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

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Job Market Paper 2

September 21, 2021
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Abstract
This research identifies the origins of the demographic transition in eighteenth-century France. The demographic transition, a turning point in history and an essential condition for development, took hold in France first, before the French Revolution and a century before any other country. Why so early is, according to Robert Darnton, one of the “big questions of history” because it challenges historical and economic interpretations—and it remains a mystery because of data limitations. My results suggest that secularization accounts for the early decline in fertility in France. I document an important process of dechristianization with novel data on devotion. Using census data available in the nineteenth century, I show a strong association between religiosity and the timing of the transition. Finally, I draw on a novel crowdsourced genealogical dataset to study individuals during the onset of the transition and to establish a causal interpretation. In particular, I study the effect of religiosity before and after secularization and exploit the choices of second-generation migrants to account for unobserved institutional factors. These findings reveal that cultural changes 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.

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1 Introduction

The demographic transition is a watershed moment in the process of development. For most of human history, improvements in standards of living were offset by demographic expansion and populations trapped into stagnation. With the advent of limitations of fertility, income per capita was allowed to rise above subsistence in a sustained way. The decline in fertility during the demographic transition is traditionally explained by technological progress and the importance of human capital in light of the trade-off between the quantity and quality of children. Yet, a shift away from tradition and dramatic cultural upheavals also took place with the emergence of modern economic growth in the eighteenth and nineteenth centuries. What came first, and could cultural changes pave the way for development?

This paper argues that secularization, not development or industrialization, brought about the demographic transition in eighteenth-century France; modernization materialized before industrialization. Why the historical fertility transition started in France first, before the French Revolution and more than a century before the rest of the world, remains a mystery because of a lack of available data so long ago. It is one of “the big questions of history” (Darnton, 1978, p. 132) and, according to Sauvy (1962), “the most important fact of all her [France] entire history” (p. 13). Because the demographic transition took hold in France so early and in a period of stagnation, it is an exceptional setting to study the effect of social norms on development.

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. Nevertheless, England and the rest of Europe went through the demographic transition between 1870 and 1920, after the Industrial Revolution, while the onset of the decline in fertility in France is dated to the second half of the eighteenth century, between 1760 and 1776.

Also before any other country, dechristianization took hold in mid-eighteenth-century France with an important loosening of traditional religious moral constraints (Chartier, 1991; Van Kley, 1996; Vovelle, 1982). Braudel (1986b) 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

1See, among many others, Coale and Watkins (1986); Cummins (2012); Henry (1972a,b, 1978); Henry and Houdaille (1973); Knodel and Van de Walle (1979); Murphy (2015); Weir (1994); Wrigley (1985a,b).
2). In some regions the move away from religion took place exceptionally early, in the first half of the eighteenth century (Vovelle, 1973).

I establish that places that remained religious experienced the transition to low fertility more than a century later, suggesting that the wave of secularization played an important role in the early demographic transition in France. To study the determinants of fertility, I rely on département-level population counts from the nineteenth-century, after the onset of the transition, and a novel individual-level dataset crowdsourced from publicly available genealogies in the eighteenth and nineteenth centuries.

I exploit variation in the intensity of religious beliefs after secularization, proxied by the population-weighed share of refractory clergy in 1791 (Tackett, 1986). The Civil Constitution of the Clergy, passed in July 1790, required all priests and vicars to take an oath of allegiance to the secular state and transformed clergymen into civil servants. The oath had to be taken “on a Sunday at the conclusion of the mass” (Decree on the clerical oath). The presence of refractory clergy is highly correlated with all other available measures of religiosity and especially Easter attendance—which is only available in 1966. It is a standard measure of devotion, used in particular by Squicciarini (2020) to study the effect of devotion on education and industrialization after 1870. 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 and preferences across time and space from wills in the region of Provence from 1690 to 1789 (Vovelle, 1973) to measure dechristianization. Using spatial variation, I also show that the share of refractory clergy following the oath of 1791 reflects not only the devotion of laypeople at the time of the French Revolution but is the product of the rise in secular attitudes that took place over the previous hundred years. These results suggest that the main independent variable captures dechristianization in the eighteenth century rather than pre-existing differences.

