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

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Abstract

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

***JEL codes**: N33, O10, Z12*
***Keywords**: fertility, development, secularization*

And the race of man cannot, by any efforts of reason, escape from it
—Thomas Malthus, An Essay on the Principle of Population (1798)

1 Introduction

Over the past three hundred years, the transition from stagnation to growth has triggered dramatic upheavals with enduring consequences as parts of the world escaped the jaws of the malthusian trap and experienced sustained growth. At the same time, a move towards modernity and away from tradition took place. Did industrialization and development come

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first, followed by a wave of institutional, demographic, and cultural changes? Or did these changes paved the way for the rise of income per capita above subsistence level?

This paper advances the hypothesis and shows that secularization, not development, brought about the demographic transition in eighteenth century France: modernization materialized before industrialization. Why the transition to low fertility started in France first, more than a century before the rest of the world, is a mystery.[1] It is one of *the big questions of history* (Darnton, 1978) or, according to Sauvy (1962) *the most important fact of her [France] entire history*. While the rest of Europe went through the demographic transition after the Industrial Revolution, in the late nineteenth century, and in 1892 for England and Wales (Coale and Watkins, 1986), the onset of the decline in fertility in France took place well before the transition to high growth and has been estimated between 1760 and 1776 (Blanc, 2020; Cummins, 2012). Because of the early nature of the process and lack of available data over time and space in the eighteenth century, the roots of the decline are still not understood.

In many ways, France was a developing country in the eighteenth century. In 1750, literacy in France was half that of England and Wales. France attained the GDP per capita of 1750 England and Wales, the cradle of the Industrial Revolution, 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 urban population outnumbered rural population in France. In the process of development and along the transition to modern growth, the demographic transition plays a major part with the Industrial Revolution (Galor and Weil, 2000; Hansen and Prescott, 2002; Kremer, 1993), and France provides an exceptional case for the study of the role of social norms on economic outcomes.[2]

Also before any other country, a widespread process of secularization took hold in France in the mid-eighteenth century (Van Kley, 1996; Vovelle, 1982). In some regions, the move away from religion has been documented exceptionally early, in the first half of the century, while de Tocqueville (1856) argues that "irreligion was able to become a general and dominant passion in eighteenth-century France" (Book 3, Chapter 2). Secular beliefs spread "in a veritable flood" (Tackett, 1986, p. 252) and left a profound impact on France with the weakening of the moral authority of the Roman Catholic Church.

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

I exploit variation in the intensity of religious beliefs after secularization, proxied by the

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

[2] "We all agree that the escape from the Malthusian trap is the most important event in world history" (McCloskey, 2008, Chapter 23).

population weighed share of refractory clergy in 1791. The main independent variable is available at the *département* and at the district levels. The 1790 Civil Constitution of the Clergy required clergymen to take an oath of allegiance to the secular State, which had to be taken "on a Sunday at the conclusion of the mass" (Decree on the clerical oath) and is a standard measure of religiosity (Franck and Johnson, 2016; Squicciarini, 2020; Tackett, 1986), as suggested by the fact that the share of refractory clergy is highly correlated with all other available measures of religiosity.

In order to capture the extent of secularization and not pre-existing differences, I control for proxies of religiosity before secularization in most regressions. In particular, I leverage novel and detailed micro-level data on secular beliefs over both time and space in the region of Provence, spanning one hundred years from 1690 to 1790 (Vovelle, 1973) in order to show that the oath reflects the devotion of lay people before the French Revolution, but is also the product of the rise in secular attitudes through the previous hundred years. I find that religiosity in 1791 captures the extent of dechristianization in the eighteenth century rather than pre-existing differences.

At any rate, although it remains unexplained, historians have 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).[3] I also find suggestive evidence that secularization hit poor and rural places disproportionately and was a separate process from the spread of the Enlightenment, hence resulting in estimates of the effect of religiosity biased towards zero.

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

I provide different strategies to show the robustness of the results and to suggest a causal effect with this data. First, in order to flexibly estimate the determinants of transition date, I use lasso, a supervised machine learning technique that relies on a selection and shrinkage algorithm to find the best available predictors (Tibshirani, 1996). No other variable is selected when religiosity in 1791 is included. Second, instead of selecting coefficients, I turn to sensitivity analysis and estimate bounds on the parameters of interest across all $131,072$ combinations of possible models (Brodeur, Cook and Heyes, 2020*b*; Leamer, 1983;

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

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

Finally, I study ordinary individuals in the past, at the time of the decline in fertility, with 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 places, are included, and I carefully show that it is a representative sample from 1680 to 1920. I find that individuals born in high religiosity places have more children, and the effect is large, statistically significant, and robust. I estimate the effect of religiosity of the district of birth on fertility with Poisson, OLS, overdispersed Poisson, and negative binomial regressions, and I show with distribution regressions that large families experienced the largest drop in fertility as religiosity declined.

I reach causal estimates thanks to different strategies that can be applied to this setting for the first time. First, I account for time-varying *département*-level unobservables with *département* by decade fixed effects. Then, I apply a differences-in-differences framework following the arrival of secularization in the mid-eighteenth century. I find that religiosity in 1791 was positively associated with fertility after secularization but had a null and insignificant effect before, further suggesting that secularization, and not unobservable pre-existing differences, is captured. Last but not least, 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 a different place, and find that religiosity in the district of birth of parents has an important effect on fertility that persists through generations and migrations.

This paper has numerous contributions. It is the first to demonstrate that the dechristianization of France in the eighteenth century played an important part in the early demographic transition. I offer a solution to a major question and identify the nature of the change in preferences that caused this puzzle.[4] Second, I contribute to a vibrant literature

[4]I also contribute to a literature that has emphasized the role of secular forces, often in the twentieth century, on fertility behaviors (Lesthaeghe, 1983, 2010), and their interaction with economic forces (Brown and Guinnane, 2002; Coale and Watkins, 1986).

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

2 Historical background and literature

2.1 Demographic transition and development

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

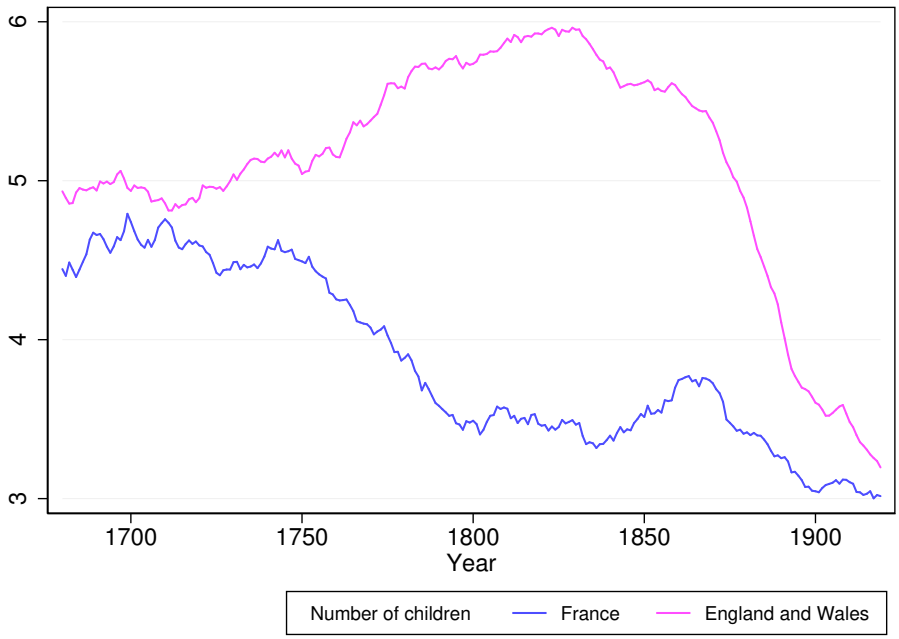
Despite the absence of industrialization in France, France and England did not grow at different rates in per capita terms after 1750 and throughout the 19th century (Appendix Figure A2.1.1). The rate of population growth in England largely surpassed that in France: in the two centuries following 1750, the population of England increased from $5,5$ to 40 millions inhabitants, while the population of France increased from $24,5$ to the same figure in 1950, 40 millions inhabitants. Figure 1 displays fertility in France and 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.

