one to two hundred years behind England, the cradle of the Industrial Revolution. France attained the GDP per capita enjoyed by England and Wales in 1750 only in the 1920s (Bolt and van Zanden, 2014; Lévy-Leboyer and Bourguignon, 1985), the rate of urbanization England had in 1750 in 1950 (Bairoch, Batou and Chèvre, 1988), and the rate of literacy England had in 1650 in 1850 (Buringh and van Zanden, 2009). Weber (1976) depicts French people as “peasants” and “savages”, Crouzet (2003) notes that “France remained fundamentally a peasant-based rural economy. Only in 1911 did employment in industry overtake that in agriculture” (p. 236), and Lévy-Leboyer (1968) discusses “the absence of a take-off in France”.

Despite the absence of industrialization in France, GDP per capita increased at the same rate in France and England after 1750 and throughout the nineteenth century (Appendix Figure A2.1.1). The rate of population growth in England largely surpassed that in France: in the two centuries following 1750, the population of England increased from 5.5 to 40 million inhabitants, while the population of France increased from 24.5 to 40 million. Figure 1 displays fertility in France and in England and Wales between 1680 and 1920. In the 1750s and throughout the second half of the eighteenth century, average fertility significantly declined in France, while it remained significantly higher in England and Wales until the end of the nineteenth century.

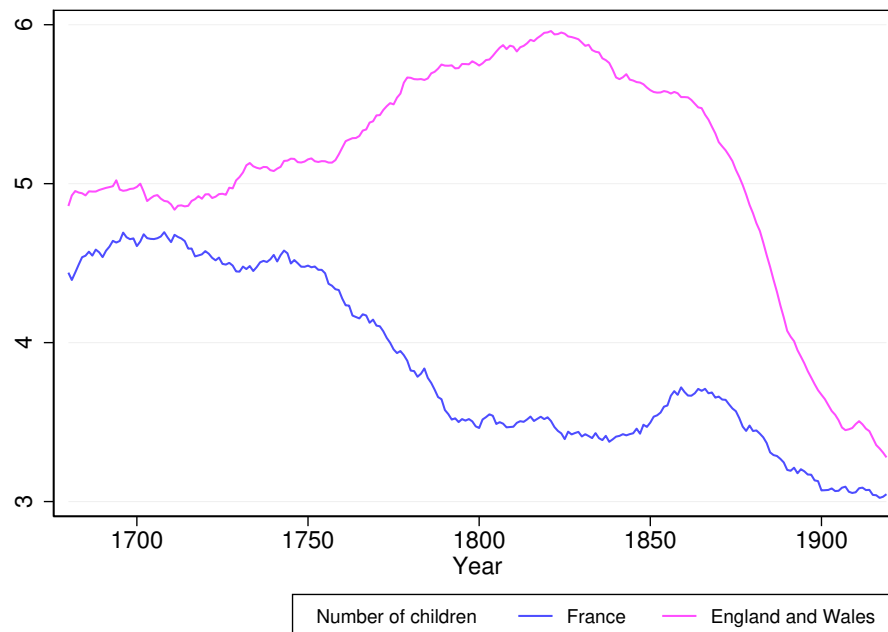
The early decline in fertility, a century before the rest of Europe, in an epoch of stagnation and before the French Revolution, has been the subject of numerous studies, yet why France experienced the demographic transition this early remains an open question. There is widespread agreement that cultural forces played a role (Braudel, 1986*b*; Sauvy, 1962),

twentieth centuries, on fertility behaviors (Hacker, 1999; Lesthaeghe, 1983, 2010) and those forces’ interaction with economic forces (Brown and Guinnane, 2002; Coale and Watkins, 1986).

but it remains one of the most important unsolved puzzles in historical demography and economic growth. The lack of data on an event taking place so long ago has so far hampered the effort to understand the roots of the decline.⁶ Demographer Louis Henry used methods of family reconstitution with parish records to reconstruct series of fertility in the eighteenth century (Henry, 1972a,b, 1978; Henry and Houdaille, 1973), and Coale and Watkins (1986) tried to assess the importance of economic and cultural factors in Europe using census data. However, parish-level studies do not offer sufficient spatial variation and suffer from many limitations, which I detail in Section 3.3, and census data only became available in 1831, long after the start of the demographic transition.

Figure 1: Demographic transition in France and England

Note: This figure displays the gross rate of fertility for France and for England and Wales over time. Appendix Figure A2.1.1 overlays GDP per capita on this graph. Source: Blanc (2020)



Contraception and the Catholic Church. Declining fertility was noticed even by contemporary observers and was attributed at the time to changing moral standards and preferences. Van de Walle and Muhsam (1995) provide a detailed and fascinating account of the evolution of sexual and moral preferences in the eighteenth century, in particular regarding the spread of *coitus interruptus* (withdrawal). In 1778 Jean-Baptiste Moheau famously used the term ‘funestes secrets’: “Already the fatal secrets *unknown to any animal but man* have penetrated in the countryside: *nature gets cheated* even in the villages.”

⁶A wide body of research, including Cummins (2012); Knodel and Van de Walle (1979); Weir (1994); Wrigley (1985a,b), studied the French fertility decline.

Moheau (1778) referred to the “*propagation of the species* as a dupery of olden times,” and according to Goudar (1756), “It is the same love of ease and convenience that is filling France with bachelors ... men who vanish from the world with all their posterity” (p. 271).

If modern methods of contraception became available well after the onset of the fertility decline, how did fertility decline? Early condoms, known as *redingotes d’Angleterre*, or ‘English riding coats’, were expensive and uncommon although they became more widespread in the Age of Enlightenment (for example, in his memoirs, Casanova reports radically changing his behavior and resorting systematically to condoms after 1760). Other methods of contraception include chastity (one of the seven virtues of the Christian faith), late marriage, sodomy, abortion, and infanticide (Van de Walle, 2005). Van de Walle and Muhsam (1995) also write of ‘the pleasures of the little goose’ (*les plaisirs de la petite oie*) to refer to mutual masturbation. These methods were less relevant since natural means of contraception such as *coitus interruptus* were no secret.⁷ Indeed the method of withdrawal “is mentioned in the Bible, the Talmud and the Muslim tradition” (Van de Walle, 2005). Van de Walle (2005) argues that it “was frequently alluded to in libertine literature” (p. 2), which was particularly widespread in eighteenth-century France (Darnton, 1991) in such works as *Venus in the Cloister or The Nun in her Smock* (1683), *The Indiscreet Jewels* (1748) by Diderot, and *Philosophy in the Bedroom* (1775) by the Marquis de Sade. Yet methods of *cheating nature* were practiced not only by the elite but also by peasants in the villages (Moheau, 1778), and it appears that withdrawal was the most widespread and efficient method at the time. Hence, Van de Walle and Muhsam (1995) hypothesize that “withdrawal was first practiced outside of marriage, but in marriage it found its true niche” (p. 276).

What were the views of the Catholic Church regarding contraception and sex remains an open question. The Bible urges, multiple times, the faithful to “be fertile, increase in number, and fill the earth” (Genesis 9:1), and the account of the sin of Onan designated both masturbation and ‘unnatural’ intercourse as evil. Still, the pronouncements of the church against contraception, while clear, were often discrete and indirect (Noonan, 1965).⁸ In 1439, the multiplicative purpose of marriage “received its strongest official approval” (Noonan, 1965, p. 276) in the *Exultate Deo* papal bull: “Through matrimony [the church] is corporally increased.” With the Council of Trent (1545–63) and the Counter-Reformation, the views of the Catholic Church shifted toward more sexual austerity outside of marriage and an increased sacramentality of marriage, suggesting the increased importance of these matters. Hoffman (1984) argues that “evidence of the new sexual morality appears throughout the Counter Reformation: bans upon nudity in religious art, harsher rules against illegitimacy, prostitution, and concubinage, and more ‘puritanical’ standards of dress and behavior.”

⁷As opposed to its Catholic counterparts—*implexus restrictus* for non-ejaculation and *amplexus reservatus* for nonpenetrative, rubbing-only sex—which were not very widespread.

⁸One of the inner struggles in the sexual morality promoted by the Catholic Church relates, indeed, to the dilemma between the multiplicative purpose of marriage and the sinful nature of ‘things of the flesh’ (Noonan, 1965). Noonan (1965) argues that “the value placed on human fecundity in the Old Testament as a whole is evident ... fruitfulness is a divine reward” (p. 31).

According to Van de Walle and Muhsam (1995), “The orthodox position available to French literati in the late sixteenth century [was that] it is considered sinful in marriage to ejaculate outside of the natural receptacle (*ex vas naturale*), and only somewhat less sinful to use ‘unnatural positions’” (p. 269): not only were innovations sinful, but the purpose of marriage was explicitly multiplicative. In the seventeenth century, notorious clergy members such as Francis de Sales and Pierre de Bourdeilles (Brantôme) referred to withdrawal and other contraceptive methods and argued that ‘*marital fertility should not be interfered with*’ (Van de Walle and Muhsam, 1995). For example, in *Les Dames galantes*, published in 1666, “Brantôme concludes that the belief that marriage is instituted for pleasure is wrong and that the greatest blessing God can send in marriage is ‘a good lineage and not through concubinage’” (Van de Walle and Muhsam, 1995, p. 269). Hence, there is mounting evidence that the Catholic clergy in the eighteenth century understood marriage and sex to be acts of procreation, as opposed to pleasure. In the early eighteenth century, the sacramentality of marriage was also increasingly criticized by the lay population—especially following the Edict of 1715 forbidding Protestants from marrying and after the controversy of the *billets de confessions* in the 1750s when the Church denied sacraments and burial in consecrated ground to Jansenists (Maire, 2019). For this reason, when secularization took place, the move away from the teachings of the Roman Catholic Church may have played a role in the decline in fertility.

Theory and empirics. According to standard economic theory, development is the best contraceptive (Hansen and Prescott, 2002; Kremer, 1993). The endogenous-growth models developed by Galor (2011); Galor and Weil (2000); Galor and Moav (2002) shed light on the interaction between human-capital accumulation, fertility, and technological progress in the long run: in the course of history, as technological progress accelerates, the return to human capital rises and fertility decisions are altered, triggering the transition. While a society is in the Malthusian trap, income per capita fluctuates around subsistence level because of the positive relationship between income and fertility. When quality is favored to quantity, the relationship reverses and the economy enters the modern growth era, in which human capital is the driver of progress. Institutional, cultural, and geographic factors interact with these forces but are not the main determinants of change.

In recent years, a number of empirical studies have tried to assess the forces driving the demographic transition in France, especially by weighing the relative importance of economic and cultural forces broadly (de la Croix and Perrin, 2018; Murphy, 2015).⁹ On the cultural origins of the transition, Blanc and Wacziarg (2020); Daudin, Franck and Rapoport (2018) study the diffusion of norms of limited fertility within France and Spolaore and Wacziarg (2019) show that the reduction in the rate of fertility in nineteenth-century Europe was

⁹Murphy (2015) suggests that the French Revolution may have been one of many causes of the decline. He examines the cross-sectional determinants of fertility in France and devotes a couple of paragraphs to the effect of the oath on fertility at the *département* level in 1831.

driven by a diffusion of norms originating in France.¹⁰ Yet no research has empirically established the cause of the decline in fertility in France.

2.2 Religion and secularization in France

Since medieval times, France has been known as “the eldest daughter of the Roman Catholic Church,” French kings as “Rex Christianissimus” or ‘most Christian king’, and the French as “God’s chosen people” (Burleigh, 2005, p. 23). This section briefly summarizes the chain of events that brought about a radical change in beliefs and religiosity in the mid-eighteenth century.

France is a major Roman Catholic country that hosted seven successive popes from 1309 to 1378. During the Renaissance, and particularly after the reign of Francis I, Protestantism marginally spread, reaching an estimated 10 percent of the population in the mid-sixteenth century (most of these Huguenots). The second half of the sixteenth century was a period of violent religious wars and political unrest, a period whose apex was the massacre of thousands of Protestants on Saint Bartholomew’s Day in 1572. In 1593, after fighting a war of succession against the Holy League to gain access to the throne, Henry IV of France renounced Protestantism and, for the second time since Saint Bartholomew’s Day, was forced to convert to Catholicism. The promulgation of the Edict of Nantes in 1598 finally put an end to the French Wars of Religion by granting Huguenots substantial rights and freedom of religion.