In the main empirical analysis at the département level, I evaluate the cross-sectional determinants of the timing of the transition to low fertility with census data from 1831 to 1961. 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 from the 75th to the 25th percentile of the distribution predicts a delay in the year of transition of more than one standard deviation—no other variable has an impact nearly as important. Unfortunately, it is impossible to say whether loosening attachment to religion led to the demographic transition by changing preferences for the quantity of offsprings, or simply by allowing individuals to reach their desired, optimal fertility after the relaxation of moral and social constraints. Yet, evidence
suggests that both played a role.

I provide different strategies to show the robustness of the results and to suggest a causal effect using département-level data. First, I estimate bounds on the effect of religiosity across 131,072 potential models, or all combinations of covariates, using sensitivity analysis (Brodeur, Cook and Heyes, 2020b; Leamer, 1983). Not a single specification returns a coefficient for religiosity in 1791 that is either statistically or economically insignificant. Then, instead of using all covariates, I turn to variable selection. Because the roots of dechristianization in France are not well understood, I use lasso, a supervised machine-learning technique that relies on a selection-and-shrinkage algorithm to find the best available predictors in a context with a large number of covariates (Tibshirani, 1996). In particular, double-lasso variable selection allows to select variables which may account for pre-existing or confounding factors in the distribution of both religiosity and fertility. 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 estimate coefficients adjusted for selection on unobservables, with standard errors bootstrapped over thousands of replications (Oster, 2016). The results suggest that the OLS coefficient on religiosity is biased downward, in line with evidence suggesting that secularization hit poor and rural areas disproportionately and was a separate process from the spread of the Enlightenment.\footnote{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).}

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 plausibly causal estimates with the aid of different strategies applied to this setting for the first time. First, I study individuals born in the same départements and account for time-varying département-level cultural and institutional unobservables with département-by-decade fixed effects (there is limited within-département variation in institutional
factors). Then, I apply a difference-in-differences estimation method by comparing the effect of religiosity before and after 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 and find that religiosity in the district in which their 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 at the root of the early demographic transition in France: dechristianization and the move away from the teachings of the Roman Catholic Church. I also contribute to an emerging literature in economics on the role of cultural factors in demographic outcomes (Beach and Hanlon, 2019; Spolaore and Wacziarz, 2019). Second, I contribute to a literature that has documented profound changes in religious beliefs in eighteenth-century France (Van Kley, 1996; Vovelle, 1973) with important consequences (Le Bras, 1942-5; Todd and Le Bras, 1981). Third, I contribute to a vibrant literature that has documented the persistence of culture over the very long run (Ashraf and Galor, 2013; Spolaore and Wacziarz, 2013; Voigtländer and Voth, 2012), but I empirically establish that cultural change, not persistence, is a determinant of development. 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, Ticci 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

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; Sauvy, 1962), 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. 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.

**Contraception and the Catholic Church.** Declining fertility was also noticed by contemporary observers and was attributed at the time to changing moral standards and preferences. 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.” 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). 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).

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 Muhssam (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. 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

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4As opposed to its Catholic counterparts—*implexus restrictus* for non-ejaculation and *amplexus reservatus* for nonpenetrative, rubbing-only sex—which were not very widespread.
the villages (Moheau, 1778), and it appears that withdrawal was the most widespread and efficient method at the time.

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). 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.”

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

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5One 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).
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). 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, Spolaore and Wacziarg (2019) show that the reduction in the rate of fertility in nineteenth-century Europe was driven by a diffusion of norms originating in France, and Perrin (2021) evaluates the role of gender equality. 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 portrayed 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 religious history in France until a radical change in beliefs and religiosity took place in the mid-eighteenth century.

**Before secularization** France was a major Roman Catholic country that hosted seven successive popes from 1309 to 1378. During the Renaissance, and particularly after

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6Murphy (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. In a similar fashion, González-Bailón and Murphy (2013) study the role of social interactions on fertility following the Revolution.