The early decline in fertility, a century before the rest of Europe, in an epoch of stagnation, and before the French Revolution, has generated numerous contributions yet, why France experienced the demographic transition this early remains a question. There is widespread agreement that cultural forces played a role (Braudel, 1986*b*; Sauvy, 1962) but it remains one of the most important unsolved puzzle in the history, demography, and economic growth literatures. The early nature of the phenomenon and lack of data has hampered the effort

to understand the roots of the decline.[5] In particular, demographer Louis Henry used parish records to reconstruct village-level series of fertility in the eighteenth century (Henry, 1972*a*,*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 after 1831. However, parish-level family reconstitutions do not offer sufficient spatial variation and suffer from many limitations, which I detail in Section 3.3. Census data is only available in 1831, way after the start of the transition.

Figure 1: Demographic transition in France and England

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



Contraception and Church Declining fertility was already noticed by contemporary observers, and attributed to changing moral standard and preferences. van de Walle and Muhsam (1995) provide a detailed and fascinating account of the evolution of sexual and moral preferences in the eighteenth century, in particular regarding to the spread of *coitus interruptus* (withdrawal). In 1778, Jean-Baptiste Moheau famously used the term 'funestes secrets': "already the fatal secrets *unknown to any animal but man* have penetrated in the countryside: *nature gets cheated* even in the villages". Moheau (1778) also referred to the "*propagation of the species* as a dupery of olden times", and according to Goudar (1756)

[5] A wide body of research, including Cummins (2012); Knodel and van de Walle (1979); Weir (1994); Wrigley (1985*a*,*b*), studied the French fertility decline in the past.

"it is the same love of ease and convenience that is filling France with bachelors...men who vanish from the world with all their posterity" (p. 271).

If modern methods of contraception became available well after the onset of the fertility decline, then how did fertility decline? Early condoms (*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 radically changes his behavior and resorts systematically to condoms after 1760. Other methods of contraception, less relevant, include chastity (one of the seven virtues of christian faith), late marriage, sodomy, abortion, or infanticide (van de Walle, 2005). van de Walle and Muhsam (1995) also refer to 'the pleasures of the little goose', *les plaisirs de la petite oie*, for mutual masturbation. Rather, natural means of contraception such as *coitus interruptus*, withdrawal, were no secret.[6] The method of withdrawal "is mentioned in the Bible, the Talmud and the Muslim tradition" (van de Walle, 2005). Interestingly van de Walle (2005) argues that it "was frequently alluded to in libertine literature" (p. 2), particularly widespread in eighteenth century France (Darnton, 1991) with *Venus in the Cloister or The Nun in her Smock* (1683), *The Indiscreet Jewels* (1748) by Diderot, or *Philosophy in the Bedroom* (1775) by the Marquis de Sade. Yet, methods of *cheating nature* were practiced not only by the elite but also by peasants in the villages (Moheau, 1778) and it appears that withdrawal was the most widespread or efficient method at the time. Hence, van de Walle and Muhsam (1995) hypothesize that "withdrawal was first practiced outside of marriage, but in marriage it found its true niche" (p. 276).

What were the views of the Catholic Church regarding contraception and sex remains a question. The Bible urges, multiple times, the faithful to "be fertile, increase in number, and fill the earth" (Genesis 9:1), while the account of the sin of Onan designated both masturbation and 'unnatural' intercourse as evil. Over time, the pronouncements of the Church against contraception, while clear, were often discrete and indirect (Noonan, 1965).[7]s The multiplicative purpose of marriage "received its strongest official approval" (Noonan, 1965, p. 276) in the *Exultate Deo* papal bull (1439): "through matrimony [the Church] is corporally increased". Following the Council of Trent (1545-63) the views of the Catholic Church shifted towards more sexual austerity outside of marriage, suggesting an 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 [is that] it is considered sinful in marriage to ejaculate

[6] As opposed to its catholic counterfactuals, *implexus restrictus* for non-ejaculation, and *amplexus reservatus* for non-penetrative, rubbing-only sex, which were not very widespread.

[7] One of the inner struggle 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).

outside of the natural receptacle (*ex vas naturale*), and only somewhat less sinful to use 'unnatural positions'" (p. 269). Hence 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 or Pierre de Bourdeilles (Brantôme) referred to withdrawal and contraceptive methods, and argued that *marital fertility should not be interfered with* (van de Walle and Muhsam, 1995, p. 269). 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' (pp. 76-77)" (van de Walle and Muhsam, 1995, p. 269). Whether a *good* lineage meant multiplication is an open question, yet 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), and 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, which might have played a role in the decline in fertility.

Theory and recent contributions According to standard economic theory, development is the best contraceptive (Hansen and Prescott, 2002; Kremer, 1993). Especially, the set of endogenous growth models developed by Galor (2011); Galor and Weil (2000); Galor and Moav (2002) enlightens 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 onset of the transition. While in the Malthusian trap, income per capita fluctuates around a subsistence level because of the positive relationship between income and fertility. As quality is favored to quantity, the relationship is reversed and the economy enters the modern growth era, where human capital is the driver of progress. Institutional, cultural, geographic factors interact with these forces but are not the main determinant 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 versus cultural forces broadly (de la Croix and Perrin, 2018; Murphy, 2015).[8] More related to the analysis of the cultural origins of the transition, Blanc and Wacziarg (2020); Daudin, Franck and Rapoport (2018) study the diffusion of norms of limited fertility whithin France and Spolaore and Wacziarg (2019) show that the reduction in the rate of fertility in 19th century Europe was driven by a process of diffusion of norms originating from France.[9] Yet, no research has empirically established the cause of the decline in fertility in France so far.

[8]Murphy (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.

[9]The 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 between countries, and Beach and Hanlon (2019) for a fascinating account of changing norms of fertility following the Bradlaugh-Besant trial of 1877 in England.

2.2 Religion and secularization in France

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

France is a major Roman Catholic country that hosted seven successive popes from 1309 to 1378. During the Renaissance, and particularly after the reign of Francis I, Protestantism marginally spread with an estimated 10% of Protestants 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, 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 which he should have inherited in 1589, 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*, French policies of legal persecution and forced conversion of Protestants ordered by Louis XIV, embodied the fight and terror against the Protestant Reformation: dragoons, infantry soldiers, were billeted to Huguenots households in order to harass and intimidate them. Thousands of Protestants left, and it set the course for the unchecked diffusion of the Counter Reformation in France.[10] This coincided with the strengthening of the Catholic resurgence that followed the Council of Trent: the Counter Reformation.

Following the demise of protestantism in France, the Counter Reformation was able to spread unchecked and to impose an austere sexual morality on lay people. Hoffman (1984) evokes "bans upon nudity in religious art, harsher rules against illegitimacy, prostitution, and concubinage, and more 'puritanical' standards of dress and behavior", and these were supported by the elites: "the harsh sexual morality of the Counter Reformation Church had the support of the royal government and of the urban elites, who had in the past tolerated a great deal more sexual license".