In the seventeenth century, France remained predominantly Catholic, and in 1685, Louis XIV revoked the Edict of Nantes with the Edict of Fontainebleau, effectively ending religious toleration. The edict deprived Protestants of all religious and civil liberties and ordered the destruction of Huguenots’ churches. *Dragonnades*—policies of legal persecution and forced conversion of Protestants ordered by Louis XIV—epitomized the fight and terror against the Protestant Reformation: dragoons (infantry soldiers) were billeted in Protestant households in order to harass and intimidate the Huguenots. Thousands of Protestants left France, and it set the course for the diffusion and strengthening of the Catholic resurgence.¹¹

With the demise of Protestantism the Counter-Reformation was able to spread unchecked, for the most part with the rise of Jansenism, a pious, austere, and rigorist theological movement unique to France. Jansenists were at the center of the controversies and clashes of the time, especially the clashes with the monarchy and Jesuits, who embodied the religious and economic elite and were also at the forefront of the Counter-Reformation.¹² Appendix Section A2.2 provides further details on clashes involving Jansenists, Jesuits, and the monar-

¹⁰The existence of deep-rooted barriers to the adoption of innovation has been documented in Spolaore and Wacziarg (2009). See also Delventhal, Fernández-Villaverde and Guner (2019) for the diffusion of the fertility transition across countries and Beach and Hanlon (2019) for a fascinating account of changing norms of fertility following the Bradlaugh-Besant trial of 1877 in England.

¹¹See Hornung (2014) for the long-run effects of the forced migration of Huguenots to Prussia.

¹²Tackett (1986) writes that “during the first half of the eighteenth century, one issue in diocesan politics dominated all others: the issue of Jansenism” (p. 128).

chy. Elites strongly opposed Jansenism, which sought to advance ideas of predestination of the elect to salvation, limitation of the sacraments, and the need for penitence—ideas also advanced in Protestantism. The opposition was not only theological but also political, as Jansenists came to embrace Gallicanism, a movement promoting the independence of the Church of France from not only the pope, but also a monarchy endowed with divine right (Maire, 1998, 2019).

Secularization. In the mid-eighteenth century, dechristianization spread to many regions of France.¹³ In comparison to the rest of Europe, the loss of moral influence of the Roman Catholic Church took place exceptionally early and at a particularly important scale in France (Todd, 1990). According to Tackett (1986) secular beliefs spread “in a veritable flood” (p. 252), de Tocqueville (1856) writes that “irreligion was able to become a general and dominant passion in eighteenth-century France” (Book 3, Chapter 2), and historian Braudel (1986b) evokes “the liberation of Frenchmen from the teachings, the restrictions, and the yoke of the Catholic Church”.

Secularization and its timing have been documented by historians in a number of regions. In particular, Vovelle (1973) documents a transition to secular attitudes and *mutation de sensibilité collective* in a fascinating and path-breaking study of Provence, in the south east of France. Similarly, Hoffman (1984) and Norberg (1985) find substantial changes in the rural parts of the diocese of Lyon and in the diocese of Grenoble in the eighteenth century. The change in attitudes could be observed in a decline in bequests and legacies for perpetual masses and offerings to the church, a decline in requests for burials in holy places, and a decline in the number of invocations of God, Jesus Christ, Virgin Mary, or various saints in wills at death, especially in Provence (Vovelle, 1973). In Brittany, evidence that such a change occurred is much more limited (Bois, 1960; Tingle, 2012), while Paris saw substantial heterogeneity, with parts experiencing a much larger decline in devotion than others (Chaunu, 1978).

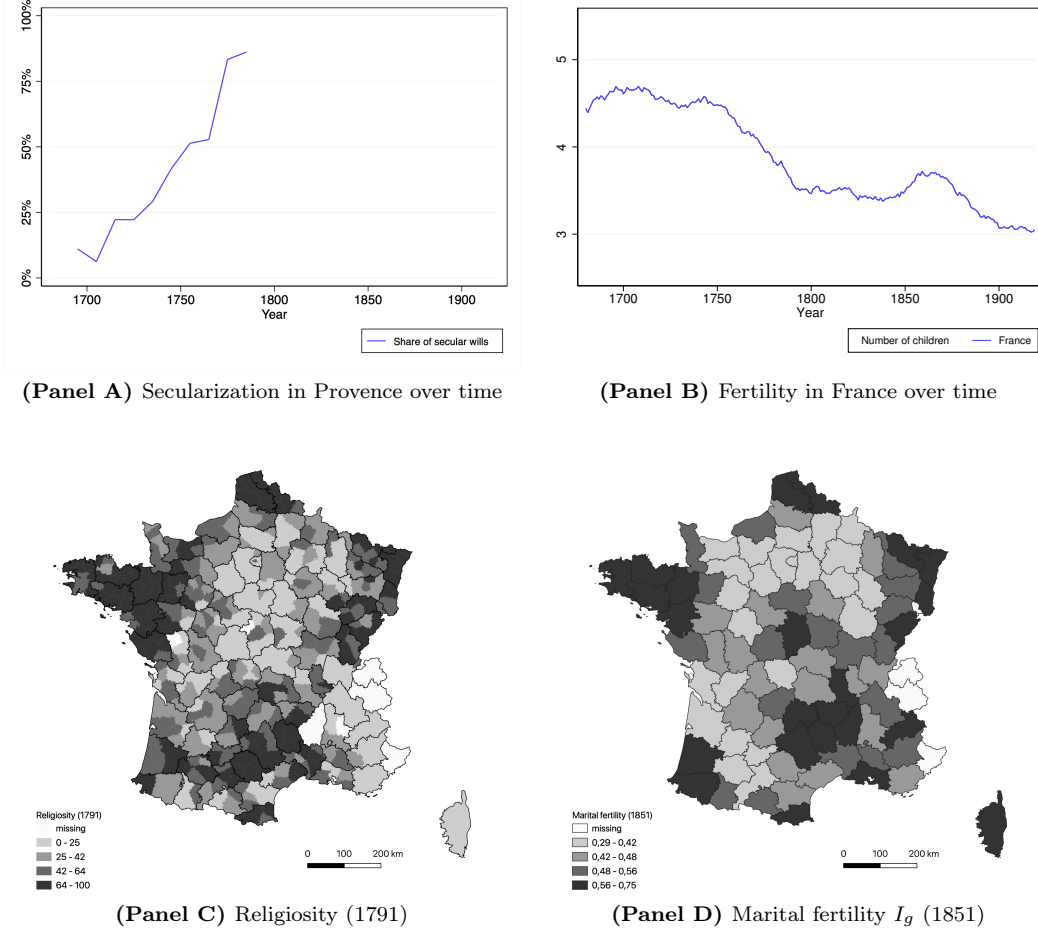
In Figure 2, I display religiosity across time (Panel A) and across space in 1791 (Panel A) with fertility across time (Panel B) and across space in 1851 (Panel D)—details are provided in Sections 3 and 4.2. Some regions, particularly Brittany, Paris, and Occitanie, were very religious, while other regions were much less religious in the late eighteenth century, an observation in line with historical and anecdotal evidence on dechristianization in Provence

¹³Note that, at least in the first place, dechristianization was not a generalized turn to atheism but rather a “mutation de sensibilité collective” (Vovelle, 1973). Why dechristianization happened so early is a mystery. The austere morality imposed by the Counter-Reformation in France, its association with political and economic elites, the rigorism of Jansenists, and the religious competition between the Jansenists and Jesuits are believed to have precipitated social unrest and the decline in religiosity (Hoffman, 1984; Maire, 1998; Tackett, 1986; Van Kley, 1996). According to Hoffman (1984), “the Counter Reformation’s austere morality was imposed in full force ... not surprisingly, it was rejected by people who saw nothing wrong in combining devotion and gaiety” (p. 138). Tackett (1986) evokes “epic struggles with the Jesuits” (p. 6) and argues that “a whole series of affaires and causes célèbres, from the repression of the convulsionnaires in the 1730’s through the billets de confessions in the 1750’s and the expulsion the Jesuits in the 1760’s, had contributed in broadly publicizing and intensifying grievances toward the clergy.” (p. 257). According to Braudel (1986b), “the drama played out in the 18th century was a sort of revenge on the part of the Reformation. Having hesitated, two centuries earlier, between Rome and Luther, or rather between Rome and Calvin, France had chosen Rome, but the choice backfired” (p. 200).

and Auvergne-Rhône-Alpes (Hoffman, 1984; Norberg, 1985; Tingle, 2012; Vovelle, 1973).¹⁴

Figure 2: Religiosity and fertility

Note: This figure displays religiosity and fertility across time and space. Panel A displays secularization over time in Provence (?). Panel B displays fertility over time in France (Blanc, 2020). Panel C displays the spatial distribution of *Religiosity (1791)* and Panel D displays the spatial distribution of the fertility index I_g in 1851. Section 4.2 details the measure of secularization in Provence, which is available from the 1690s to the 1780s. *Religiosity (1791)* is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Section 3 details the measures used in Panels B-D.



3 DATA

This section presents the main data sources and variables. The main explanatory variable is introduced in Section 3.1, and I present the dependent variables and controls at the *département* level in 3.2 and at the individual level in 3.3.

¹⁴Note that Savoy—which was not part of France—had a high level of marital fertility after 1851, when the data became available. This is consistent with the evidence presented by Chartier (1991) showing the absence of secularization there: “Habits thus seem to have been quite different on different sides of the frontier, which suggests the singularity of dechristianization in France” (p. 97).

Départements have been the main administrative units in France since 1790. All are of nearly equal size (about 2,300 square miles) and designed to ensure that travel by horse from any location within the *département* to the main administrative center would not exceed one day. Districts are lower-level units, with close to no administrative purpose, and were created in 1790 such that there could not be more than 9 or less than 3 districts per *département*. They were replaced by and merged into (larger) *arrondissements* in 1795. In total, there are ninety *départements* and 513 districts.¹⁵

3.1 Religiosity

After secularization. The main explanatory variable throughout the paper is the share of refractory clergy in 1791—after the bulk of secularization.¹⁶ In July 1790, during the French Revolution, the National Constituent Assembly passed the Civil Constitution of the Clergy, which required all clergymen to swear an oath of loyalty to the secular state. I use the share of clergymen that did not take the oath (known as refractory clergy or non-jurors) to proxy for religiosity in 1791. According to Tackett (1986), “The regional reactions of clergymen in 1791 can be revealing of the attitudes and religious options of the lay population with which the clergymen lived” (p. xvi).¹⁷

The oath has been commonly used in the literature as a proxy for religiosity in late-eighteenth-century France (Franck and Johnson, 2016; Squicciarini, 2020) and there is widespread evidence that the refractory clergy captured religiosity on the eve of the French Revolution remarkably well. According to Tackett (1986), “The map of clerical reactions in 1791 was remarkably similar to the map of religious practice in the middle of the twentieth century” (p. xv). In Sections 4.1 and 4.2, I also show that the presence of refractory clergy is highly correlated with religious practices and attitudes at the time of the decline of religiosity and in the nineteenth and twentieth centuries. For that reason, the population weighed share of refractory clergy in 1791 is henceforth referred to as religiosity in 1791, or *Religiosity (1791)*, in the main tables and figures.

Importantly, the share of refractory clergy is measured before the August 1792 decree that ordered all non-jurors to leave the country and before the War in Vendée, the Paris Commune, the Reign of Terror, and the establishment of anticlerical cults (the Cult of Reason and the Cult of the Supreme Being, among others). Moreover, before the 1792 decree, according to Tackett (1986), “the National Assembly ... allowed the continued presence of the refractory clergy.” Hence, the refractory clergy in 1791 does not capture the effect of the main revolutionary events and policies of dechristianization but rather religious attitudes right before the French Revolution. In order to account for state legitimacy at the

¹⁵For regions, I use the 2016 division of thirteen regions. I generate district boundaries with Thiessen polygons.

¹⁶Because the oath is measured at the district level, I use the district population-weighted average of the district-level share of refractory clergy in the analysis at the *département* level.

¹⁷The oath generated passionate reactions everywhere: “the issue of the oath soon became a veritable obsession, unleashing emotional reactions and factional strife in parishes everywhere” (Tackett, 1986, p. 4).

time of the French Revolution, I control for the share of deserters among conscripts in the French army between 1798 and 1805 (Forrest, 1989).¹⁸

The data on oath-taking priests in 1791 are available at the *département*, diocese, and district levels and are constructed from the choices of more than fifty thousand parish clergymen, who made up more than 90 percent of all priests and vicars holding posts (Tackett, 1986, p. 39). At the district level, the share of non-oath-taking priests is almost uniformly distributed from 0 to 1, while it varies from 8 to 91 percent at the *département* level, with an average of 48 percent.

Before secularization. Given the fact that the loss of influence on the part of the Roman Catholic Church took hold in France in the eighteenth century, showing that devotion has a positive impact on fertility should be sufficient to claim that dechristianization accounts for the decline in fertility. Yet in the paper I try to capture dechristianization—the decline in religiosity. In particular, I leverage data on devotion in both time and space in Section 4.2 and find an important correlation of the change in devotion over time with religiosity in 1791, suggesting that the distribution of religiosity in 1791 is indeed the result of the process of secularization.