7The 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.
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.8

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 Chartier (1991); Van Kley (1996). Jansenists were at the center of the controversies and clashes of the time, especially with the monarchy and Jesuits, who embodied the religious and economic elite and were also at the forefront of the Counter-Reformation.9 Appendix Section A2.2 provides further details on clashes involving Jansenists, Jesuits, and the monarchy. 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). What links these events to secularization is unclear, but Jansenism and Gallicanism played an important role in eighteenth-century France.

**Secularization.** In the mid-eighteenth century, dechristianization spread to many regions of France.10 In comparison to the rest of Europe, the loss of moral influence of the

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8See Hornung (2014) for the long-run effects of the forced migration of Huguenots to Prussia.
9Tackett (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).
10Why dechristianization happened so early is not well understood. 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...
 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). Figure 2 displays the spatial distribution of religiosity in 1791. Some regions, particularly Brittany, Paris, and Occitania, were very religious, an observation in line with historical and anecdotal evidence on dechristianization in Provence and Auverge-Rhône-Alpes. Section 4 describes the measure of religiosity in more details.

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.

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

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11Note 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).
Figure 2: Religiosity (1791)

Note: This figure displays the spatial distribution of religiosity in 1791. Religiosity (1791) is defined as the population-weighed share of refractory clergy (non-jurors) in 1791.

exceed one day. Districts are lower-level units about a third of the size of a US county, with close to no administrative purpose, and were created in 1790 with no 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.\textsuperscript{12}

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.\textsuperscript{13} 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).\textsuperscript{14}

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

\textsuperscript{12}For regions, I use the 2016 division of thirteen regions. I generate district boundaries with Thiessen polygons.
\textsuperscript{13}Because the oath is measured at the district level, I use the district population-weighed average of the district-level share of refractory clergy in the analysis at the département level.
\textsuperscript{14}The 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).
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 time of the French Revolution, I control for the share of deserters among conscripts in the French army between 1798 and 1805 (Forrest, 1989).

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

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15Although 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.
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. The first three measures aim at capturing religiosity in the pre-1750 era. 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.

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). 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

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16 I 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.

17 Clergymen 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.

18 A 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.
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 institu-
tional 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 develop-
ment, I include département-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? Does it capture secularization or differences in religiosity that persisted through 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. 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-weighed 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-weighed 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). 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.
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-weighed 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. * \( p < 0.1 \), ** \( p < 0.05 \), *** \( p < 0.01 \)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Religiosity (1791)</td>
<td>Marginal effect</td>
<td>Standardized beta coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logit</td>
<td>OLS</td>
<td>Logit</td>
<td>OLS</td>
<td>OLS</td>
</tr>
<tr>
<td>Marginal effect</td>
<td>1.570***</td>
<td>0.313***</td>
<td>0.954***</td>
<td>0.466***</td>
</tr>
<tr>
<td></td>
<td>(0.197)</td>
<td>(0.116)</td>
<td>(0.106)</td>
<td>(0.072)</td>
</tr>
<tr>
<td>Observations</td>
<td>80</td>
<td>82</td>
<td>503</td>
<td>503</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.14</td>
<td>0.23</td>
<td>0.25</td>
<td>0.18</td>
</tr>
</tbody>
</table>

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 (more details in footnote 17), 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 religiosity. Yet some dimensions of religiosity seem to have persisted through secularization.\(^{19}\) 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 The spread of secular beliefs

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

\(^{19}\)Consistent with what Squicciarini (2020) find when examining the role of historical plagues.
of a process that took place in the eighteenth century or does it simply reflect pre-existing differences? There is substantial evidence that the population-weighed 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, there is no direct evidence—an issue I address with novel data in what follows.

**Secularization in eighteenth-century 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 in a comprehensive sample of villages and cities in about ten *bailliages* in four *départements* of Provence (Vovelle, 1973).\(^{20}\) 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.\(^{21}\) The language used in the wills is an indication of the intensity of the devotion 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), and 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

\(^{20}\)The *bailliage* was an administrative unit roughly the size of a district or *arrondissement* before the French Revolution.