In France, the diffusion and consolidation of the Counter Reformation took place with the rise of Jansenism, a pious, austere, and rigorist theological movement unique to France.[11]

[10] See Hornung (2014) for the long run effects of the forced migration of Huguenots to Prussia.
[11] Tackett (1986) writes that "during the first half of the eighteenth century, one issue in diocesan politics dominated

Jansenists were at the intersection 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 Reform. Appendix Section A2.2 provides further details on clashes involving Jansenists, Jesuits, and the monarchy. Religious competition was primarily between these two movements. Elites strongly opposed Jansenism, who sought to advance ideas of predestination of the elect to salvation, limitation of sacrements and need for penitence, ideas also advanced by 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 the Pope, but also from a Monarchy endowed with divine right (Maire, 1998, 2019).[12]

Secularization In the mid-eighteenth century, yet, an important and early process of secularization took place in France. Why this happened is a mystery, but the austere morality imposed by the Counter Reformation in France and its association with political and economic elites, the rigorism of Jansenists, or religious controversies and competition with Jesuits are believed to have precipitated the decline in religiosity and social unrest (Hoffman, 1984; Maire, 1998; Tackett, 1986; Van Kley, 1996).[13]

Many regions of France experienced dechristianization in the 1750s. In particular, Vovelle (1973) documented the transition to secular attitudes in a fascinating and pathbreaking study in Provence, while Hoffman (1984) finds substantial changes in the rural parts of the diocese of Lyon.[14] The change in attitudes, or *mutation de sensibilité collective* was found in a decline in 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 change occurred is much more limited (Tingle, 2012), while Paris saw substantial heterogeneity with parts experiencing a much larger decline than others (Chaunu, 1978). Finally, Chartier (1991) describes how regions such as Savoy experienced a radically different evolution from that on the other side of the border: "habits thus seem to have been quite different on different sides of the frontier, which suggests the singularity of dechristianization in France." (p. 97).

all others: the issue of Jansenism" (p. 128).

[12] Regarding the role of Gallicanism and the separation of temporal from religious matters, "Following the royal edict of 1715, Protestants could no longer legally unite through marriage (...) parliamentarians and many state clerks defend the principle that marriage is first of all a civil contract, a purely temporal engagement, which must therefore be accessible to all" (Grenier and Maire, 2019).

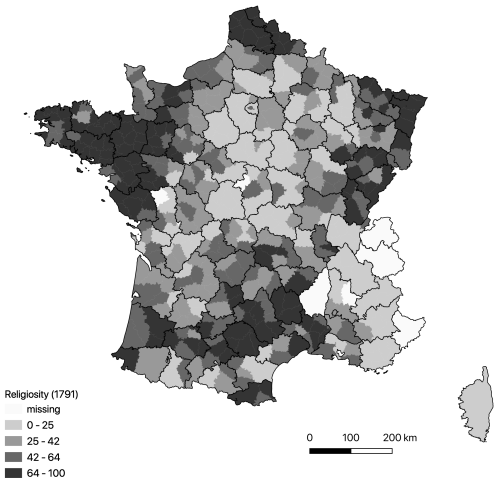
[13] According to (Hoffman, 1984), "the Counter Reformation's austere morality was imposed in full force (...) not surprisingly, it was rejected by people who saw nothing wrong in combining devotion and gaiety" (p. 138). Tackett (1986) evokes "epic struggles with the Jesuits" (p. 6) and argues that "a whole series of affaires and causes célèbres, from the repression of the convulsionnaries in the 1730's through the billets de confessions in the 1750's and the expulsion the Jesuits in the 1760's, had contributed in broadly publicizing and intensifying grievances toward the clergy." (p. 257). According to Braudel (1986*b*), "the drama played out in the 18th century was a sort of revenge on the part of the Reformation. Having hesitated, two centuries earlier, between Rome and Luther, or rather between Rome and Calvin, France had chosen Rome, but the choice backfired." (p. 200).

[14] Also, in the diocese of Grenoble by Norberg (1985).

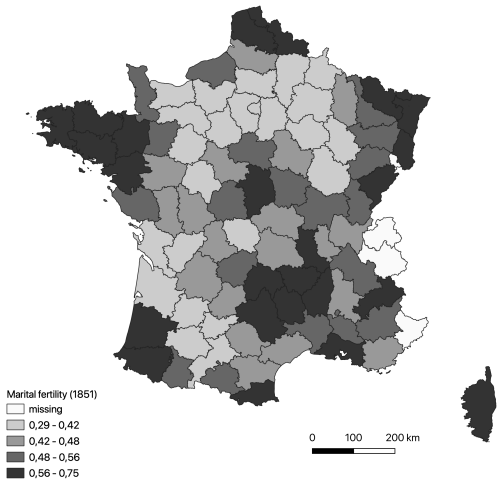
In Figure 2, I display the spatial distribution of *Religiosity (1791)* along with marital fertility in 1851 (details are provided in Section 3). Some regions, particularly Brittany, Paris, and Occitanie, were religious while other regions such as Provence and Auverge-Rhône-Alpes were much less religious in the late eighteenth century, in line with existing historical and anecdotal evidence on the decline (Hoffman, 1984; Norberg, 1985; Tingle, 2012; Vovelle, 1973). Although the data is not available in 1851, Savoy has a high level of marital fertility after, consistent with the anecdotal evidence presented by Chartier (1991) relative to the absence of secularization there.

Figure 2: Religiosity and fertility

Note: This figure displays the spatial distribution of *Religiosity (1791)* and of the fertility index I_g in 1851. *Religiosity (1791)* is defined as the population weighed share of refractory clergy (non-jurors) in 1791. Section 3 details these measures.



(Panel A) Religiosity (1791)



(Panel B) Fertility index I_g (1851)

3 Data

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

Départements are the main administrative units in France since 1790, all of nearly equal size (about 2,300 sq. miles) and designed to ensure that travel distance by horse from any location within the department to the main administrative center would not exceed one day. Districts are lower units, with close to no administrative purpose, created in 1790 such that there could not be more than 9 or less than 3 districts per *département* (which was practically their sole feature). They were replaced by and merged into (larger) arrondissements in 1795.

In total, there are 90 *départements* and 513 districts.[15]

3.1 Religiosity

The main explanatory variable throughout the paper is *Religiosity (1791)*. It is a measure of the outcome of the process of secularization in the eighteenth century. 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 State. I use the share of clergymen that did not take the oath ("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). Finally, there is evidence that 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).

The oath has been commonly used in the literature as a proxy to religiosity in late eighteenth century France (Franck and Johnson, 2016; Squicciarini, 2020). There is widespread evidence that the share of refractory clergy captured religiosity at 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 show that the presence of refractory clergy is highly correlated with religious practices and attitudes at the time of the decline and in the 19th and 20th century, and that it mostly scaptures the extent of the process of secularization.

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 establishment of anti-clerical cults (the Cult of Reason and the Cult of the Supreme Being among others), the War in Vendée, the Paris Commune, and the Reign of Terror. Moreover, before the 1792 decree, according to Tackett (1986), "*the National Assembly (⋯) allowed the continued presence of the refractory clergy*". Hence, it does not capture the effect of main Revolutionary events and policies of dechristianization but rather religious attitudes before the French Revolution (I document this in more details in Section 4).

The data is available at the *département*, diocese, and district levels and is constructed from the choice of more than 50,000 parish clergymen, more than 90% of all priests and vicars holding posts in 1791 France (Tackett, 1986, p. 39).[16] 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% at the *département* level, with an average of 48%.

[15] For regions, I use the 2016 division of 13 regions. I generate district boundaries with Thiessen polygons.

[16] At the *département* level, *Religiosity (1791)* is constructed as a district population-weighed average of the district-level share of refractory clergy. Doing so ensures that rural districts, which could have more clergymen per capita, do not bias the average *département*-level value.

In order to capture religiosity, I control for the share of deserters among conscripts in the French army between 1798 and 1805 (Forrest, 1989) to account for State legitimacy at the time of the French Revolution.[17] I supplement this data with a set of controls aimed at capturing religiosity before secularization (in order to ensure that dechristianization, the decline in religiosity, is captured). At the *département* level, the pre-secularization religiosity controls include the number of clergymen per capita in 1791, the average tithe in 1750, the number of abbeys in 1756, the duration of Jesuit presence before 1763, and finally the share of Protestants in 1815, after the 1685 revocation of the edict of Nantes.[18] The first three measures aim at capturing religiosity in the pre-1750 era. Squicciarini (2020) shows that religiosity is highly correlated with priests ordinations in the twentieth century, suggesting that the stock of clergymen in 1791 should be a good indicator of the intensity of religious beliefs before secularization (since the stock should take some decades to adjust to changes).[19] There is a particularly high number of clergymen in 1791, with 1 per 500 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, Jesuits and Protestants. At the district level, I control for the number of abbeys and the duration of Jesuit presence, along with 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 has been constructed by Coale and Watkins (1986) as part of the Princeton European Fertility Project (PEFP), and is available for about 80 *départements*. The PEFP provides data at the sub-national level for all countries in Europe, at the *département* level for France.[20]

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

[17] Although 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 controlling for proxies of State legitimacy.