At the *département* level, I supplement the data on religiosity in 1791 with a set of controls aimed at capturing pre-existing differences in devotion, before secularization. The pre-secularization religiosity controls include the number of clergymen per capita in 1791, the average tithe in 1750, the number of abbeys in 1756, the duration of Jesuit presence before 1763, and finally the share of Protestants in 1815, after the revocation of the Edict of Nantes.¹⁹ The first three measures aim at capturing religiosity in the pre-1750 era.²⁰ The prevalence of clergymen was particularly high, with one per five hundred inhabitants. Abbeys and monasteries played a significant role in local religious life (Heldring, Robinson and Vollmer, 2017) and are therefore included too. Finally, the average tithe is clearly a correlate of religiosity in a club-good model à la Iannaccone (1998). The last two measures are standard measures used to capture the presence of specific religious groups that may especially matter for upper-tail human capital—namely, Jesuits and Protestants. At the district level, I control for the number of abbeys and the duration of Jesuit presence and include dummies for their presence.

¹⁸Although there is no reason state legitimacy would have any impact on fertility. Because of that, I expect that the coefficient estimated from the regression of fertility on the share of refractory clergy will be the same as the coefficient on religiosity, irrespective of whether I control for proxies for state legitimacy.

¹⁹I do not include the 1670 measure of the share of Protestants (the only other available year) because it would not capture the effect of the revocation of the Edict of Nantes in 1685. Including the 1670 share of Protestants instead does not change the point estimates but increases standard errors because the number of observations is lower.

²⁰Clergymen per capita is measured in 1791, at the same time as the share of refractory clergymen is measured. However, this is a stock measure, and it is unlikely that the total number of clergymen would have immediately declined following the decline in religiosity (if it did, it would drive the coefficient on the share of refractory clergy to zero). Point estimates are larger in most regressions without adding this control.

3.2 Département level

Marital fertility. The main dependent variable at the *département* level is the index of marital fertility, I_g . The index was constructed by Coale and Watkins (1986) as part of the Princeton European Fertility Project (PEFP), and it is available for about eighty *départements*. The PEFP provides data at the subnational level for all countries in Europe (in France, they are at the *département* level).²¹

The index I_g measures the fertility of a population relative to the maximum that might be attained—that is, “how closely the married population approaches the maximum fertility it might experience” (Coale and Watkins, 1986, p. 161). It is constructed from the counts of the French census. It equals the total number of children born to married women divided by the number of children that would be born to these women had they not practiced any form of limitation (the denominator uses data from the Hutterites, an Anabaptist sect that does not practice any fertility control):

$$(I_g)_i = \frac{B_i^m}{\sum_j M_{ij} G_j}$$

B_i^m is the total number of children born to married women in society i , M_{ij} the number of married women in age cohort j , and G_j the rate of fertility of Hutterites for age cohort j . I focus on marital fertility rather than overall fertility because it is the standard measure to detect the presence of fertility control achieved through parity-specific means (Coale and Watkins, 1986). Table A3.2.1 Panel A presents summary statistics for the index of marital fertility. The index is available for nineteen years (from 1831 to 1961) and decreases from 0.56 to 0.33. Section 5 reports cross-sectional regressions for both the year of transition to a marital-fertility index below 50 percent and levels of marital fertility in 1851 and 1901.

Controls. I supplement these data with a set of controls used in the *département*-level regressions in Section 5. Table A3.2.2 details these controls while Figure A3.2.1 displays the spatial distribution of some variables of interest. In addition to the proxies for religiosity before secularization, I also control for broadly defined cultural and institutional factors with a dummy that measures the presence of a printing press in 1500, the number of books printed in 1500, a dummy for the presence of a university before 1750, *Encyclopédie* subscriptions per capita in the period 1776–79 (as a proxy for the diffusion of the Enlightenment), and linguistic distance from French in 1901. Institutional factors include dummies for *pays* status (fiscal regions in *Ancien Régime* France, which may capture differences in culture or state capacity), and the share of deserters among conscripts in the French army between 1798 and 1805. I further control for education using the literacy rate of conscripts in the year of observation. Finally, in order to control for pre-industrial development, I include *dé-*

²¹A number of minor issues have been identified with the data from the PEFP, mainly with respect to the identification of the presence of fertility controls—see Brown and Guinnane (2007); Guinnane (2011). These issues are less relevant in this context since I study fertility levels after the transition already took place.

partement-level population density (a standard proxy for development in the pre-industrial era—see Ashraf and Galor (2011)) and average soldier height before 1760. I control for contemporary development with the log rate of urbanization in the year of observation, defined as the share of the population living in towns with more than five thousand inhabitants.

3.3 Individual level

The *département*-level data are supplemented with a new individual-level dataset crowd-sourced from publicly available genealogies. Blanc (2020) reconstructs rates of completed fertility (number of children born) at the individual level from family trees posted on the genealogical website geni.com and scraped by Kaplanis et al. (2018). The dataset contains thousands of individuals and is nationally representative of France from roughly 1680 to 1920 (while the *département*-level data are only available after 1831).

Lineage reconstruction from crowdsourced genealogies relies on the work of descendants reconstituting their family tree today by searching through the same parish records as the ones used by demographers. Parish records are available online with unrestricted access in all French *départements* from the mid-seventeenth century onward. However, family reconstitution requires a great deal of information on handwritten birth, marriage, and death records of often-dubious quality (Séguy, 2001). Tracing fertility requires knowing all the birth records of the children of an individual. Because of poor handwriting, individuals with same first names, imprecise information (rounded dates, changing names), and migration, it is a very tedious job with results that are often imprecise. Descendants have better incentives than demographers to thoroughly gather this information and have a knowledge of family history and past migrations that may help them in the process. This allows us to fully account for migration, to gather family trees more comprehensive than what demographers constructed, and to get a substantial degree of spatial variation, which demographers were not able to get because they worked one parish at a time.

An important caveat is that a significant number of observations in the sample might not have a recorded horizontal lineage, as individuals reconstituting their family tree today have a greater incentive to record their direct ancestors (the vertical lineage) than the horizontal branches. Following Blanc (2020), I deal with this issue by defining the *fertility sample*, the sample of individuals for which at least one parent in any of the four generations preceding the individual observation is recorded as having a fertility rate strictly greater than one. Finally, since the dataset does not always contain both spouses, I cluster all regressions at the couple level, thereby accounting for couples fully recorded, and use a male dummy in order to account for possible differences in gender.

Appendix Figure A3.3.2 provides the time series of fertility, urbanization, and mortality in the crowdsourced data (for individuals who lived in France during that period) and in representative data for France (using a combination of sources including censuses when available). There are no substantive differences, suggesting that selection into the sample

is limited during that period of time (see Blanc (2020) for a detailed discussion). All observations contain geocoded places of birth, marriage, and death, which allows me to match individuals with *Religiosity (1791)* at the level of their district of birth. Figure A3.3.1 displays the towns of birth included in the fertility sample. Summary statistics for the 17,358 individuals in the fertility sample are found in Table A3.3.1.

4 RELIGIOSITY AND SECULARIZATION

Does the share of refractory clergy capture religiosity? Did religiosity persist after secularization? And does the distribution of religiosity in 1791 capture secularization or pre-existing differences that persisted through the centuries? This section seeks to answer these questions. First, I evaluate the persistence of religious practice before and after secularization. I provide strong evidence suggesting that the share of refractory clergy captures religiosity in 1791 and that the distribution does not reflect pre-existing differences. Then I leverage detailed town-level data on religiosity in the region of Provence over time, throughout the eighteenth century, in order to show that religiosity in 1791 captures secularization rather than pre-existing differences in religiosity. Finally, I discuss the correlation of religiosity in 1791 with development and provide suggestive evidence that poor places experienced stronger secularization.

4.1 Persistence of religious practice

After secularization. Is the share of refractory clergy capturing religiosity, and did it persist after secularization? There is mounting evidence that the answer to both of these questions is yes. Appendix Figure A4.1.1 displays the spatial distribution of measures of the intensity of religious beliefs in the nineteenth and twentieth centuries: a dummy variable that equals one if Catholic practice in a *département* was deemed ‘good’ by the local administration in 1877 (Gadille, 1967) or if a district was coded as Catholic in 1947 (Boulard, 1947), the share of Catholic schools in 1901 (SGF, 1901), average Easter attendance in 1966 (Boulard, 1966), and the share of baptized births in 2013 (Vaillant and Dufour, 2013). In contrast to the population-weighted share of refractory clergy in 1791, which may capture noise and the political legitimacy of the French Revolution, these variables are more direct (and the best available) measures of religious beliefs, although they are only available much later. I show that the population-weighted share of refractory clergy is highly correlated with these measures of religiosity in the nineteenth and twentieth centuries, which suggests that it does captures religiosity and that religiosity persisted over time. Similarly, Squicciarini (2020) shows that the share of refractory clergy in 1791 is highly correlated with the share of antireligious *cahiers de doléances* in 1789. For these reasons, I use the term *religiosity in 1791* to denote the main independent variable.

Table 1 reports the results of the regressions of these measures on *Religiosity (1791)*.

Table 1: Persistence of religious practice (after secularization)

Note: This table displays the results of the cross-sectional regressions of different proxies for religiosity in 1877 (Gadille, 1967), 1901 (SGF, 1901), 1947 (Boulard, 1947), 1966 (Boulard, 1966), and 2013 (Vaillant and Dufour, 2013) on *Religiosity (1791)*. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. All specifications control for the share of deserters among conscripts in the French army between 1798 and 1805. Specifications 1 and 3 report average marginal effects and are estimated with maximum likelihood. All observations are weighted by *département* population in the year of observation of the outcome variable. Robust standard errors are reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Dummy=1 if 'good' Catholic practice (1877)	(2) Share Catholic Schools (1901)	(3) Dummy=1 if Catholic (1947)	(4) Average Easter attendance (1966)	(5) Share baptized births (2013)
	Logit	OLS	Logit	OLS	OLS
<i>Religiosity (1791)</i>					
Marginal effect	1.570*** (0.197)		0.954*** (0.106)		
Standardized beta coefficient		0.313*** (0.116)		0.466*** (0.072)	0.418*** (0.108)
Observations	80	82	503	503	92
R^2	.	0.14	.	0.23	0.18

In all specifications, I control for the share of deserters among conscripts in the French army between 1798 and 1805 (Forrest, 1989) in order to account for state legitimacy at the time of the French Revolution. I report standardized beta coefficients, or marginal effects for dummy variables, in order to assess the size of the correlation. In the first and third columns, I estimate (with a logit model) the marginal effect of the share of refractory clergy in 1791 on a dummy that equals one if Catholic practice was ‘good’ in 1877 or if the district was Catholic in 1947. The marginal effect is close to or higher than one in both cases, suggesting that having only refractory clergy in 1791 predicts full Catholic practice later on. In specification 2, I show that *Religiosity (1791)* is highly correlated with the share of Catholic schools in 1901. Specification 4 uses the best available measure of religiosity, Easter attendance in 1966 (Boulard, 1966). I find that a one-standard-deviation increase in *Religiosity (1791)* is predicted to increase Easter attendance by almost half a standard deviation. Finally, in specification 5, I find results similar in magnitude for the share of baptized births in 2013.

Before secularization. In order to understand whether religiosity persisted through dechristianization, Appendix Table A4.1.1 presents regressions of religiosity in 1791 on proxies for religiosity before secularization at the *département* and district levels. In specifications 1 to 5, the main independent variables are the number of clergymen per ten thousand inhabitants in 1791 (footnote 20 describes why this is a proxy for religiosity before secularization), the number of abbeys in 1756, average tithe rate in 1750, the duration of Jesuits’ presence before their suppression in 1763, and the share of Protestants in the population in 1815, after the revocation of the Edict of Nantes. In specification 6, I include all of these variables.

Religiosity in 1791 does not correlate with any of these proxies for religiosity before secularization at the *département* level, which suggests that religiosity did not persist through dechristianization and that religiosity in 1791 does not capture pre-existing differences in re-

ligiosity. Yet some dimensions of religiosity seem to have persisted through secularization.²² At the district level, the duration of Jesuit presence has a positive and significant effect on religiosity after secularization. The magnitude of the effect is important since religiosity in 1791 was 13 percentage points higher in places where the Society of Jesus had settled for two centuries compared with those where it was absent. As many districts, especially the rural ones, did not have either Jesuits or abbeys, specification 8 adds dummy variables if either was present. I find that the presence of abbeys in 1756 also has an effect (significant at the 20 percent level) that seems to have persisted through secularization.