\(^{21}\)For 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.
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. 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).

22This 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).
On the eve of the French Revolution, more than 80 percent of wills were secular in Provence, while the population-weighed 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. The results—especially the standard errors—should be taken with a grain of salt because of the small size of the sample, but this is the best available data. In Appendix Figure A4.2.1, 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 bailiages for which the share of refractory clergy is also recorded: Aix-en-Provence, Arles, Brignoles, Draguignan, Forcalquier, Marseille, and Toulon.

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. 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. 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.

23The 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.
24If there is virtually no variation in religiosity before secularization within Provence, then it is logical to find that religiosity in 1791 fully captures secularization.
25In 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.
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). 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 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

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26This is a stock variable, and it is unlikely to have been affected significantly by the decline in fertility.
50%. 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.

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

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.

**Table 2: Determinants of transition date**

<table>
<thead>
<tr>
<th>Controls</th>
<th>Dep var.</th>
<th>Transition date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Religion (pre-secularization)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cultural and institutional factors</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Education and schooling</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pre-industrial development</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Contemporary development</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Mean of dep var</td>
<td>1863</td>
<td>1862</td>
</tr>
<tr>
<td>Standard deviation of dep var</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Perc. 25-75 Religion (1791)</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>OLS</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Tobit</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Left censored observations</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Adjusted R² (OLS)</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Log likelihood (Tobit)</td>
<td>-322.3</td>
<td>-293.6</td>
</tr>
</tbody>
</table>

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 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). Specification 5 controls for literacy to account for the quality-quantity 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. The coefficient on religiosity is maximized for the first year in which marital fertility dropped below 0.6, which corresponds to a 10 percent decline from the average level of marital fertility in pre-transition Europe—about 0.65, compared to 0.55 in France (Coale and Watkins, 1986)—with a 10 percent decline the criterion used to date the transition in Europe. A decline in marital fertility below 0.5 corresponds to a drop of about 25 percent—this is the main specification because it has the least censored observations.

Magnitude and mechanisms. Table 3 presents standardized beta coefficients for selected determinants of transition date. I evaluate and compare the magnitude of a number of factors that may have played a role in the early demographic transition in France, including religiosity but also Encyclopédie subscriptions, linguistic distance from French, literacy, and development. I report the results without any controls but also, in the last column, after accounting for the full set of controls, corresponding to the last specification of Table 2.

The first column corresponds to the first specification of Table 2. In column (2), I evaluate the role of cultural attributes and find a large and significant correlation with subscriptions to Diderot and d’Alembert’s Encyclopédie. 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 throughout most of Western Europe and

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27 After 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.
especially England and Scotland.

Then, because religiosity could capture barriers to the diffusion of norms favoring limited fertility, rather than a direct effect of cultural differences, I look at linguistic distance from French in 1900 in (3).\footnote{Similar to what Spolaore and Wacziarg (2019) do in Europe as a whole, but I use data from the Atlas Linguistique de la France (Blanc and Kubo, 2021) in order to leverage more granular variation in linguistic distance within linguistic areas. Results are similar when using the data from Spolaore and Wacziarg (2019).} Without controls, the effect is large and significant yet the standardized beta coefficient is more than four times smaller than that of the effect of religiosity in 1791, suggesting that the main independent variable is capturing a direct effect of religiosity rather than barriers. After accounting for the full set of controls, the estimated coefficient becomes null and statistically not different from zero. Finally, neither literacy, nor population density, or urbanization had a significant or large effect on the timing of transition. These results suggest that the accumulation of human capital, pre-industrial, or contemporary development were not drivers of the transition in France, in line with the evidence at the macroeconomic level.