[18] 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 due to a lower number of observation.

[19] Clergymen per capita is measured in 1791, at the same time as the share of refractory clergymen is measured. However this is a stock and it is unlikely that the total number of clergymen would have immediately declined following the decline in religiosity (and 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.

[20] 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.

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 from these women should they not practice any form of limitation, using data from the Hutterites, an Anabaptist sect that does not practice any fertility control:

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

with B_i^m the total number of children born from married women in society i, M_{ij} the number of married women in age cohort j, and G_j the rate of fertility of Hutterites for age cohort j. I focus on marital fertility rather than overall fertility because it is the standard measure in the literature 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 19 years from 1831 to 1961, and decreases from .56 to .33. Section 5, reports cross-sectional regressions for both the year of transition to a marital fertility index below 50% and levels of marital fertility in 1851 and in 1901.

Controls I supplement this data with a set of controls used in the *département*-level regressions in Section 5. Table A3.2.2 details these controls, while Figure A3.2.1 displays the spatial distribution of some variables of interest. In addition to the proxies for religiosity before secularization, I also control for broadly defined cultural and institutional factors with: a dummy that measures the presence of a printing press in 1500, the number of books printed in 1500, a dummy for the presence of a University before 1750, Encyclopedie Subscriptions per capita in 1776-1779 (as a proxy to 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 cultural differences or state capacity), and the share of deserters among conscripts in the French army between 1798 and 1805. I further control for education using the literacy rate of conscripts in the year of observation. Finally, in order to control for pre-industrial development, I include *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 of more than $5,000$ inhabitants.

3.3 Individual level

The *département*-level data is supplemented with a new individual-level dataset crowdsourced from publicly available genealogies. Blanc (2020) reconstructs rates of fertility (children ever born) at the individual level from genealogies posted on geni.com and scrapped by Kaplanis et al. (2018). The dataset contains thousands of individuals and is nationally

representative of France from roughly 1680 to 1920.

Lineage reconstruction from crowdsourced genealogies relies on the work of descendants reconstituting their family tree today searching through the same parish records as the ones used by demographers. Parish records are available online with unrestricted access in all French departments from the mid-seventeenth century onwards. However, family reconstitution requires lots of informations in handwritten birth, marriages, and death records of often dubious quality (Séguy, 2001). Tracing fertility requires knowing about all the birth records of the children of an individual. These records are hard to locate, individuals often have the same first names, are recorded with imprecise information (rounded dates, names that change, poor handwriting), and may migrate, therefore it is a very tedious and often imprecise job. Descendants have better incentives to thoroughly gather these informations and have a knowledge of family history and past migrations that may help them in the process. This allows to fully account for migration, to gather family trees more comprehensive than what demographers found, and last but not least, to have a substantial degree of spatial variation, which demographers were not able to get because they did it one parish at a time.

An important caveat is that a significant number of observations in the sample may not have a recorded horizontal lineage as individuals reconstituting their family tree today have a greater incentives recording their direct ancestors (the vertical lineage) rather 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, therefore 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 (individuals who lived in France during that period) and in representative data for France (using a combination of sources including censuses for available years). There are no substantive differences, suggesting that sample selection is limited (see Blanc (2020) for a detailed discussion).

The rate of fertility at the individual level is simply the total number of children ever born. While the *département* level data is only available after 1831, the individual-level data contains individuals observed between 1680 to 1920. All observations contain geo-coded places of birth, marriage, and death, which allows to match individuals with *Religiosity (1791)* at their district of birth level. Figure A3.3.1 displays the towns of birth included in the fertility sample. Summary statistics for the $17,358$ individuals in the fertility sample are found in Table A3.3.1.

4 Religiosity and secularization

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

4.1 Persistence of religious practice

After secularization Is the share of refractory clergy capturing religiosity, and did it persist after secularization? There is mounting evidence that the answer to both of these questions is yes. Appendix Figure A4.1.1 displays the spatial distribution of measures of the intensity of religious beliefs in the nineteenth and twentieth centuries: a dummy variable that equals one if catholic practice in a *département* was deemed 'good' by the local administration in 1877 (Gadille, 1967), or if a district was coded as catholic in 1947 (Boulard, 1947), the share of catholic schools in 1901 (SGF, 1901), average easter attendance in 1966 (Boulard, 1966), and the share of baptized births in 2013 (Vaillant and Dufour, 2013). While the population weighed share of refractory clergy in 1791 is possibly capturing 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, suggesting 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 anti-religious *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 only standardized beta coefficients, and marginal effect 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 (2), I show that *Religiosity (1791)* is highly correlated with the share of catholic schools in 1901. Column (4) uses the best available measures 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 column (5), I find similar results 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 to 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. Columns 1 and 3 report average marginal effects and are estimated with maximum likelihood. All observations are weighed by *département* population in the year of observation of the outcome variable. Robust standard errors are reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

Before the mid-eighteenth century In order to understand if religiosity persisted through dechristianization in the eighteenth century, Appendix Table A4.1.1 presents regressions of religiosity in 1791, after the bulk of secularization, on proxies of religiosity before secularization at the *département* and at the district level. In columns 1 to 5, the main independent variables are the number of clergymen per 10,000 inhabitants in 1791 (footnote 19 describes why this is a proxy of religiosity before secularization), the number of abbeys in 1756, average tithe rate in 1750, the duration of Jesuit presence before their suppression in 1763, and the share of protestants in the population in 1815, after the 1685 revocation of the edict of Nantes. In (6), I include all these variables together.

At any rate, religiosity in 1791 does not correlate with any of these proxies of 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.[21] 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 is 13 percentage point higher in places where the Society of Jesus

[21] Consistent with what Squicciarini (2020) argues by looking at the role of historic plagues.

has settled for two centuries compared to those where it is absent. As many districts do not have either Jesuits or abbeys, especially the rural ones, column 8 adds dummy variables if either is present. I find that the presence of abbeys in 1756 also has an effect (significant at the 20% level) that seem to have persisted through secularization.

4.2 Religiosity, or secularization?

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

Secular beliefs in the eighteenth century: evidence from Provence In order to answer this question, I exploit detailed and never-used-before data on secular beliefs *over time and space*, from the universe of wills at death in a comprehensive sample of villages and cities in about ten *bailliages* in four *départements* of Provence (Vovelle, 1973).[22] Wills at death were written by individuals from all social class and tell a similar story whatsoever (Vovelle, 1982). Although wealthier individuals were slightly more likely to leave a will at death, this is the only available measure of the intensity of religious beliefs before secularization and the first, most detailed, and best available account of secularization. Other measures, such as church attendance or donations (in particular in Hoffman (1984)) are only available across space or time but not both. The language used in wills is an indication of the devotion of those who wrote them and changes radically over the course of the eighteenth century. Especially, in the second half of the century, references to God, Jesus Christ, the Virgin Mary (which was particularly important in Provence for some reason), or various Saints disappear and are replaced with secular language:

> In the late seventeenth and early eighteenth centuries, testators consistently described themselves as adherent of the holy, apostolic Roman Catholic Church, who were prepared to meet their Maker, God the Creator, and Jesus Christ,