4.2 Religiosity or secularization?

The share of refractory clergy appears to capture religious devotion on the eve of the French Revolution, but is the cross-sectional distribution of religiosity in 1791 the result of a process that took place in the eighteenth century or does it simply reflect pre-existing differences? There is substantial evidence (of two types) that the population-weighted refractory clergy does not capture pre-existing differences but the intensity of secularization. First, places where secularization was documented (Hoffman, 1984; Vovelle, 1973) also had a low share of refractory clergy in 1791. Second, as documented in the section above, proxies for religious beliefs before secularization largely do not correlate with religiosity in 1791. Although these are only proxies, the results indicate that religiosity in 1791 is not capturing pre-existing differences. Yet because of the lack of good data on beliefs or attitudes across time and space before secularization, we have no direct evidence.

Secular beliefs in the eighteenth century: evidence from Provence. In order to answer this question, I exploit detailed and never-before-used data on secular beliefs across time and space from the universe of wills at death in a comprehensive sample of villages and cities in about ten *bailliages* in four *départements* of Provence (Vovelle, 1973).²³ Although wealthier individuals were slightly more likely to leave a will at death, they were written by individuals of all social classes and in some places by more than 80 percent of deceased adults. The use of attitudes towards death as an indicator of devotion goes back to Ariès (1974). In Provence, this is the only measure of the intensity of religious beliefs available across space both before and after secularization took place. For that reason, it is the best available account of secularization. Other measures such as church attendance or donations to the Church provide similar accounts but are available across either time or space, not both.²⁴ The language used in the wills is an indication of the intensity of the devotion

²²Consistent with what Squicciarini (2020) find when examining the role of historical plagues.

²³The *bailliage* was an administrative unit roughly the size of a district or *arrondissement* before the French Revolution.

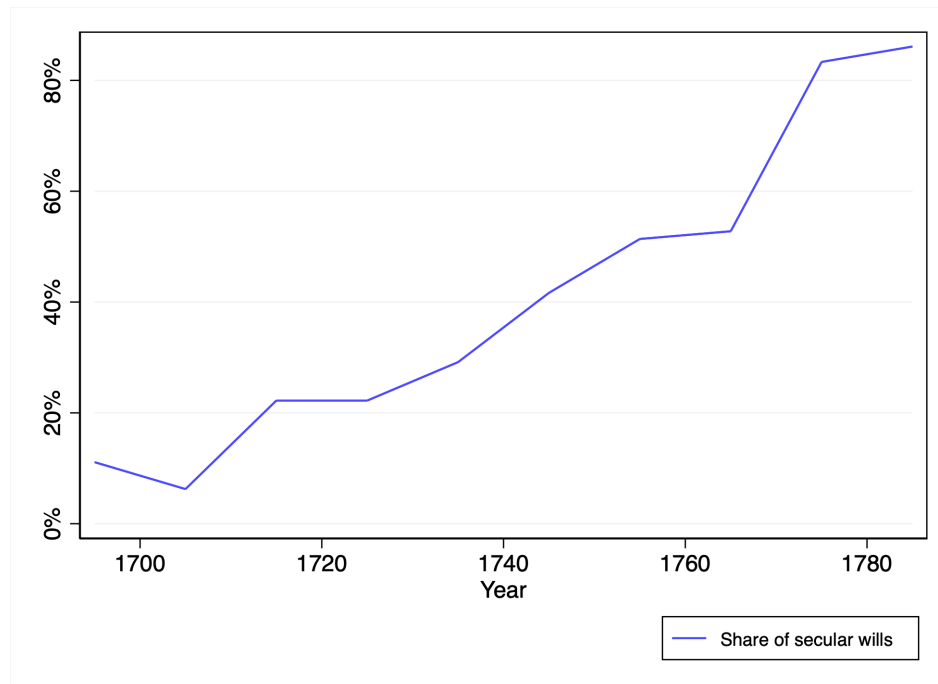
²⁴For example, Vovelle (1973) finds a decline in requests for perpetual masses after one's death, from 90 percent of wills at the beginning of the eighteenth century to less than half before the French Revolution. Hoffman (1984) finds similar figures in the rural parts of the diocese of Lyon. However this measure is not available across space—which is important since I relate the secular wills to the refractory clergy below.

of those who wrote them and changes radically over the course of the eighteenth century, when references to God, Jesus Christ, the Virgin Mary (who was particularly important in Provence), or various saints disappear and are replaced with secular language:

In the late seventeenth and early eighteenth centuries, testators consistently described themselves as adherent of the holy, apostolic Roman Catholic Church, who were prepared to meet their Maker, God the Creator, and Jesus Christ, His Son, by whose death and passion they hoped to be pardoned for their sins and to join the saints and angels in the Celestial Court of Paradise. ... By the 1780s most Provençal wills had reduced the traditional formula to a single clause: *‘Having recommended his soul to God’*. The Virgin Mary and saintly intercessors were gone, the Celestial Court emptied of angels. Christ himself had receded into the background, while God the Father sometimes took the form of *‘Divine Providence’*. Many wills had become totally secularized, and some even described death as *‘the indispensable tribute that we owe to Nature’*. (Darnton, 1978, p. 126)

Figure 3: Secularization in eighteenth-century Provence

Note: This figure displays the median share of secular wills over time in Provence, from 1690 to 1789. The share of secular wills at the *bailliage* level is taken from and coded by Vovelle (1973).



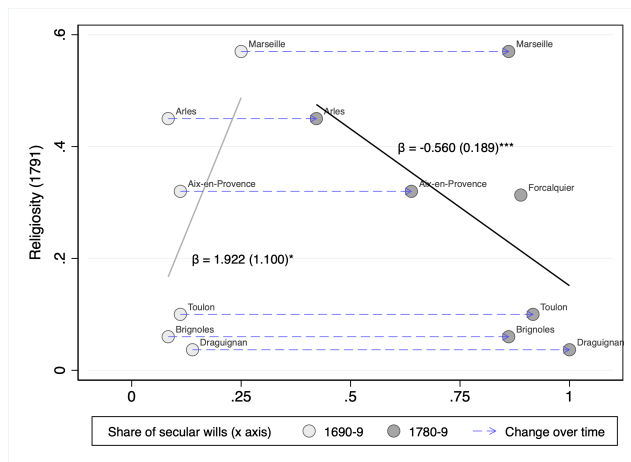
In order to grasp the magnitude and the timing of secularization, Figure 3 displays the share of secular wills in Provence over time as coded by Vovelle (1973). At the turn of the

eighteenth century, only 13 percent of wills used secular language.²⁵ Following the Great Plague of Marseille, which killed as many as 100,000 people in the 1720s, the share of secular wills significantly decreased in places most affected by the plague. However this was only temporary. After the mid-eighteenth century, widespread secular changes in attitudes towards death took place with significant increases in the share of secular wills. Provence, which was one of the poorest, most rural *départements*, experienced dechristianization particularly early, before most of France (Vovelle, 1973).

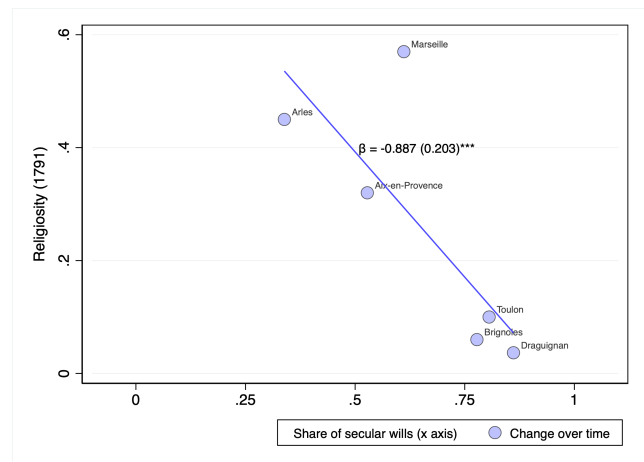
On the eve of the French Revolution, more than 80 percent of wills were secular in Provence, while the population-weighted share of refractory clergy (religiosity in 1791) was 26 percent. Hence, to understand the drivers of the distribution of religiosity after secularization, I relate religiosity in 1791 to the extent of dechristianization in the cross-section as captured by the share of secular wills across time and space in Provence. In Figure 4, I plot the share of refractory clergy in 1791 against the share of secular wills in the 1690s and 1780s and against the change in the share of secular wills over time (Appendix Table A4.2.1 displays the results of the corresponding regressions). The data are available in seven *bailliages* for which the share of refractory clergy is also recorded: Aix-en-Provence, Arles, Brignoles, Draguignan, Forcalquier, Marseille, and Toulon. The results (especially the standard errors) should be taken with a grain of salt because of the small size of the sample, yet this is the best available data.

Figure 4: Religiosity in 1791 and secularization in eighteenth-century Provence

Note: This figure displays the scatterplot of *Religiosity (1791)* on the share of secular wills in the 1690s in Panel A and on the share of secular wills in the 1780s in Panel B. *Religiosity (1791)* is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. The share of secular wills at the *bailliage* level is taken from and coded by Vovelle (1973).



(Panel A) Secular wills (1690-1789) and refractory clergy



(Panel B) Secularization and refractory clergy

²⁵This figure is likely overestimating secular beliefs before dechristianization since, as Vovelle (1973) argues, it is mostly the result of illiteracy or clergy members who deemed references to their faith too obvious (and are therefore coded as secular).

In Panel A, I show that the share of secular wills in the 1780s is negatively correlated with religiosity in 1791, providing further evidence that the share of refractory clergy captures religiosity. However, before secularization, in the 1690s, religiosity was at near-maximal levels everywhere, with only about 13 percent of wills coded as secular in the 1690s and virtually no variation. I find that, if anything, the share of secular wills in the 1690s is positively correlated with religiosity in 1791, suggesting that the most devoted places in the 1690s experienced the strongest secularization.²⁶ However, the result is not statistically significant at the 5 percent level and the regression line is essentially vertical. This is in line with the results at the *département* level and suggests that religiosity mostly did not persist through secularization.

In Panel B, I plot the refractory clergy in 1791 against secularization as captured by the change in the share of secular wills over time, from the 1690s to the 1780s. Despite the small sample, there is a clear negative and tight correlation between the two measures. An increase of the change in the share of secular beliefs of 100 percentage points is associated with a decrease in religiosity in 1791 of about 90 percentage points.²⁷ In specification 5 of Appendix Table A4.2.1 I show that the share of secular wills in the 1780s, not only the refractory clergy in 1791, is associated with the increase in the share of secular wills in the eighteenth century and the relationship is almost one to one. This suggests that not only does the share of refractory clergy in 1791 capture religiosity, but it also mostly reflects dechristianization in the eighteenth century rather than pre-existing differences.²⁸

4.3 Religiosity and development in France

How does religiosity in 1791 correlate with development at the time? In Appendix Table A4.3.1, I show that religiosity in 1791 is positively correlated with various proxies for development at the town level. In order to capture the correlation of secularization, rather than religiosity, with development, I also control for proxies for religiosity before secularization. Finally, I only report average marginal effects since the table only tests for the sign and statistical significance of the relationship.

I find a positive correlation of religiosity with log population in 1793 (the earliest available year) at the town level, a traditional proxy for development in the pre-industrial era (Ashraf and Galor, 2011).²⁹ The results also hold for urbanization, estimated with logit. Next, I show that religiosity in 1791 is positively correlated with *Encyclopédie* subscriptions per capita at the district level. Hence, not only the size of the population is correlated with

²⁶The results hold when comparing the share of secular wills in the 1690s to the share of secular wills in the 1780s, instead of the refractory clergy in 1791.

²⁷If there is virtually no variation in religiosity before secularization within Provence, then it is logical to find that religiosity in 1791 fully captures secularization.

²⁸In the bulk of my empirical analysis of fertility, I use region fixed effects and proxies for religiosity before secularization in order to account for regional-level unobserved pre-existing differences and to capture the small variation observed in the late seventeenth century.

²⁹This is a stock variable, and it is unlikely to have been affected significantly by the decline in fertility.

religiosity, but also its quality. Subscriptions to the *Encyclopédie* are a traditional proxy for the presence of knowledge elites or of the diffusion of the Enlightenment in France (Squicciarini and Voigtländer, 2015, 2016). The point estimate drops after controlling for religiosity before secularization, but that is likely because the controls at the district level include a dummy that equals one if there was a Jesuit school at some point in the past and the presence of Jesuits is highly correlated with subscriptions to the *Encyclopédie* (Sunde and Rosenberger, 2019). Finally, I find that the sign of the correlation is also positive for soldier height before 1760 (Komlos, 2006), also a traditional proxy for development.

The results indicate that secularization may have happened in poor and rural places first. This is surprising to the extent that the correlation between religiosity and development is usually believed to be negative (Barro and McCleary, 2003): wealthier places are less religious and traditional. However, this is consistent with what Hoffman (1984); Norberg (1985); Vovelle (1973) find in Provence and in the rural parts of the dioceses of Lyon and Grenoble. If anything, these results suggest that the effect of religiosity in 1791 on fertility is downward biased since urban places are also centers of innovation and human-capital accumulation.