Table 3: Magnitude 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 $I_g \leq 0.5$. Standardized beta coefficients and significance levels are reported. All observations are weighted by département population.

\[ p < 0.2, \quad * p < 0.1, \quad ** p < 0.05, \quad *** p < 0.01 \]

<table>
<thead>
<tr>
<th></th>
<th>dep var: Transition date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) (2) (3) (4) (5) (6) (7)</td>
</tr>
<tr>
<td><strong>Standardized beta coefficients</strong></td>
<td></td>
</tr>
<tr>
<td>Religiosity (1791)</td>
<td>0.64***</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td>log 1 + Encyclopedie</td>
<td>-0.28**</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Linguistic distance to French</td>
<td>0.23**</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td>Literacy</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Population density</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
</tr>
<tr>
<td>log 1 + urbanization</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td><strong>Full set of controls</strong></td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>85 87 85 86 88 86 76</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.40 0.07 0.04 0.01 -0.01 -0.01 0.60</td>
</tr>
</tbody>
</table>

Table 4 shows the heterogeneous effect of religiosity in order to understand some of the mechanisms that could have played a role in the transition to low fertility. We interact the
share of refractory clergy in 1791 with the selected determinants used in the table above, and all variables are standardized—therefore the baseline coefficient for the refractory clergy in 1791 corresponds to the case where the interacted variable is evaluated at its mean. The first column corresponds to the first specification of Table 2. In (2), we estimate the heterogeneous effect of religiosity with respect to subscriptions to the Encyclopedie. It is possible that local elites allowed secularization to impact fertility, for example through the diffusion of the libertine literature to the general population. Yet, the effect is small and not significant. Similarly, the effect of linguistic distance and literacy is close to zero and not significant.

Table 4: Heterogeneity in the determinants of transition date

<table>
<thead>
<tr>
<th></th>
<th>dep var: Transition date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) (2) (3) (4) (5) (6)</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardized beta coefficients</td>
<td></td>
</tr>
<tr>
<td>Religiosity (1791)</td>
<td>0.64*** 0.61*** 0.60*** 0.63*** 0.74*** 0.68***</td>
</tr>
<tr>
<td></td>
<td>(0.09) (0.10) (0.09) (0.09) (0.10) (0.09)</td>
</tr>
<tr>
<td>× log 1 + Encyclopedie</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>× Linguistic distance to French</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
</tr>
<tr>
<td>× Literacy</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
</tr>
<tr>
<td>× Population density</td>
<td>0.69+</td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
</tr>
<tr>
<td>× log 1 + urbanization</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
</tr>
<tr>
<td>Controlling for interaction variable</td>
<td>Yes Yes Yes Yes Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>85 85 83 84 85 83</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.40 0.45 0.38 0.39 0.40 0.41</td>
</tr>
</tbody>
</table>

Finally, in column (5), we find that the effect of religiosity is twice as large when population density is one standard deviation away from its mean. The result suggest an important interaction between cultural and economic factors—suggesting that pre-industrial development was a necessary condition for the decline in fertility and that, before dechristianization, individuals had more offsprings than their desired level of fertility because of the constraints imposed by the Church. Coale and Watkins (1986); Spolaore and Wacziarg (2019) find a similar pattern in Europe as a whole. Our results also suggest that overpopulation could
have played a role, as suggested by Braudel (1986b). We do not find the same pattern when looking at urbanization, another traditional proxy for development. The absence of heterogeneous effect could be explained by the fact that urbanization is only a proxy of development in the post-malthusian era, after the onset of the demographic transition, or it could be that the result above is really about overpopulation and not about some interaction between economic and cultural factors.

**Determinants of marital fertility.** Finally, as an alternative to looking at the timing of the transition, I estimate the cross-sectional determinants of $I_g$ from 1831 to 1901 with Equation 2 using OLS.

\[
(I_g)_{i,t} = \beta_t \times Religiosity_{i,1791} + \mathbf{X}_{i,t}^\prime \delta_t + \epsilon_{i,t}
\]

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.

Appendix Figure A5.1.2 displays the standardized beta coefficients over time—as in Table 3—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.

### 5.2 Alternative explanations and robustness: lasso estimation and sensitivity analysis

**Sensitivity of estimates and coefficient bounds.** 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 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).