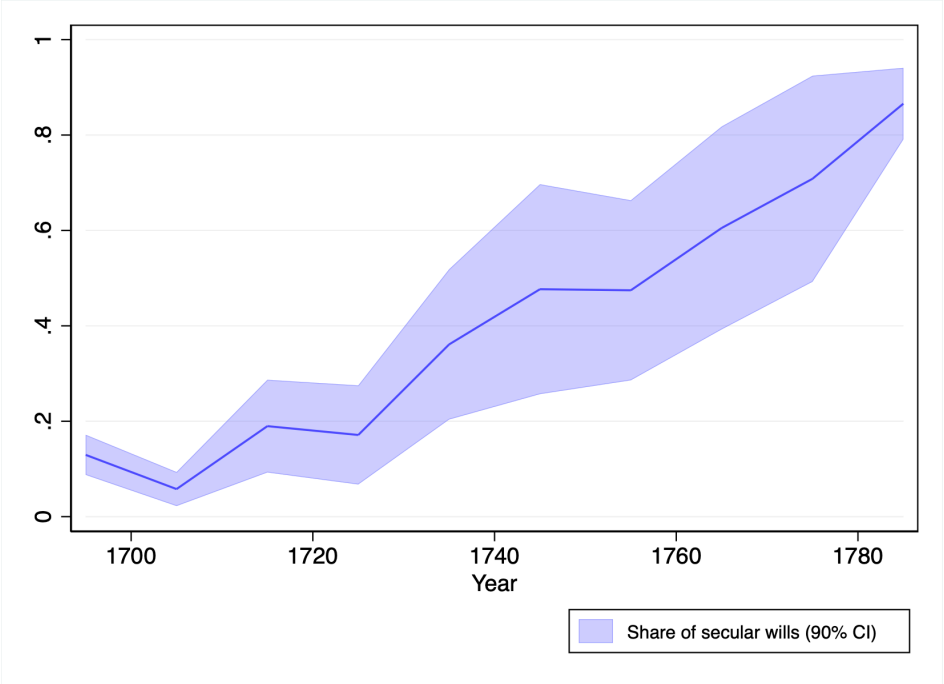
[22] The bailliage was an administrative unit roughly the size of a district or an arrondissement before the French Revolution.

> His Son, by whose death and passion they hoped to be pardoned for their sins and to join the saints and angels in the Celestial Court of Paradise. (...) By the 1780s most Provençal wills had reduced the traditional formula to a single clause: '*Having recommended his soul to God*'. The Virgin Mary and saintly intercessors were gone, the Celestial Court emptied of angels. Christ himself had receded into the background, while God the Father sometimes took the form of 'Divine Providence'. Many wills had become totally secularized, and some even described death as '*the indispensable tribute that we owe to Nature*'. (Darnton, 1978, p. 126)

In order to grasp the magnitude and the timing of the process 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% of wills used secular language.[23] After the 1730s, the share of secular wills increases significantly and almost all were secular in the 1780s. Indeed, Provence, which was also one of the poorest, most rural, *départements*, experienced one of the earliest process of dechristianization in France (Vovelle, 1973).

Figure 3: Secularization in eighteenth century Provence

Note: This figure displays the 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).

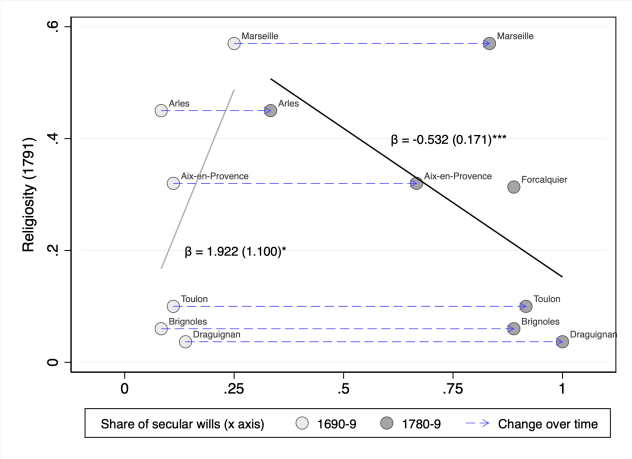


[23] This figure is likely over-estimating the spread of secular beliefs since, as Vovelle (1973) suggests, it is mostly the result of illiteracy or clergy members who deemed too obvious references to their faith.

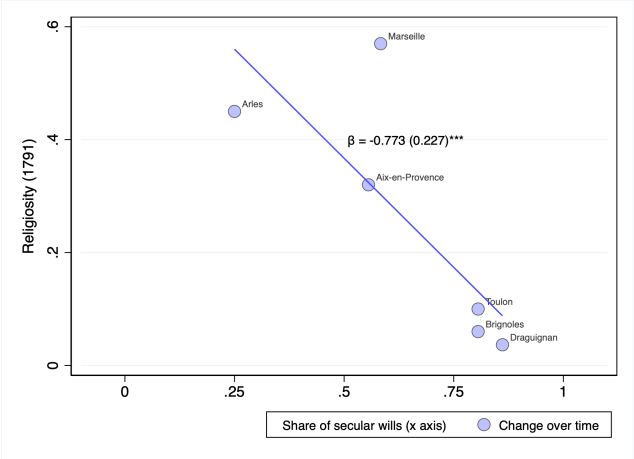
At the eve of the French Revolution, more than 80% of wills were secular in Provence, while the population weighed share of refractory clergy, religiosity in 1791, was 26%. Hence, to understand the drivers of the distribution of religiosity after secularization, I relate religiosity in 1791 to the size of the process of dechristianization in the cross-section as captured by the share of secular wills over time and space in Provence. In Figure 4, I plot the share of refractory clergy in 1791 against the share of secular wills in the 1690s, in the 1780s, and against the change in the share of secular wills over time.[24] The data is available in seven *bailliages* for which the share of refractory clergy is also recorded: Aix-en-Provence, Arles, Brignoles, Draguignan, Forcalquier, Marseille, and Toulon. The results (and especially the standard errors) should be taken with a grain of salt due to the small size of the sample, yet this is the best available data.

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

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



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



(Panel B) Secularization and refractory clergy

In Panel A, I show that the share of secular wills in the 1780s is negatively correlated with *Religiosity (1791)*, providing further evidence that the share of refractory clergy does capture religiosity. However, before secularization, in the 1690s, religiosity was at near maximal levels everywhere, with only about 13% of wills coded as secular in the 1690s and virtually no variation. If anything, I find that the share of secular wills in the 1690s is positively correlated to religiosity in 1791, suggesting that the most devoted places in the 1690s experienced the strongest process of secularization.[25] However, the result is not

[24] Table A4.2.1 provides the corresponding regressions in table format.

[25] The 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.

statistically significant at the 5% level and the regression line is essentially vertical. This is in line with the results at the *département* level and it suggests that religiosity mostly did not persist through secularization.

In Panel B, I plot *Religiosity (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 in the share of secular beliefs of 100 percentage point is associated with a decrease in religiosity in 1791 of almost 80 percentage points.[26] It suggests that, not only the share of refractory clergy in 1791 captures religiosity, but it also mostly reflects the process of dechristianization in the eighteenth century rather than pre-existing differences.[27]

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 of development at the town level. In order to capture the correlation of the process of secularization, rather than simply religiosity, with development I also control for proxies to 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 to development in the pre-industrial era (Ashraf and Galor, 2011).[28] Results hold for urbanization, estimated with logit. Next, I show that religiosity in 1791 is positively correlated with Encyclopedie 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 Encyclopedie are a traditional proxy of 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 it is likely due to the fact that 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 Encyclopedie (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 to development.

The results indicate that secularization 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

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

[27] In the bulk of the empirical analysis of fertility, I use region fixed effects and the proxies to 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.

[28] This is a stock variable and it is unlikely to have been affected significantly by the decline in fertility.

traditional. However, this is consistent with what Hoffman (1984); Vovelle (1973) find in Provence and in the rural parts of the diocese of Lyon. For example, Vovelle (1973) finds that local elites secularized less than peasants and laborers. If anything it suggests that the effect of religiosity in 1791 on fertility will be 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 .5. I estimate Equation 1 with OLS and a Tobit model (by maximum likelihood) in order to account for the left censoring nature of the data, since about a quarter of *départements* had already transitioned in 1831.

$$(1) \qquad (\text{Transition date})_i = \beta \times Religiosity_{i,1791} + \boldsymbol{X}_i^{'}\delta + \varepsilon_i$$

Table 2 reports the results, along with robust standard errors. Appendix Figure A5.1.1 plots the scatterplot and partial residual plot. A 10 percentage point increase in religiosity in 1791 is associated with a delay in the year of transition of more than 10 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 40 years.