5 MAIN EMPIRICAL FINDINGS AT THE *département* LEVEL

5.1 Baseline results

Determinants of year of transition. In this section, I study the cross-sectional determinants of transition date. The main variable of interest is religiosity in 1791, while the dependent variable is defined as the first year of transition below a marital-fertility index of 0.5. I estimate Equation 1 with OLS and a Tobit model (by maximum likelihood) in order to account for the left-censoring nature of the data since about a quarter of *départements* had already transitioned in 1831.

$$(1) \quad (\text{Transition date})_i = \beta \times \text{Religiosity}_{i,1791} + \mathbf{X}'_i \delta + \varepsilon_i$$

Table 2 reports the results, along with robust standard errors. Appendix Figure A5.1.1 plots the scatterplot and partial residual plot. A 10-percentage-point increase in religiosity in 1791 is associated with a delay in the year of transition of more than ten years. This is a remarkably large effect: moving from the 25th to the 75th percentile of the distribution of religiosity predicts a delay in the demographic transition of about forty years.

The estimates are stable and significant at the 1 percent level across all specifications. Specification 2 controls for proxies for religiosity before secularization in order to capture the effect of secularization. These controls include, notably, the number of clergymen per capita, the number of abbeys, and the average rate of the tithe collected by the church. Specification 3 controls for observed cultural and institutional factors. In particular, the

Table 2: Determinants of transition date

Note: This table displays the results of the cross-sectional regression of transition dates on *Religiosity (1791)*. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Transition date is defined as the first year with $I_g \leq .5$. Controls are described in Appendix Table A3.2.2. All observations are weighed by *département* population in 1831. Robust standard errors are reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	<i>dep var:</i> Transition date						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Religiosity (1791)</i>							
Ordinary Least Squares	97.228*** (13.143)	98.293*** (13.425)	85.210*** (13.459)	104.872*** (20.189)	102.227*** (20.072)	100.894*** (22.050)	103.821*** (22.895)
Tobit (Maximum likelihood)	118.603*** (16.896)	117.550*** (16.745)	95.390*** (15.529)	121.714*** (20.392)	118.050*** (20.395)	115.283*** (22.134)	119.438*** (22.958)
Controls							
Religiosity (pre-secularization)		Yes	Yes	Yes	Yes	Yes	Yes
Cultural and institutional factors			Yes	Yes	Yes	Yes	Yes
Region fixed effects				Yes	Yes	Yes	Yes
Education and schooling					Yes	Yes	Yes
Pre-industrial development						Yes	Yes
Contemporary development							Yes
Mean of dep var	1863	1862	1861	1861	1861	1861	1861
Standard deviation of dep var	34	33	33	33	33	33	33
Perc. 25-75 <i>Religiosity (1791)</i>							
OLS	34	34	29	36	35	35	36
Tobit	41	41	33	42	41	40	41
Left censored observations	24	24	23	23	23	23	23
Observations	85	80	77	77	77	77	76
Adjusted R^2 (OLS)	0.40	0.40	0.54	0.61	0.62	0.61	0.60
Log likelihood (Tobit)	-322.3	-293.6	-267.9	-253.8	-252.8	-252.5	-248.1

share of deserters in the army during the French Revolution and fiscal status (*pays d'élection*, *d'Etat*, or *d'imposition*) in the *Ancien Régime* allow me to capture religiosity and not state legitimacy with the refractory-clergy measure. The specification also controls for linguistic distance to French (in order to capture the diffusion and adoption of new cultural norms (Spolaore and Wacziarg, 2019)) and *Encyclopédie* subscriptions (in order to capture the diffusion of the Enlightenment and the presence of local knowledge elites, who may have had an impact on cultural change and the modernization of society as a whole). Specification 4 adds twelve region fixed effects to account for unobserved cultural or economic factors that might confound the effect of religiosity in 1791. For example, ancestry may have an effect on the diffusion of modernization (Weber, 1976), while the presence of nuclear family structure might influence on fertility (Todd, 1990).³⁰ Specification 5 controls for literacy to account for the quantity-quality trade-off, while specifications 6 and 7 account for development. The results remain virtually unaffected.

Finally, I estimate Equation 1 for alternative definitions of transition date in Appendix Table A5.1.1. As expected, the coefficient on religiosity is maximized for the first year in which marital fertility dropped below 0.6. The average level of the marital-fertility index

³⁰After including fixed effects for family structure, the estimated OLS coefficient drops to 95.19 (still significant at the one percent level). I do not report this in the table because of measurement and reverse causality (family structure is measured after the decline in religiosity and fertility), in order to limit the number of fixed effects, and for ease of interpretation.

in Europe in 1831 was about 0.65, compared to 0.55 in France (Coale and Watkins, 1986), while a decline below 0.5 corresponds to a drop of about 25 percent.

Determinants of marital fertility. I estimate the cross-sectional determinants of I_g from 1831 to 1901 using Equation 2 (separately for each year t) using OLS.

$$(2) \quad (I_g)_{i,t} = \beta_t \times \text{Religiosity}_{i,1791} + \mathbf{X}'_{i,t} \delta_t + \varepsilon_{i,t}$$

Appendix Table A5.1.2 reports the results for 1851 (the first year with Paris in the data) and 1901, along with robust standard errors. A 10-percentage-point decrease in *Religiosity (1791)* is associated with a decrease in the marital-fertility index of about 3 percentage points. The marital-fertility index in France averaged 0.49 in 1851, about half the Hutterite standard. The Table also reports standardized coefficients: throughout specifications, increasing *Religiosity (1791)* from the 25th to the 75th percentile of the distribution is predicted to increase I_g by about 10 percentage points, slightly less than a standard deviation. Finally, Appendix Figure A5.1.2 plots marital fertility in 1851 and 1901 against *Religiosity (1791)*, with and without controls.

5.2 Alternative explanations and robustness: magnitude, lasso estimation, and sensitivity

Magnitude and relative importance. I assess the magnitude of the effect of *Religiosity (1791)* on transition date and compare it to the effect of some variables of interest that are included in the regression as controls and are important prior candidates to explain the decline in fertility. For each variable of interest, I report standardized beta coefficients both without any controls and with the full set of controls.

Table 3 presents standardized beta coefficients of selected determinants of transition date. Each cell represents the result of a different regression and reports the standardized beta coefficient of the variable of interest in the left column. In specification 1, no controls are included. In specification 2, the full set of controls and *Religiosity (1791)* are included; therefore, cells represent coefficients from the same regression (specification 7). This allows me not only to evaluate the relative magnitude of each of these explanatory factors but also to grasp the robustness of the estimated effects to the inclusion of controls.

As a first step, I evaluate the role of cultural attributes and find that subscriptions to Diderot and d’Alembert’s *Encyclopédie* have a large and significant effect on transition date. Decreasing the number of subscriptions per capita by one standard deviation is predicted to delay the transition date by one-third of a standard deviation, with or without controls. This is the second-largest effect after religiosity in 1791 and is consistent with the pattern documented by Squicciarini and Voigtländer (2015, 2016). Yet it is unlikely that it played a major role in the French demographic transition because Enlightenment ideas diffused

Table 3: Magnitude and importance of the determinants of transition date

Note: This table displays the results of the cross-sectional regression of transition dates on a set of variables of interest. Transition date is defined as the first year with $I_q \leq .5$. Standardized beta coefficients and significance levels are reported. Each cell reports the result of a different regression. All observations are weighed by *département* population.
⁺ $p < 0.2$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Specification in columns, each cell reports result of a different regression w/ var of interest below:	<i>dep var:</i> Transition date	
	(1) No controls	(2) Full set of controls
Standardized beta coefficients		
<i>Religiosity (1791)</i>	0.64***	0.69***
log 1 + Encyclopedie per 10,000 inhab. (1777-79)	-0.28***	-0.31**
Linguistic distance to French (1900)	0.15 ⁺	0.09
Literacy (1831)	-0.13	0.31 ⁺
Population density (1831)	-0.03	-0.10
Urbanization (1831)	-0.03	-0.11

throughout most of Western Europe and especially England and Scotland. One possibility is that it accelerated the effect of, or enabled, secularization. For example, one could imagine that in places with many subscriptions, the libertine literature diffused to the general population in such a way that it triggered a decline in rates of fertility. I test this idea by interacting religiosity in 1791 with *Encyclopédie* subscriptions, but I find no significant effect.³¹

Moreover, it could be the case that religiosity in 1791 captures not only the direct effect of cultural differences but also barriers to the diffusion of norms favoring limited fertility. In order to understand the role of diffusion, I look at the size of the effect of linguistic distance from standard French in 1900.³² The effect is important but only statistically significant at the 20 percent level, and it is more than four times smaller than the effect of religiosity in 1791, suggesting that the main independent variable is capturing a direct effect of religiosity rather than barriers. Finally, neither literacy, nor population density, nor urbanization had a significant or large effect on the timing of transition.

Appendix Figure A5.2.1 displays the standardized beta coefficients over time, allowing for a more detailed analysis. Without controls, urbanization and population density first had a positive or null effect on the level of fertility and the effect became negative as time passed, somewhat consistent with a Malthusian mechanism or with the idea that overpopulation led to lower fertility in the nineteenth century (Braudel, 1986a,b). For literacy, I find a pattern consistent with a quantity-quality trade-off: at first, the correlation between fertility and literacy is positive; then it becomes negative. Yet none of these variables are statistically significant or robust to the inclusion of controls.

³¹Results are available upon request or in the first version of this paper.

³²This is, in essence, the same idea that Spolaore and Wacziarg (2019) test in Europe but I use a different data source in order to get more granular variation in linguistic distance within a linguistic area.

Double lasso estimation and variable selection. Since the number of potential variables of interest is large, in order to flexibly achieve variable selection and evaluate the robustness of the effect of religiosity in 1791, I use lasso, a supervised machine-learning technique, to further estimate the determinants of transition date. The least absolute shrinkage and selection operator (lasso) is a regularization (like ridge) and variable selection method introduced by Tibshirani (1996). Its purpose is twofold. First, it allows me to flexibly and more accurately estimate the effect of religiosity in 1791 on transition date in a setting with a large number of regressors (*Religiosity (1791)* and seventeen others, including fixed effects). Second, it allows me to understand the robustness of the estimated effects and the relevance of specific predictors by shrinking the regression coefficients to zero.

Lasso is essentially an ℓ_1 -penalized least squares estimate in which coefficients are estimated by minimizing the sum of squared residuals, as in OLS, but a shrinking process is also applied in order to penalize some of the variables by down weighing their coefficients toward zero. The tuning parameter λ controls the strength of the penalty and is chosen by k -fold cross-validation by finding the lambda with the smallest average mean squared error in all out-of-sample predictions.

Table 4: Double lasso estimation of the determinants of transition date

Note: This table displays the results of the cross-sectional double lasso regression of transition dates on *Religiosity (1791)*. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Transition date is defined as the first year with $I_g \leq .5$. The tuning parameter λ is chosen by cross-validation. The set of available controls to be chosen by the double lasso procedure is described in Appendix Table A3.2.2. In specifications 3, 4, and 5, I force the selection of *Encyclopédie* subscriptions (3), region and *pays*-status fixed effects (4), or both (5) as controls. Observations are not weighed by *département* population; therefore specification 1 corresponds to the same specification as in specification 7 of Table 2, estimated without weighing by population. Robust standard errors are reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	<i>dep var:</i> transition date				
	(1) OLS	LASSO			
		(2)	(3)	(4)	(5)
<i>Religiosity (1791)</i>	102.600*** (21.944)	83.792*** (15.059)	84.847*** (14.417)	102.403*** (18.916)	106.515*** (17.957)
Controls always included	All				
Region & pays status FE				Yes	Yes
log 1 + Encyclopedie (1777-79)			Yes		Yes
Controls selected by LASSO					
log 1 + Encyclopedie (1777-79)			Yes		Yes
Share of deserters among conscripts (1798-1805)				Yes	Yes
Clergymen per 10,000 inhabitants (1791)				Yes	
Linguistic distance from French (1900)				Yes	
Books printed (1500)				Yes	Yes
log 1 + Urbanization (1831)				Yes	
Soldier height (bef. 1760)				Yes	
Number of controls selected		0/15	1/15	8/17	5/17
Observations	76	85	85	76	76
Adjusted R^2	0.56

The determinants of transition date are estimated in Table 4 with the double-selection lasso estimation method described in Belloni, Chernozhukov and Hansen (2013); Urminsky, Hansen and Chernozhukov (2019). This two-step procedure identifies covariates that

predict the dependent variables and those that predict the independent variable. First, a lasso of transition dates on the full set of controls selects the determinants of transition date (excluding religiosity in 1791) that were not shrunk to zero. Second, using a lasso of *Religiosity (1791)* on the same set of controls allows me to select nonzero predictors. The variables selected in both steps are included in the final regression. This allows me to alleviate the biases commonly associated with lasso because excluding variables with moderate, non-null effects results in omitted-variable bias while the selected coefficients are underestimated because of regularization.