In order to assess the fragility of coefficients and to estimate bounds on the parameters
of interest, I evaluate the robustness of the association of transition date with religiosity in 1791 across all 131,072 \( (2^{17}) \) combinations of controls. Appendix Figure A5.2.1 plots the distribution of estimated coefficients (and robust t-statistics) on Religiosity (1791) across all combinations of controls when region and pays-status fixed effects are included.\(^{29}\) Panels A and B plot raw distributions, while Panels C and D plot effect size and robust t-statistic 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. If anything, the more controls are added the higher the estimated effect is, consistent with the expectation that the results are downwards biased because of the positive correlation between religiosity and development.

**Double lasso estimation and variable selection.** Since the number of potential variables of interest is large and the determinants of both the decline in fertility and dechristianization are not well understood, I use lasso, a supervised machine-learning technique. Its purpose is threefold. First, it allows me to flexibly select important covariates of religiosity in 1791 in order to account for pre-existing differences. Second, it selects covariates of the timing of the demographic transition in a context where the decline in fertility cannot be explained by traditional theories. Third, it allows me to understand the robustness of the estimated effects and the relevance of specific predictors by shrinking the regression coefficients to zero.

The least absolute shrinkage and selection operator (lasso) is a regularization and variable selection method introduced by Tibshirani (1996). Lasso is essentially an \( \ell_1 \)-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. A tuning parameter \( \lambda \) 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.

The determinants of transition date are estimated in Appendix Table A5.2.1 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 both the dependent and the independent variable. The variables selected in both steps are included in the final regression. This method alleviates biases commonly associated with lasso to the extent that excluding variables with moderate but non-null effects results in omitted-variable bias. In the first column, I report the unweighted OLS coefficient on religiosity in 1791 with the full set of controls.\(^{30}\) 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, otherwise not included in the set of controls. Without including the region and pays-status fixed effects, no variable other than religiosity in 1791 is selected by default. Moreover, the variables selected with fixed effects mostly capture cultural traits. Last but not least, 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—which is reassuring. The estimated coefficient on religiosity in 1791 remains particularly large while, as predicted, lasso reduces variance.

Appendix Figure A5.2.3 plots the coefficient paths for the two lassos with fixed effects. The size of each of the coefficients is plotted against the penalty term $\lambda$. 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. This is consistent with the evidence on Provence suggesting that there were only small differences in religiosity before secularization within region. As expected, the variable with the largest predictive power is the share of deserters among conscripts—validating its inclusion as control to account for institutional factors related to the French Revolution. Yet although none of the controls seem to matter for the distribution of religiosity, religiosity in 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).

### 5.3 Accounting for omitted variables and spatial dependance

**Omitted variables.** While reverse causality is not an issue, omitted variables may result in bias. Religious areas may place more emphasis on tradition and be less prone to innovation and change, which would bias estimates and be a threat to identification. 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. Because religiosity in 1791 is positively correlated with development after secularization took place (Section 4.3), estimates are expected to be downward biased toward zero.

I estimate a coefficient on religiosity accounting for omitted variables under the assumption of equal selection suggested by Altonji, Elder and Taber (2005); Oster (2016)—that is, that unobservables and observables are equally related to the treatment.\(^{31}\) Through-

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\(^{31}\)Oster (2016) shows that movements in the $R^2$, and not only coefficient movements, can give information about...
out this section, I alternatively make the two following assumptions about selection on unobservables: unobservable selection is exactly proportional to selection on observables (Assumption A); unobservable selection is exactly proportional to selection on the diffusion of the Age of Enlightenment (as proxied by log $1 + Encyclopédie$ subscriptions per capita in the period 1777–79) conditional on other observables (Assumption B).

The first assumption is fairly standard, while the other 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 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 Table A5.3.1 report the results of the regression on the determinants of transition year accounting for unobservable selection. I report Oster’s beta for both assumptions, assuming a degree of proportionality of one, and the $\delta$ 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.

Finally, Appendix Figure A5.3.1 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

the direction and the size of the bias arising from omitted variables. The $\beta^*(R^2_{max}, \delta)$ statistics proposed by Oster (2016), with $\delta$ 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 $\beta^*(R^2_{max}, 1)$ (Oster’s beta), then one can reject the null that the coefficient of interest is exclusively driven by unobservables. Following Oster (2016), I set $R^2_{max}$ to min{$1.3R^2, .9$} because of measurement error due to the historical nature of the data.