The estimates are stable and significant at the 1% level across all specifications. Column (2) controls for proxies to 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. Column (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 to capture religiosity and not State legitimacy with the refractory clergy. 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 Encyclopedie 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). Column (4) adds 12 regions fixed effects to account for unobserved cultural or economic factors that may confound the effect of *Religiosity (1791)* (for example, shared identity or language could have an effect on broadly defined modernization (Weber, 1976)). Column (5) controls for literacy to account for the quantity-quality trade-off, while (6) and (7) account for development. Results

remain virtually unaffected.

Table 2: Determinants of transition date

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

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

Finally, I estimate Equation 1 for alternative definitions of transition date in Appendix Table A5.1.1. As expected, the coefficient on religiosity is maximized for the first year when marital fertility dropped below .6. The average level of marital fertility in Europe in 1831 was about .65, compared to .55 in France (Coale and Watkins, 1986), while a decline below .5 corresponds to a drop of about 25%.

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

$$(I_g)_{i,t} = \beta_t \times Religiosity_{i,1791} + \boldsymbol{X}'_{i,t}\delta_t + \varepsilon_{i,t} \tag{2}$$

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 point. The marital fertility index in France averaged .49 in 1851, about half the Hutterites 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 of about 10 percentage points, slightly less than a standard deviation. Finally, Appendix Figure A5.1.2 plots marital fertility in 1851 and 1901 against *Religiosity (1791)*, with and without controls.

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

This section turns to alternative explanations that could have played a role in mitigating of permitting the effect of *Religiosity (1791)* on marital fertility.

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

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

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

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

Table 3 presents standardized beta coefficients of selected determinants of transition date.[29] Each cell represents the result of a different regression and reports the standardized beta coefficient of the variable of interest in the left column. In column 1, no control whatsoever is included. In column 2, the full set of controls and *Religiosity (1791)* are included, therefore cells represent coefficients from the same regression (specification 7). This allows not only to evaluate the relative magnitude of each of these explanatory factors but also to grasp the robustness of the estimated effects.

First, I evaluate the role of cultural attributes and find that subscriptions to Diderot and d'Alembert's Encyclopedie have a large and significant effect on transition date. Decreasing

[29] Figure A5.2.1 displays the standardized beta coefficients over time.

the number of subscriptions per capita of one standard deviation is predicted to delay transition date by one third of a standard deviation, with and 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 since Enlightenment ideas diffused in most of Western Europe and primarily in England and Scotland. One possibility is that it could have accelerated or permitted the effect of secularization. For example, one could imagine that in places with lots of subscriptions, the diffusion of the libertine literature reached the general population in such a way that it could have triggered a decline in rates of fertility. I test for this idea by interacting religiosity in 1791 with Encyclopedie subscriptions but find no significant effect.[30]

Moreover, it could be the case that religiosity in 1791 captures not only the direct effect of cultural differences but rather barriers to the diffusion of norms of limited fertility. In order to understand the role of the process of diffusion, I look at the size of the effect of linguistic distance to standard French in 1900.[31] The effect is important but only statistically significant at the 20% level, and more than four times smaller than the effect of *Religiosity (1791)*, suggesting that it is capturing a direct effect of religiosity.

Finally, neither literacy, nor population density, or urbanization had a significant or large effect on the timing of transition. However, a more detailed analysis over time shows that, without controls, urbanization and population density first had a positive or null effect on the level of fertility, and that the effect became negative as time passed, somewhat consistent with a Malthusian mechanism or with the idea that overpopulation lead to lower fertility in the nineteenth century (Braudel, 1986*a*,*b*). For literacy, I find a pattern consistent with a quantity-quality trade-off: at first, the correlation between fertility and literacy is positive. Then, it becomes negative. Yet, none of these is statistically significant or robust to the inclusion of controls.

Double LASSO estimation and variable selection Since the number of potential variables of interest is large, in order to flexibly achieve variable selection and evaluate the robustness of the effect of religiosity in 1791, I use lasso, a supervised machine learning technique, to further estimate the determinants of transition date. The least absolute shrinkage and selection operator is a regularization (like ridge) and variable selection method introduced by Tibshirani (1996). The aim is twofold. First, it allows to flexibly and more accurately estimate the effect of religiosity in 1791 on transition date in a setting with a large number of regressors (17, on top of *Religiosity (1791)* and including fixed effects). Second, it allows to understand the robustness of the estimated effects and the relevance of specific predictors by shrinking the regression coefficients to zero.

[30] Results are available upon demand, or in the first version of this paper.

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

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

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

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

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

The determinants of transition date are estimated in Table 4 with the double selection lasso estimation method described in Belloni, Chernozhukov and Hansen (2013); Urminsky, Hansen and Chernozhukov (2019). This two steps procedure identifies covariates that predict the dependent variables and those that predict the independent variable. First, a lasso of transition dates on the full set of controls selects the determinants of transition date (excluding religiosity in 1791) that were not shrinked to zero. Second, a lasso of *Religiosity (1791)* on the same set of controls allows to select non-zero predictors. The variables selected in either steps are included in the final regression. This allows to alleviate the biases commonly associated with lasso since excluding variables with moderate, non-null, effects results in omitted variable bias, while the selected coefficients are under-estimated because of regularization.

In the first column, I report the un-weighed OLS coefficient on religiosity in 1791 with

the full set of controls.[32] Columns 2 to 5 display the double lasso-estimated coefficients. In column 3 and 5, in light of the standardized coefficients estimated in Table 3, I force the selection of Encyclopedie subscriptions per capita by not penalizing its coefficient. In (4) and (5) I force the selection of fixed effects, which were otherwise not included in the set of controls. Several observations stand. First, without including the regions and pays status fixed effects, no variable other than religiosity in 1791 is selected by default. Second, the variables selected with fixed effects mostly capture cultural traits. Finally, the share of deserters among conscripts, which controls for state legitimacy at the time of the French Revolution in order to capture the effect of religiosity, is selected. The estimated coefficient on religiosity in 1791 remains particularly large while, as predicted, lasso reduces variance.

Figure A5.2.2 plots the coefficient paths for the two lassos with fixed effects, including religiosity in 1791 in the determinants of transition date. The size of each of the coefficient is plotted against the penalty term λ. When *lambda* equals zero lasso is equivalent to OLS, while 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 regions and pays status fixed effects are included. If anything, as expected, the variable with the largest predicting power is the share of deserters among conscripts. Yet, although none of the controls seem to matter for the distribution of religiosity, *Religiosity (1791)* itself has a large and robust predicting power on transition date (and, consistent with the standardized beta coefficients estimated previously, so does Encyclopedie subscriptions).

Sensitivity of estimates and coefficient bounds The baseline results relied on a set of seventeen control variables in seven different models, while the regularization properties of lasso allowed to do variable selection. 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, resulting in biased and distorted coefficients (Brodeur et al., 2016; Brodeur, Cook and Heyes, 2020*a*; 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 determinants of transition date accounting for religiosity in 1791 and all possible combinations of controls, resulting in $131,072$ (2^{17}) different models. Figure 5 plots the distribution of estimated coefficients (and robust t-statistics) on *Religiosity (1791)* across all combinations of controls, with regions and pays status fixed effects.[33] Panels A

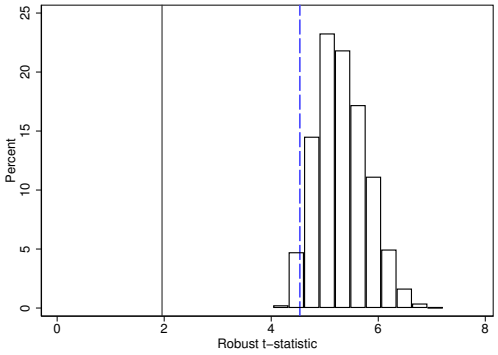
[32] Because weighing creates significant issues with LASSO, observations are not weighed by population. Therefore, the result in column 1 can be compared to the result in specification 7 of Table 2, where observations are weighed by population.