In the first column, I report the unweighed OLS coefficient on religiosity in 1791 with the full set of controls.³³ Specifications 2 to 5 display the double lasso-estimated coefficients. In specifications 3 and 5, in light of the standardized coefficients estimated in Table 3, I force the selection of *Encyclopédie* subscriptions per capita by not penalizing its coefficient. In specifications 4 and 5, I force the selection of fixed effects, which were otherwise not included in the set of controls. Several observations are in order. First, without including the region and *pays*-status fixed effects, no variable other than religiosity in 1791 is selected by default. Second, the variables selected with fixed effects mostly capture cultural traits. Finally, the share of deserters among conscripts, which controls for state legitimacy at the time of the French Revolution in order to capture the effect of religiosity, is selected. The estimated coefficient on religiosity in 1791 remains particularly large while, as predicted, lasso reduces variance.

Figure A5.2.2 plots the coefficient paths for the two lassos with fixed effects. The size of each of the coefficients is plotted against the penalty term λ . When lambda equals zero, lasso is equivalent to OLS; and all coefficients gradually shrink to zero as it increases. Only limited regularization is needed for the determinants of religiosity in 1791, suggesting that few observables explain its distribution with a large or robust effect when region and *pays*-status fixed effects are included. As expected, the variable with the largest predictive power is the share of deserters among conscripts. Yet although none of the controls seem to matter for the distribution of religiosity, *Religiosity (1791)* itself has a large and robust predictive power for transition date (and, consistent with the standardized beta coefficients estimated previously, so does *Encyclopédie* subscriptions).

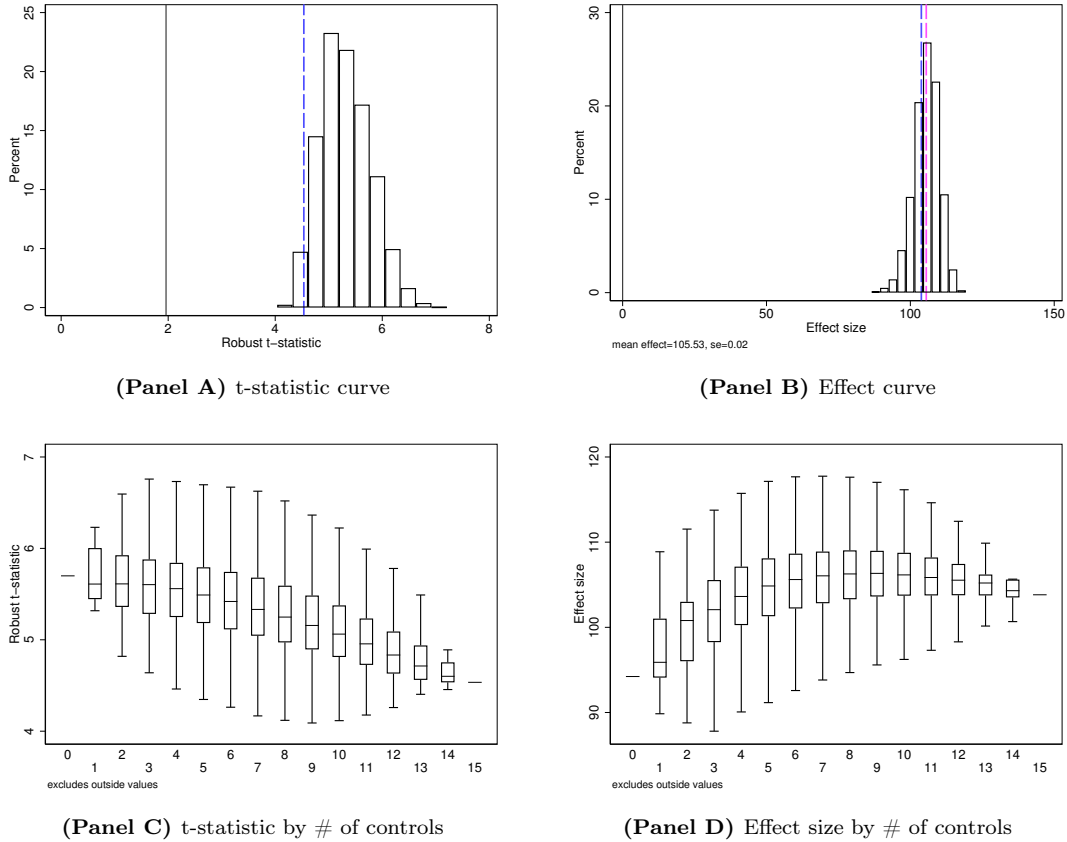
Sensitivity of estimates and coefficient bounds. The baseline results relied on a set of seventeen control variables in seven different models, while the regularization properties of lasso allowed me to select the most important variables. The set of seventeen control variables presented in Table A3.2.2 was gathered through an extensive process of data collection and accounts for a large number of cultural, economic, and institutional factors. Yet only a particular choice of covariates could be accounted for in the specifications

³³Because weighing creates significant issues with lasso, observations are not weighed by population. Therefore, the result in specification 1 can be compared to the result in specification 7 of Table 2, where observations are weighed by population.

under study, and collinearity or omitted variables could be introduced, which would result in biased and distorted coefficients (Brodeur et al., 2016; Brodeur, Cook and Heyes, 2020a; Granger and Uhlig, 1990; Leamer, 1983; Leamer and Leonard, 1983).

Figure 5: Determinants of transition date: distribution of estimates and t-statistics across all combinations of controls

Note: This table displays the results of $2^{15} = 32,768$ cross-sectional regressions of transition dates on *Religiosity (1791)* and all possible combinations of controls (with fixed effects included in all specifications). The upper-left panel displays the distribution of t-statistics, while the upper-right panel displays the distribution of coefficients. The blue line plots the coefficient estimated in Table 2 with the full set of controls (specification 7), and the red line plots the mean coefficient across all combinations. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Transition date is defined as the first year with $I_g \leq .5$. Controls are described in Appendix Table A3.2.2. All observations are weighed by *département* population in 1831. Robust standard errors are reported. This figure was generated using the Stata program provided by Brodeur, Cook and Heyes (2020b). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$



In order to assess the fragility of coefficients and to estimate bounds on the parameters of interest, I evaluate the determinants of transition date by accounting for religiosity in 1791 and all possible combinations of controls. This results in 131,072 (2^{17}) different models. Figure 5 plots the distribution of estimated coefficients (and robust t-statistics) on *Religiosity (1791)* across all combinations of controls, with region and *pays*-status fixed effects.³⁴ Panels A and B plot raw distributions, while Panels C and D plot effect size and robust t-statistic

³⁴There are 32,768 (2^{15}) such regressions, with region and *pays*-status fixed effects. Alternatively, Figure A5.2.3 provides the results with all combinations of seventeen controls (including fixed effects). The results are unchanged.

by number of controls. Across all combinations, the mean estimated coefficient is 105.53 years, and no specification returns a coefficient for the marginal effect of religiosity in 1791 below 85 years.

5.3 Accounting for omitted variables and spatial dependence

Omitted variables. While reverse causality is not an issue, omitted variables may result in bias. Religious areas could place more emphasis on tradition (broadly defined) and be less prone to innovation and change, which would bias estimates and be a threat to identification. However, as discussed in Section 4.3, religiosity in 1791 is positively correlated with the best available measures of development in eighteenth-century France after secularization took place. Because urban centers have historically been centers of innovation and human-capital accumulation, estimates are expected to be downward biased toward zero. In what follows, I formally account for unobservables and rely on Altonji, Elder and Taber (2005); Oster (2016) to construct bounds to the true effect of religiosity in 1791.

Oster (2016) shows that movements in the R-squared, and not only coefficient movements, can give information about the direction and the size of the bias arising from omitted variables. Therefore, I estimate a coefficient on religiosity accounting for omitted variables under the assumption of proportional selection and under some theoretical maximum R-squared. Altonji, Elder and Taber (2005); Oster (2016) suggest that we should assume equal selection—that is, that unobservables and observables are equally related to the treatment.³⁵ Throughout this section, I alternatively make the two following assumptions about selection on unobservables:

Assumption A. *Selection on unobservables is exactly proportional to selection on observables.*

Assumption B. *Selection on unobservables is exactly proportional to selection on the diffusion of the Age of Enlightenment (as proxied by $\log 1 + \text{Encyclopédie subscriptions per capita in the period 1777–79}$) conditional on other observables.*

The first assumption is fairly standard, while assumption B relies on the idea that one can learn about unobservables that explain marital fertility from unobservable determinants of *Encyclopédie* subscriptions per capita, a standard measure to proxy for the diffusion of the Age of Enlightenment (Darnton, 1973; Squicciarini and Voigtländer, 2015). Using this proxy for a different dimension of cultural change allows us to sensibly model unobservables that may have affected marital fertility. Intuitively, although this is an oversimplification, I

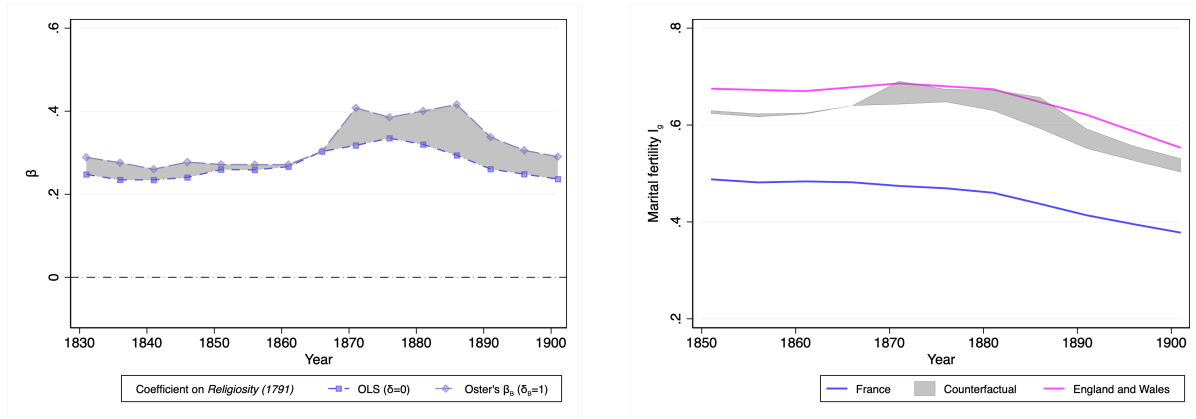
³⁵Oster (2016) shows that the $\beta^*(R_{max}^2, \delta)$ statistics, with δ being the degree of proportionality between selection on unobservables and observables, converges in probability to the true coefficient. If 0 does not lie in the interval between the OLS coefficient and $\beta^*(R_{max}^2, 1)$ (Oster’s beta), then one can reject the null that the coefficient of interest is exclusively driven by unobservables. Following Oster (2016), I set R_{max}^2 to $\min\{1.3R^2, .9\}$ because of measurement error due to the historical nature of the data.

assume that the Age of Enlightenment affected marital fertility through unobserved factors (for example, libertinage, emphasis on change as opposed to tradition, industrial mindset) that are also correlated with secularization.

Appendix Tables A5.3.1 report the results of the regression on the determinants of transition year accounting for unobservable selection. Panel A relies on Assumption A and Panel B on Assumption B, which is the main assumption. In both cases I report both Oster's beta, assuming a degree of proportionality of one, and the δ statistics, which reflect how strong selection on unobservables should be to explain away the estimated effect of religiosity in 1791. Standard errors bootstrapped over one thousand replications are reported. Results are virtually unaffected by selection on unobservables, and if anything the estimated coefficients under the equal-selection assumption are larger than under OLS. In most specifications, selection on unobservables would have to be between 2 and 120 times as strong as selection on observables to drive the estimates to zero.

Figure 6: Accounting for unobservables (1831-1901)

Note: This figure displays the estimated impact of *Religiosity (1791)* on marital fertility over time. *Religiosity (1791)* is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Panel A displays the estimated coefficients accounting for the full set of controls under no selection (OLS) and equal selection (β_B), where Oster's beta is computed under Assumption B. Panel B displays the marital-fertility index for France and for England and Wales over time, along with a counterfactual index for France.