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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 of 250 kilometers (Assumption 1) or 500 kilometers (Assumption 2). Then, I report the p-value of Moran’s test for spatial dependence of OLS residuals, a standard spatial-correlation statistic. Last, 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.

Appendix Table A5.3.2 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). 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 $\lambda_t$. Each individual is assigned the level of religiosity in 1791 of her district of birth $b(i)$.

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

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

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 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 5 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).

All specifications include a male dummy and decade fixed effects. Standard errors are two-way clustered at the district-of-birth and couple levels. 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: the reduction in fertility was not achieved by delayed age of marriage.

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

33 Appendix Figure A6.1.1 plots the average timespan between the births of the first and last child (Panel A) and 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. A previous version of the paper also included the log fertility of parents. Estimates were smaller because the fertility of parents is obviously collinear with religiosity in 1791 for non-migrants.
Table 5: 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-weighed 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

<table>
<thead>
<tr>
<th>dep var: log fertility</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religiosity (1791)</td>
<td>0.252***</td>
<td>0.297***</td>
<td>0.281***</td>
<td>0.233***</td>
</tr>
<tr>
<td></td>
<td>(0.083)</td>
<td>(0.084)</td>
<td>(0.090)</td>
<td>(0.075)</td>
</tr>
<tr>
<td>Marginal effect of religiosity on fertility</td>
<td>0.893***</td>
<td>1.055***</td>
<td>0.997***</td>
<td>0.829***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
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<td>Individual-level</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Religiosity (pre-secularization)</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Cultural factors and development</td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>11,887</td>
<td>11,728</td>
<td>11,728</td>
<td>11,727</td>
</tr>
<tr>
<td>Clusters (couples)</td>
<td>10,358</td>
<td>10,228</td>
<td>10,228</td>
<td>10,227</td>
</tr>
<tr>
<td>Clusters (districts)</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.01</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Specification 3 adds proxies for religiosity before secularization at the district 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.34 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.35 As a result, the standard error of the estimated coefficient may be too small and significance could be overestimated. Hence, in

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34 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.

35 For example, see Spolaore and Wacziarg (2019).
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 negative-binomial regressions. Results are practically unchanged. In overdispersed Poisson, the conditional variance is scaled by a parameter $\phi \equiv \chi^2_{\text{Pearson}}/p$ in order to directly account for the observed overdispersion. In negative-binomial regression, heterogeneity among individuals is accounted for by assuming that the outcome follows a negative-binomial distribution, hence adding variability that Poisson regression does not allow for.

**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).\(^{36}\) This method allows 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 $1_{\text{fert}_{i,t} \leq f}$ is a dummy that equals one if individual $i$ had less than $f$ children.

\[
1_{\text{fert}_{i,t} \leq f} = \beta_f \times \text{Religiosity}_{b(i),1791} + X'_{i,t}\delta + \lambda_i + \lambda_t + \epsilon_{i,t}
\]

Figure 4 plots the results at different levels of fertility. The effect of religiosity in 1791 on the cumulative distribution is negative everywhere and is the most important for large families with fertility above the mean and 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.\(^{37}\) 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.\(^{38}\) Hence, it fully characterizes the average effect of religiosity in 1791 on fertility.

**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 plausibly causal effect. To the best of my knowledge, this is the first time any of these strategies has been used in a historical context or with individual-level data in France or elsewhere.

\(^{36}\)A thoughtful implementation of this methodology is provided by Goodman-Bacon (2016).

\(^{37}\)In 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.

\(^{38}\)This is why I estimate Equation 4 with a linear probability model instead of logit or probit.
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 unobservables at the département level. This is particularly important to the extent that départements are the main administrative units, hence exploiting within-département variation allows to account for most institutional differences. For example, 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.\(^{39}\)

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).\(^{40}\) The causal effect of religiosity on fertility can be identified by differencing its effect after secularization from its effect before using 1760 as

\(^{39}\)This issue is known and has been acknowledged—for example, in Henry (1972a, b, 1978); Henry and Houdaille (1973); Séguy (2001)—and experienced firsthand by the author (Blanc and Wacziarg, 2020).