[33] There are $32,768$ (2^{15}) such regressions, with regions and pays status fixed effects. Alternatively, Figure A5.2.3

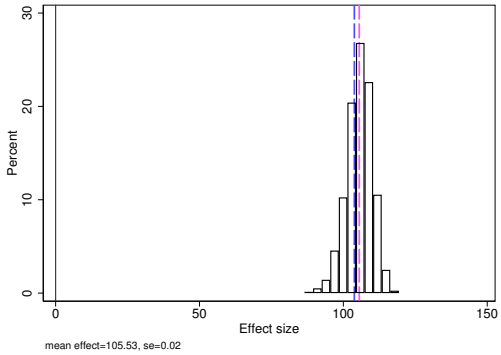
and B plot raw distributions, while Panels C and D plot effect size and robust t-statistic by number of controls. Across all combinations the mean estimated coefficient is 105.53, and no specification returns a coefficient for the marginal effect of religiosity in 1791 below 85 years.

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

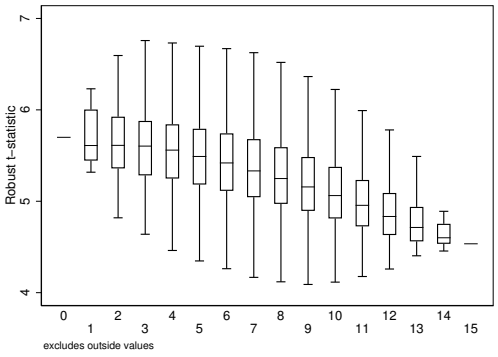
Note: This table displays the results of $2^{15} = 32,768$ cross-sectional regressions of transition dates on *Religiosity (1791)* and all possible combinations of controls (with fixed effects included in all specifications). The upper left Panel displays the distribution of t-statistics, while the upper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



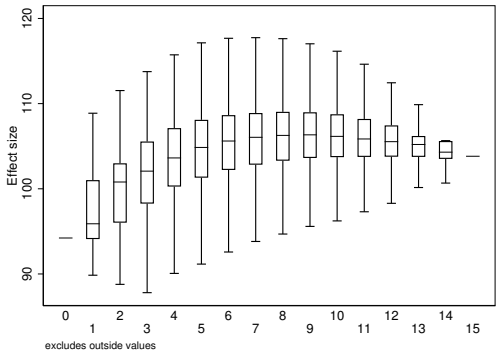
(Panel A) t-statistic curve



(Panel B) Effect curve



(Panel C) t-statistic by # of controls



(Panel D) Effect size by # of controls

5.3 Accounting for omitted variables and spatial dependance

Omitted variables While reverse causality is practically not an issue, omitted variables may result in bias. Religious areas could place more emphasis on tradition broadly

provides the results with all combinations of seventeen controls (including fixed effects). Results are unchanged.

defined, and be less prone to innovation and change, which would bias estimates and be a threat to identification. However, as discussed in Section 4.3, religiosity in 1791 is positively correlated to the best available measures of development in eighteenth century France after the process of secularization took place. Since urban centers have historically been centers of innovation and human capital accumulation, estimates are expected to be downwards biased towards zero. In what follows, I formally address the issue of unobservables and rely on Altonji, Elder and Taber (2005); Oster (2016) to construct bounds to the true effect while accounting for unobservables.

Oster (2016) shows that movements in the R-squared, and not only coefficient movement, can inform about the direction and the size of the bias arising from omitted variables. Therefore, I estimate a coefficient on religiosity accounting for omitted variables under the assumption of proportional selection and under some theoretical maximum R-squared. Altonji, Elder and Taber (2005); Oster (2016) suggest to assume equal selection, that is that unobservables and observables are equally related to the treatment.[34] Throughout this section, I alternatively make the two following assumptions on selection on unobservables:

Assumption *A*. *Unobservable selection is exactly proportional to selection on observables.*

Assumption *B*. *Unobservable selection is exactly proportional to selection on the diffusion of the Age of Enlightenment (as proxied by* $\log 1+$ *Encyclopedie subscriptions per capita in* $1777-1779$*) conditional on other observables.*

The first assumption is fairly standard, while Assumption *B* relies on the idea that one can learn about unobservables explaining marital fertility from unobservable determinants of Encyclopedie 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 of a different dimension of cultural change allows us to sensibly model unobservables that may have affected marital fertility. Intuitively, although this is an over-simplification, I assume that the Age of Enlightenment affected marital fertility through unobserved factors (e.g. libertinage, emphasis on change as opposed to tradition, industrial mindset) that are also correlated with secularization.

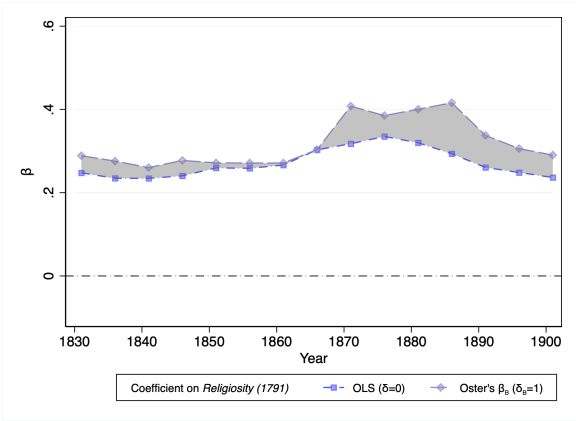
Appendix Tables A5.3.1 report the results of the regression on the determinants of transition year accounting for unobservable selection. Panel A relies on Assumption *A* and Panel B on Assumption *B*, which is the main assumption. In both cases I report both Oster's beta, assuming a degree of proportionality of one, and the δ statistics, which reflects how strong selection on unobservables should be to explain away the estimated effect of religiosity in 1791. Standard errors bootstrapped over $1,000$ replications are reported. Results

[34] Oster (2016) shows that the $\beta^*(R^2_{max}, \delta)$ statistics, with δ the degree of proportionality between unobservable and observable selection, 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.

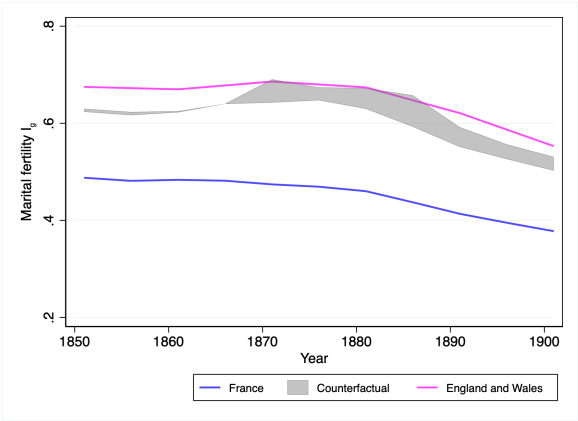
are virtually unaffected by unobservable selection, and if anything the estimated coefficients under the equal selection assumption are larger than OLS. In most specifications, selection on unobservables would have to be between twice to one hundred and twenty times as strong as selection on observables to drive the estimates to zero.

Figure 6: Accounting for unobservables (1831-1901)

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



(Panel A) Omitted variables-adjusted coefficient



(Panel B) Counterfactual fertility

Finally, Figure 6 plots the effect of religiosity in 1791 over time after accounting for omitted variables. Panel A displays the estimated coefficients (OLS and omitted variable-adjusted coefficient) for *Religiosity (1791)* from 1831 to 1901. OLS coefficients are biased downwards throughout. Unobserved factors such as a lower emphasis on tradition, a scientific and industrial mindset, 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 England and Wales over time, along with a counterfactual index for France, which is inputed by setting religiosity in 1791 to maximal level under the coefficient bounds suggested by Oster. This would be the level of fertility in France if no clergymen took the oath of allegiance to the secular state, other things equal. *Religiosity (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, it could result in an erroneous interpretation of the results as strong and robust although spurious in nature since nearby places are naturally more likely to possess the same at-

tributes. It is possible to account for spatial dependence by reporting adjusted standard errors (August 2019 Fabrizio Colella, 2019; Conley, 1999). Yet, Kelly (2019) shows that Conley standard errors are often too small due to low cutoff values, the distance after which spatial correlation is assumed to vanish. As a consequence, spatial noise with the same spatial correlation structure as in the data can significantly outperform the results, which is highly problematic.