(Panel A) Omitted variables-adjusted coefficient

(Panel B) Counterfactual fertility

Finally, Figure 6 plots the effect of religiosity in 1791 over time after accounting for omitted variables. Panel A displays the estimated coefficients (OLS and omitted-variable-adjusted coefficient) for *Religiosity (1791)* from 1831 to 1901. OLS coefficients are biased downward throughout. Unobserved factors, such as a scientific and industrial mindset and less emphasis on tradition, were likely to play an observable role in the course of development as income per capita took off and the second phase of the demographic transition started, which could explain why the negative bias of OLS is more important after the 1870s. Panel B displays the marital-fertility index for France and for England and Wales over time, along with a counterfactual index for France, which is imputed by setting religiosity in 1791 to

the maximal level (if no clergymen took the oath of allegiance to the secular state) under the coefficient bounds suggested by Oster. Religiosity in 1791 accounts for the majority of the difference between France and England and Wales.

Spatial dependence. The spatial distribution of religiosity in 1791 and marital fertility is geographically clustered. Although cultural attributes are often spatially clustered, this could lead one to interpret the results as strong and robust, but the interpretation would be erroneous since nearby places are naturally more likely to possess the same attributes. It is possible to account for spatial dependence by reporting adjusted standard errors (Colella et al., 2019; Conley, 1999). Yet Kelly (2019) shows that Conley standard errors are often too small because of low cutoff values, the distance beyond which spatial correlation is assumed to vanish. As a consequence, spatial noise with the same spatial-correlation structure as that in the data can significantly outperform the results, which is highly problematic.

I implement the solutions suggested by Kelly (2019) and report Conley standard errors for two different correlation ranges. In particular, I alternatively assume a correlation range of 250 kilometers (Assumption 1) or 500 kilometers (Assumption 2). First, I report the p-value of Moran’s test for spatial dependence of OLS residuals, a standard spatial-correlation statistic. Second, I report the results of simulations where the dependent and independent variables are alternatively replaced by spatial noise. I run one thousand independent simulations each time and report the fraction of regressions significant at the 0.1 percent level.

Table 5: Accounting for spatial dependence in the determinants of transition date

Note: This table displays the results of the cross-sectional regression of transition dates on *Religiosity (1791)* and various tests to assess the extent of spatial dependence. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791. Transition date is defined as the first year with $I_g \leq .5$. Controls are described in Appendix Table A3.2.2. All observations are weighed by *département* population in 1831. Assumption 1 (2) assumes a correlation range of 250 (500) kilometers. Results under Assumption 2 are displayed in parentheses. Moran statistics are computed using an inverse-distance spatial weighing matrix. Conley standard errors are computed using the Stata program provided by Hsiao (2010), and assuming a linearly declining spatial weighing kernel. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	dep var: Transition date						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Testing spatial correlation on OLS residuals							
Assumption 1: 250 kilometers correlation range ; 2: 500 kms (in parenthesis)							
p-val of Moran’s test for spatial dependence (H_0 : error is iid)	.00 (.00)	.00 (.00)	.00 (.01)	.60 (.47)	.57 (.41)	.75 (.49)	.60 (.44)
Fraction of simulations with significant (p=.001) spatial noise	6% (4%)	6% (5%)	0% (2%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)
Fraction of simulations where independent variable explains (p=.001) noise	9% (9%)	8% (11%)	6% (9%)	1% (1%)	1% (1%)	1% (0%)	1% (0%)
Panel B: Spatial correlation-adjusted standard errors							
<i>Religiosity (1791)</i>	97.228	98.293	85.210	104.872	102.227	100.894	103.821
Non-adjusted standard errors	(12.975)***	(13.680)***	(13.753)***	(17.655)***	(17.389)***	(18.531)***	(19.264)***
Conley standard errors (Assumption 1)	(21.118)***	(16.844)***	(10.649)***	(14.164)***	(14.955)***	(15.574)***	(15.980)***
Conley standard errors (Assumption 2)	[24.309]***	[20.228]***	[8.446]***	[10.089]***	[9.577]***	[6.267]***	[7.815]***

Table 5 displays the results. Panel A provides the outcome of the simulations and tests

for spatial correlation. Moran’s statistic is significant (with $p < 0.01$) in the first three specifications and for both ranges, suggesting a high degree of spatial correlation. Spatial noise significantly explains marital fertility at the 0.1 percent level in less than 10 percent of simulations. Panel B displays the estimated coefficient on religiosity in 1791 (as in Table 2) and spatial-correlation-adjusted standard errors. In the first specification, the standard error increases as the correlation range increases. However, the results remain highly significant. After the inclusion of fixed effects in specifications 3 and 4 to account for regional-level unobserved cultural and institutional factors, the p-value of Moran’s test significantly increases and I fail to reject the null that errors are randomly distributed across the landscape. With fixed effects, less than 1 percent of simulations return significant results, and Conley standard errors become smaller than non-adjusted standard errors: accounting for spatial dependence with fixed effects significantly improves the precision of the estimation (Case, 1991).³⁶ These results suggest that the effect of religiosity on marital fertility is not spurious and cannot be explained by simply fitting spatial noise.

6 INDIVIDUAL-LEVEL RESULTS

In this section, I turn to individual-level analysis using crowdsourced genealogies. I relate the fertility decisions of ordinary individuals in the past to attributes of their place of birth. This is the first research to leverage spatial variation at the time of the decline in fertility in France. Section 6.1 presents the baseline results, while Section 6.2 attains causal estimates of the role of dechristianization in the decline in fertility.

6.1 Baseline results

Empirical strategy. I model the fertility decision of individual i in Equation 3, where $fert_{i,t}$ is the completed fertility of individual i in decade t . I exploit cross-sectional variation in fertility with decade fixed effects λ_t . Each individual is assigned the level of religiosity in 1791 of her district of birth $b(i)$.

$$(3) \quad \log \lambda_{i,t} = \beta \times \text{Religiosity}_{b(i),1791} + \mathbf{X}'_{i,t} \delta + \lambda_i + \lambda_t \equiv \mathbf{z}'_{i,t} \gamma$$

with $fert_{i,t} \sim \mathcal{P}(\lambda_{i,t})$ and $\lambda_{i,t} = \lambda(\mathbf{z}_{i,t}) \equiv \mathbb{E}(fert_{i,t} | \mathbf{z}_{i,t})$

In order to account for the count nature of the dependent variable, I use a Poisson-model framework. In particular, I assume that fertility follows a Poisson distribution and that the log of the conditional mean of fertility is a linear function of observables. Equation 3 is therefore estimated with maximum likelihood as a Poisson regression in the bulk of the

³⁶Appendix Figure A5.3.1 compares the OLS confidence intervals with the Conley ones over time under the 250-kilometers assumption.

analysis, but the results are robust to using OLS or other estimation methods to account for overdispersion and heterogeneity in count outcomes such as negative-binomial regressions.

Main results. Table 6 presents the baseline results at the individual level for observations after 1760, when dechristianization and the decline in fertility started. The estimated coefficient is particularly large and stable throughout specifications, with the marginal effect of religiosity in 1791 on fertility estimated to be about one. This means that individuals born in a place with only refractory clergymen are predicted to have about one more child than those born in a place without any. This is roughly the size of the decline in fertility during the second half of the eighteenth century, when the number of children ever born went from 4.5 to 3.5 in about forty years (Figure 1).

Table 6: Determinants of fertility at the individual level

Note: This table displays the results of the individual-level regression of the log total number of children ever born on *Religiosity (1791)*. The main explanatory variable is defined as the population-weighted share of refractory clergy (non-jurors) in 1791, at the district-of-birth level. All specifications include a male dummy and decade fixed effects. Individual-level controls include a quadratic in the age of marriage interacted with the male dummy. Religiosity (pre-secularization) controls include the number of abbeys in 1756 and the duration of Jesuit presence until 1763 (both at the district-of-birth level; plus dummies). Development and Enlightenment controls include the urban status of the town of birth in the year of birth and the log of *Encyclopédie* subscriptions in 1777 – 79 at the district level (plus a dummy for nonzero subscriptions). Two-way clustered standard errors (at the couple and district levels) are reported. Average marginal effects are reported. The results were generated using the Stata program provided by Correia, Guimarães and Zylkin (2020). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	<i>dep var:</i> log fertility			
	(1)	(2)	(3)	(4)
<i>Religiosity (1791)</i>	0.252*** (0.083)	0.297*** (0.084)	0.281*** (0.090)	0.274*** (0.088)
Marginal effect of religiosity on fertility	0.893***	1.055***	0.997***	0.971***
Controls				
Individual-level		Yes	Yes	Yes
Religiosity (pre-secularization)			Yes	Yes
Cultural factors and development				Yes
Observations	11,887	11,728	11,728	11,649
Clusters (couples)	10,358	10,228	10,228	10,155
Clusters (districts)	440	440	440	438
Pseudo R^2	0.01	0.06	0.06	0.06

All specifications include a male dummy and decade fixed effects. Standard errors are two-way clustered at the district-of-birth and couple levels.³⁷ In specification 2, individual-level controls are included with a quadratic in the age at birth of the first child interacted with the male dummy.³⁸ The reduction in fertility was not achieved by delayed age of marriage.³⁹ Specification 3 adds proxies for religiosity before secularization at the district

³⁷Indeed, information about both parents is not always available. Therefore only about 10 percent of individuals have spouses also included in the regressions.

³⁸A previous version of the paper included the log fertility of parents. Estimates were slightly smaller because it is obviously collinear with religiosity in 1791.

³⁹Appendix Figure A6.1.1 plots the average timespan between the births of the first and last child (Panel A) and

level: the presence (dummy) and number of abbeys in 1756, and the presence (dummy) and duration of Jesuit presence before 1763. In the last column, I control for a (time varying) dummy capturing the urban status of the town of birth at the time and I control for the presence (dummy) and number of knowledge elites by using *Encyclopédie* subscriptions at the district level.⁴⁰ The results are statistically significant and stable throughout.

Robustness to method of estimation. Poisson regressions are appropriate for non-negative count dependent variables, yet they rely on the assumption of equality of the mean and variance. That said, the fact that the Poisson distribution is specified by only one parameter is attractive to the extent that, in the post-Malthusian period, it is likely that there was less variance as the mean fertility declined.⁴¹ As a result, the standard error of the estimated coefficient may be too small and significance could be overestimated. Hence, in order to evaluate the robustness of the results and to account for overdispersion, Appendix Table A6.1.1 estimates Equation 3 with OLS, overdispersed Poisson, and a negative-binomial regression. Results are practically unchanged. In overdispersed Poisson, the conditional variance is scaled by a parameter $\phi \equiv \chi^2_{Pearson}/p$ in order to directly account for the observed overdispersion. By assuming that the outcome follows a negative-binomial distribution, negative-binomial regression accounts for heterogeneity among individuals with additional variability that Poisson regression does not allow for (hence overdispersion).

Distribution regression. Is the effect of higher religiosity uniform at all levels of fertility? I run a distribution regression in order to trace out the effect of religiosity in 1791 on the cumulative distribution function (CDF) of fertility, following Chernozhukov, Fernández-Val and Melly (2013).⁴²

This method allows me to estimate the entire conditional distribution, and, importantly, it does not require the outcome to have a smooth conditional density as in quantile regressions. Therefore it is more adapted to the study of fertility, which is a discrete outcome. I evaluate the effect of *Religiosity (1791)* on the cumulative distribution of fertility for all observed levels, and I estimate Equation 4 with OLS, where $\mathbb{1}_{fert_{i,t} \leq f}$ is a dummy that equals one if individual i had less than f children.

$$(4) \quad \mathbb{1}_{fert_{i,t} \leq f} = \beta_f \times Religiosity_{b(i),1791} + \mathbf{X}'_{i,t} \delta + \lambda_i + \lambda_t + \epsilon_{i,t}$$

Figure 7 plots the results at different levels of fertility. The effect of religiosity in 1791

average duration between births of children (Panel B). Lower fertility was indeed achieved mostly through parity-specific controls: there is no significant change in duration, and age of marriage only increases slightly.

⁴⁰ It is also possible to control for soldier height before 1760, at the town-of-birth level, as a proxy for development: this increases the point estimate of religiosity in 1791 but decreases the number of observations by one-third; hence the result is not reported here. Similarly, I can control for age at death since adult longevity may confound the effect of religiosity on fertility. Yet evidence suggests that religiosity declines with age (Lechler and Sunde, 2020), which would bias the estimates of the impact of religiosity on fertility downward. When I include age at death (which also results in a significant drop in the number of observations), point estimates are virtually unaffected. Results are available upon request.