\(^{40}\)Note that difference-in-differences is essentially a fixed-effects estimator.
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.\footnote{For example, the evidence presented about Provence in Section 4.2 suggests that secular values spread starting in the 1730s.} Moreover, the distribution of religiosity before secularization is unknown, although Section 4.2 suggests that region or départements fixed effects would account for such differences across space since devotion may have been 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’Haultfoeuille (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 confounding 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 institutional variation within 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.\footnote{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 also implement multiway clustered standard errors at the parents and districts of birth of parents levels.}

Table \ref{table:6} displays the results.\footnote{In Appendix Figure \ref{fig:6.2.1}, 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.} 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,
Table 6: 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-weighed 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 5. 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

<table>
<thead>
<tr>
<th>dep var: log fertility</th>
<th>(1) Baseline specification</th>
<th>(2) Fixed Effects</th>
<th>(3) Time-varying FE</th>
<th>(4) Diff-in-diff</th>
<th>(5) a b Second gen migrants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religiosity (1791) a</td>
<td>0.233*** (0.075)</td>
<td>0.327*** (0.118)</td>
<td>0.363*** (0.125)</td>
<td>0.052 (0.171)</td>
<td>0.210** (0.096)</td>
</tr>
<tr>
<td>× After 1760</td>
<td></td>
<td></td>
<td></td>
<td>0.357** (0.166)</td>
<td></td>
</tr>
<tr>
<td>Marginal effect of religiosity on fertility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between 1680 and 1759</td>
<td>0.175</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between 1760 and 1919</td>
<td>0.829*** (0.118)</td>
<td>1.161*** (0.125)</td>
<td>1.290*** (0.171)</td>
<td>1.718*** (0.190)</td>
<td>0.753** (0.14)</td>
</tr>
</tbody>
</table>

Sample

| Observed between 1680 and 1919 | Yes | Yes | Yes | Yes | Yes |
| Observed between 1760 and 1919 | Yes | Yes | Yes | Yes | Yes |

Controls

| Baseline controls            | Yes | Yes | Yes | Yes | Yes |
| Département of birth fixed effects | Yes | Yes | Yes | Yes | Yes |
| Département of birth by decade fixed effects | Yes | Yes | Yes | Yes | Yes |
| District of birth fixed effects |                  |                   |                   |                |                         |
| Observations                 | 11,727 | 11,727 | 11,525 | 16,503 | 1,438 |
| Clusters (couples b)         | 10,227 | 10,227 | 10,042 | 14,283 | 1,151 |
| Clusters (districts b)       | 440   | 440   | 429   | 451   | 235  |
| Pseudo R²                    | 0.06  | 0.08  | 0.11  | 0.13  | 0.14 |

a district of birth of parents in (5), b more details in table notes

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 insignificant effect on log fertility before 1760, consistent with the fact that religiosity in 1791 does not capture pre-existing differences. 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. I find that religiosity in 1791, in the district of parents, has a persistent and significant effect on fertility. These regressions show that higher fertility was the result of devotion in the eighteenth and in the nineteenth century, suggesting that dechristianization caused the early decline in fertility.

44 Appendix Figure A6.2.2, Panel A displays the difference-in-differences result graphically.
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). 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). 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 establishes that devotion was positively associated with fertility as early as in the eighteenth century, suggesting that secularization brought about the demographic transition in France.

Using a variety of novel sources and methods, I show that the Roman Catholic Church had a large effect on fertility in eighteenth- and nineteenth-century France. I leveraged new data on religiosity across time and space to measure dechristianization and to suggest 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. By tracing the cultural origins of the demographic transition, this paper seeks to address the role of ideas, preferences, and culture in shaping development. The results

45 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.
suggest that cultural change and preferences matter in the process of development. In particular, I establish that the transition from tradition to modernity played a role in the transition from stagnation to growth.

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).

References


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46 In 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.

47 In 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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