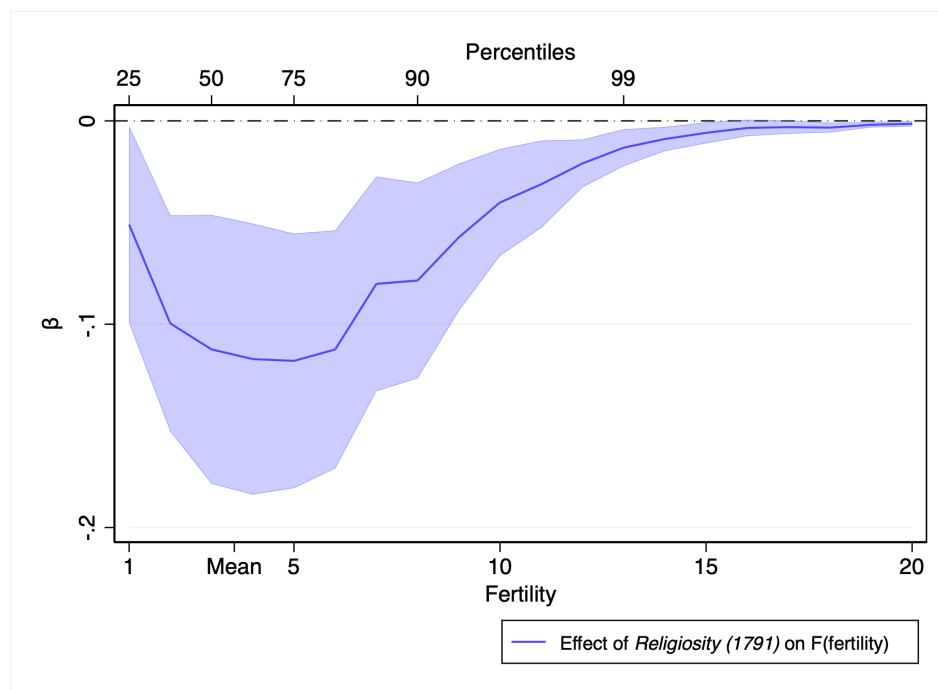
⁴¹ For example, see Spolaore and Wacziarg (2019).

⁴² A thoughtful implementation of this methodology is provided by Goodman-Bacon (2016).

on the cumulative distribution is negative everywhere and is the most important for large families with fertility above the mean or median. Especially, increasing religiosity by 100 percentage points is predicted to increase the probability of having more than six children by about 12 percentage points.⁴³ Finally, a property of distribution regressions is that the estimated coefficients on the CDF (with the linear-probability model) sum up to the OLS coefficient of the effect of religiosity in 1791 on fertility in Appendix Table A6.1.1.⁴⁴ Hence, it fully characterizes the average effect of religiosity in 1791 on fertility.

Figure 7: Effect of religiosity in 1791 on the cumulative distribution of fertility

Note: This figure displays the estimated impact of *Religiosity (1791)* on the cumulative distribution function of fertility, with robust standard errors, for all levels of fertility up to twenty children (the maximum observed is thirty-six). *Religiosity (1791)* is defined as the population-weighted share of refractory clergy (non-jurors) in 1791.



6.2 Identification of a causal effect: fixed effects, difference-in-differences, and second-generation migrants

The crowdsourced genealogical data allow me to employ three different strategies in order to identify a causal effect. To the best of my knowledge, this is the first time any of these has been used in a historical context or with individual-level data.

First, it is possible to study within-*département* variation using fixed effects. In particular, *département*-by-decade fixed effects account for time-invariant *and* time-varying unobserv-

⁴³In order to visualize the effect of secularization on the CDF of fertility, I generate a counterfactual distribution by setting religiosity to the maximum level everywhere in Appendix Figure A6.1.2.

⁴⁴This is why I estimate Equation 4 with a linear probability model instead of logit or probit.

ables. Some *départements* may have been more affected by the French Revolution than others (for example, during the War in the Vendée or during the Reign of Terror), or the crowdsourced data may be of higher quality in some periods in some *départements* (since the records are kept in the online *départemental* archives), which could result in bias.⁴⁵

Second, by extending the sample to individuals observed before dechristianization took place, it is possible to contrast the effect of religiosity in 1791 before and after secularization using a difference-in-differences framework with continuous treatment, similar to Acemoglu, Autor and Lyle (2004).⁴⁶ The causal effect of religiosity on fertility can be identified by differencing its effect after secularization from its effect before using 1760 as the cutoff for the onset of secularization (also the start of the decline in fertility). Unfortunately, the exact date is an unknown parameter (although there is a consensus that it was in the mid-eighteenth century) and neither is it discontinuous (or clear-cut) nor is it, in all likelihood, identical across space.⁴⁷ Moreover, the distribution of religiosity before secularization is unknown, although Section 4.2 suggests that region or *département* fixed effects would account for such differences across space and that religiosity was close to the maximum level everywhere. It is impossible to directly address these issues, and therefore the common-trend assumption cannot be tested for and a fuzzy DID à la de Chaisemartin and D’Haultfoeulle (2017) cannot be implemented formally. Nevertheless, the fact that secularization was a smooth process would likely result in the underestimation of the true effect since some places were likely already treated before 1760 and the design relies on the assumption that that was not the case. Moreover, by estimating the effect of religiosity in 1791 on fertility before secularization, it is possible to further draw inferences about whether religiosity in 1791 captures pre-existing differences or the extent of secularization.

Finally, it is possible to study the fertility decisions of second-generation migrants while holding constant unobserved institutional characteristics of places of arrival, following Algan and Cahuc (2010); Fernández (2011); Guiso, Sapienza and Zingales (2004). This methodology allows me to separate the effect of religious beliefs and norms passed through generations from that of potentially correlated institutional characteristics. What is particularly novel in this setting is both the historical dimension and the fact that it accounts for institutional and cultural variation within the country. Indeed, the traditional approach only uses migrants surveyed recently, leverages between-country variation in place of origin, and assumes that there is no variation within a country in either place of origin or place of arrival. Here I leverage variation in religiosity at the district-of-origin level, holding constant district-of-birth characteristics. Moreover, in order to account for correlation among parents (less than a third of second-generation migrants had parents born in different districts from each other), I implement multiway clustered standard errors at the parents and districts of birth

⁴⁵This issue is known and has been acknowledged—for example, in Henry (1972a,b, 1978); Henry and Houdaille (1973); Ségué (2001)—and experienced firsthand by the author (Blanc and Wacziarg, 2020).

⁴⁶Note that difference-in-differences is essentially a fixed-effects estimator.

⁴⁷For example, the evidence presented about Provence in Section 4.2 suggests that secular values spread starting in the 1730s.

of parents levels.

Table 7: Determinants of fertility at the individual level: causal identification

Note: This table displays the results of the causal-identification individual-level regression of the log total number of children ever born on *Religiosity* (1791). The main explanatory variable is the population-weighted share of refractory clergy (non-jurors) in 1791, at the district-of-birth level (except in specification 5, in which it is evaluated at the district-of-birth-of-parents level and corresponds to the average level for the two parents, which ensures that individuals with a missing parent are not dropped). All specifications include the full set of controls. The baseline specification corresponds to the last specification in Table 6. Two-way clustered standard errors (at the couple and district levels) are reported in all specifications but the last. In specification 5, standard errors are four-way clustered at the district-of-birth-of-parents and parents levels (in this specification, the number of districts reported in the table is for the first parent; for the sake of simplicity I don't report the fact that there are 1,148 second parents originating from 237 districts). Average marginal effects are reported. The results were generated using the Stata program provided by Correia, Guimarães and Zylkin (2020). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	<i>dep var:</i> log fertility				
	(1) Baseline specification	(2) Fixed Effects	(3) Time- varying FE	(4) Diff- in-diff	(5) ^{a,b} Second gen migrants
<i>Religiosity</i> (1791) ^a	0.274*** (0.088)	0.395*** (0.129)	0.431*** (0.134)	0.091 (0.171)	0.224** (0.099)
_____ × After 1760				0.353** (0.165)	
Marginal effect of religiosity on fertility					
Between 1680 and 1759				0.309	
Between 1760 and 1919	0.971***	1.402***	1.535***	1.864***	0.801**
Sample					
Observed between 1680 and 1919				Yes	
Observed between 1760 and 1919	Yes	Yes	Yes		Yes
Controls					
Individual-level	Yes	Yes	Yes	Yes	Yes
Religiosity (pre-secularization)	Yes	Yes	Yes	Yes	Yes
Cultural factors and development	Yes	Yes	Yes	Yes	Yes
Département of birth fixed effects		Yes	Yes	Yes	
Département of birth by decade fixed effects			Yes	Yes	
District of birth fixed effects					Yes
Observations	11,649	11,649	11,450	16,413	1,433
Clusters (couples ^b)	10,155	10,155	9,973	14,200	1,146
Clusters (districts ^b)	438	438	427	449	234
Pseudo R^2	0.06	0.08	0.11	0.13	0.14

^adistrict of birth of parents in (5), ^bmore details in table notes regarding (5)

Table 7 displays the results.⁴⁸ The first specification displays the baseline results with the full set of controls at the individual, town, and district-of-birth levels. In specifications 2 and 3, I add, respectively, fixed effects for *département* of birth and *département* of birth by decade. Point estimates increase, as suggested by the analysis in the rest of the paper, and the marginal effect of religiosity in 1791 on fertility is estimated to be between 1.4 and 1.5 children. All results are significant at the 1 percent level. In specification 4, I extend the sample to all individuals observed between 1680 and 1920. Interacting religiosity in 1791 with a dummy that equals one if the individual was observed after 1760—that is, after the start of secularization—allows me to identify the causal effect of religiosity. The point estimate is similar to that in the previous specifications and is significant at the 5 percent level. Moreover, I find that religiosity in 1791 only has a small and statistically

⁴⁸In Appendix Figure A6.2.1, I display the variation in religiosity in 1791 at the district-of-birth and district-of-birth-of-parents levels, with and without fixed effects.

insignificant effect on log fertility before 1760, consistent with the fact that religiosity in 1791 does not capture pre-existing differences.⁴⁹ Finally, specification 5 restricts the sample to second-generation migrants and includes district-of-birth fixed effects in order to account for unobserved institutional factors that might confound the analysis. Religiosity in the district of parents' birth in 1791 has a persistent and significant effect on fertility. These results indicate that secularization caused the early decline in fertility in eighteenth-century France.

Finally, it is possible to evaluate the effect of religiosity in 1791 over time, from 1680 to 1920. In what follows, I estimate the effect with forty-year periods (a higher frequency would require many more observations than are available).⁵⁰ I display the results in Panel B of Appendix Figure A6.2.2. In the first period, 1680–1720, when secularization had likely not started anywhere, the estimated effect is virtually null, slightly negative, and not statistically significant. Then, in the period that immediately precedes the aggregate decline in fertility, the effect increases slightly and becomes positive, which is consistent with a smooth and heterogeneous-across-space process of secularization and with some places experiencing dechristianization earlier. Indeed, the process of secularization may have started before 1760 in some places, as in Provence, where there is evidence of important changes in the 1730s (Vovelle, 1973) (see Section 4.2). Nevertheless, the effect is statistically insignificant before 1760. After 1760, which marks the start of aggregate-level dechristianization and the decline in fertility, religiosity in 1791 has a positive and statistically significant effect. The effect slightly increases at the time of the second wave of decline in fertility (during industrialization) and then decreases, consistent with a process of diffusion (Spolaore and Wacziarg, 2019) or of interaction between cultural and economic forces as documented by Squicciarini (2020).

7 CONCLUDING REMARKS

The remarkably early timing of the decline in fertility in France, more than a hundred years before the rest of Europe and in a period of stagnation, has long been a mystery. This research suggests that secularization brought about the demographic transition in France.

Using a variety of novel sources and methods, I show that religiosity in 1791 had a large effect on fertility. I leveraged new data on religiosity across time and space to measure dechristianization and to show that religiosity in 1791 does not capture pre-existing differences. Finally, with crowdsourced genealogies, I was able to study the determinants of fertility in France in the eighteenth century at the time of and before the decline, at the individual level. Taken together, my results suggest that dechristianization accounts for most of the early demographic transition.

⁴⁹ Appendix Figure A6.2.2 Panel A displays the difference-in-differences result graphically.

⁵⁰ Also, even with the forty-year periods, statistical power is insufficient to run a difference-in-differences regression by period, which adds to the limitations discussed above.

This paper is not only about the causes of the demographic transition, but also and more importantly about, broadly, the role of ideas, preferences, and culture in shaping development. The results suggest that cultural change and preferences matter in the process of development.⁵¹ In particular, I establish that the transition from tradition to modernity played a role in the transition from stagnation to growth.⁵²

For future research, it would be fascinating to explore the deep roots of the process of dechristianization in France and its short- and long-run effects on political outcomes and democratization, particularly during and following the French Revolution (Bois, 1960; Siegfried, 1913).

⁵¹In a sense, this echoes the work of Becker, Murphy and Tamura (1990) on the role of multiple equilibria and Galor and Moav (2002) on the role of preferences and human evolution.

⁵²In this context, the consequences of low fertility are straightforward. However, as Jones (2020) points out, there can be unintended and harmful consequences if fertility is below replacement level in the long run.

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