I implement the solutions suggested by Kelly (2019) and report Conley-adjusted standard errors for two different correlation ranges. In particular, I alternatively assume a correlation range of 250 kilometers (Assumption 1) or 500 kilometers (Assumption 2). First, I report the p-value of Moran's test for spatial dependence of OLS residuals, a standard spatial correlation statistics. Second, I report the results of simulations where the dependent and the independent variables are alternatively replaced by spatial noise. I run 1,000 independent simulations each time and report the fraction of regressions significant at the .1% level.

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

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

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

Table 5 displays the results. Panel A provides the outcome of the simulations and tests for spatial correlation. Moran's statistics is significant (with $p < .01$) in the first three specifications and for both ranges, suggesting a high degree of spatial correlation. Spatial noise significantly explains marital fertility at the .1% level in less than 10% of simulations. Panel B displays the estimated coefficient on religiosity in 1791 (as in Table 2) as well as 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 columns (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 a 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).[35] These results suggests 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 from 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 tries to achieve causal estimates of the role of dechristianization on 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 total number of children ever born to individual i in decade t. I exploit cross-sectional variation in fertility with decade fixed effects λ_t and each individual is assigned the level of *Religiosity (1791)* of its district of birth $b(i)$.

$$\log \lambda_{i,t} = \beta \times Religiosity_{b(i),1791} + \boldsymbol{X}'_{i,t}\delta + \lambda_i + \lambda_t \equiv \boldsymbol{z}'_{i,t}\gamma \tag{3}$$

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

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 6 presents the baseline results at the individual level for observations after 1760, when dechristianization and the decline in fertility started. The estimated coefficient is particularly large and stable throughout specifications, with a marginal effect

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

of religiosity in 1791 on fertility estimated to be roughly one. It means that individuals born in a place with only refractory clergymen are predicted to have about one more child than those born in a place without any. This is roughly the size of the decline in fertility during the second half of the eighteenth century, when the number of children ever born went from 4.5 to 3.5 in about forty years (Figure 1).

Table 6: Determinants of fertility at the individual level

Note: This table displays the results of the individual-level regression of the log total number of children ever born on *Religiosity (1791)*. The main explanatory variable is defined as the population 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 Encyclopedie subscriptions in 1777 − 1779 at the district level (plus a dummy for non-zero subscriptions). Two-way clustered standard errors (at the couple and district level) are reported. Average marginal effects (AME) are reported. This results were generated using the Stata program provided by Correia, Guimarães and Zylkin (2020). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

All specifications include a male dummy and decade fixed effects, and standard errors are two-way clustered at the district of birth and couple levels.[36] In the second column individual-level controls are included with a quadratic in the age at birth of the first child, interacted with the male dummy.[37] The reduction in fertility was not achieved with delayed age of marriage.[38] Column (3) adds proxies of 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 for the presence (dummy) and number of knowledge elites with Encyclopedie subscriptions at the district

[36] Indeed, information about both parents is not necessarily available, therefore only about 10% of individuals have spouses also included in the regressions.

[37] A previous version of the paper included the log fertility of parents. Estimates were slightly smaller because it is obviously collinear to religiosity in 1791.

[38] Appendix Figure A6.1.1 plots the average timespan between the birth of the first and last child (Panel A) and average duration between birth 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.

level.[39] Results are statistically significant and stable throughout.

Robustness to method of estimation Poisson regressions are appropriate for non-negative count dependent variable, yet rely on the assumption of equality of the mean and variance, which is not necessarily verified in the data - although 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 is less variance as the mean fertility declines.[40] As a result, the standard error of the estimated coefficient may be too small and significance could be overestimated. Hence, in order to evaluate the robustness of the results and to account for overdispersion, Appendix Table A6.1.1 estimates Equation 3 with OLS, overdispersed Poisson, and a negative binomial regression. Results are practically unchanged. In overdispersed Poisson, the conditional variance is scaled by a parameter $\phi \equiv \chi^2_{Pearson}/p$ in order to directly account for the observed overdispersion. By assuming that the outcome follows a negative binomial distribution, negative binomial regression accounts for heterogeneity between individuals with additional variability that Poisson regression does not allow (hence overdispersion).

Distribution regression Is the effect of higher religiosity uniform at all levels of fertility? I implement a distribution regression in order to trace out the effect of religiosity in 1791 on the cumulative distribution function of fertility, following Chernozhukov, Fernández-Val and Melly (2013).[41]

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

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

Figure 7 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 or median. Especially, I find that increasing religiosity of 100 percentage points is predicted to increase the probability of having more than 6 children

[39] It is also possible to control for soldier height before 1760, at the town of birth level, as a proxy to 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 aging (Lechler and Sunde, 2020), which would downward bias the estimates of the impact of religiosity on fertility. When I include age at death (which also results in a significant drop in the number of observations), point estimates are virtually not affected. Results available upon demand.

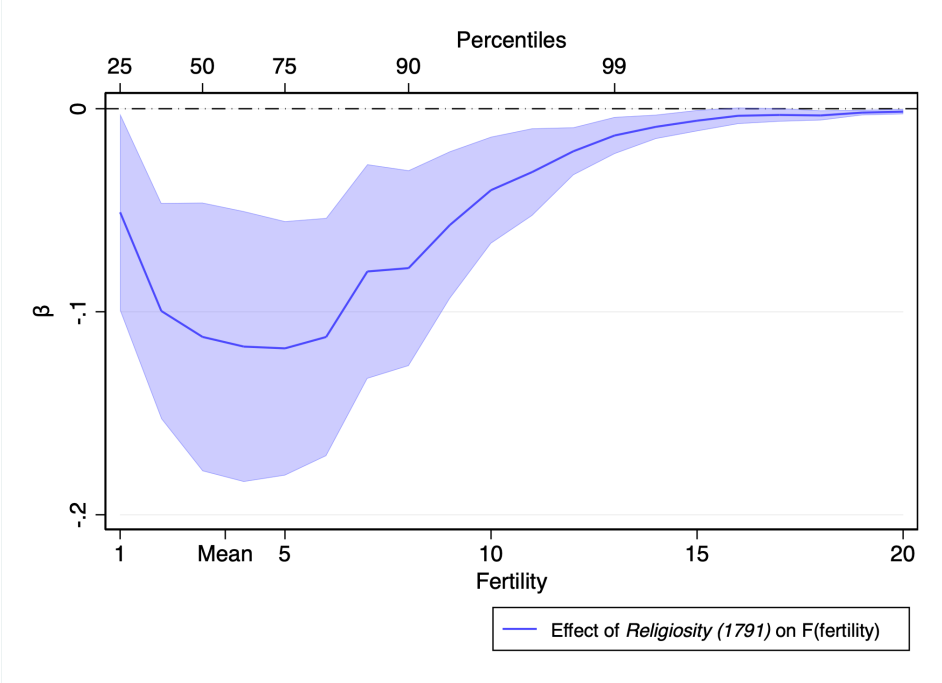
[40] For example, see Spolaore and Wacziarg (2019).

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

by about 12 pp.[42] 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.[43] Hence, it fully characterizes the average effect of religiosity in 1791 on fertility.

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

Note: This figure displays the estimated impact of *Religiosity (1791)* on the CDF of fertility, with robust se, for all levels of fertility up to 20 children (the maximum observed is 36). *Religiosity (1791)* is defined as the population weighed share of refractory clergy (non-jurors) in 1791.



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

Although it is unlikely that development played an important role (see Section 4.3), unobserved institutional factors or cultural traits may confound the effect of religiosity in 1791 on fertility. The crowdsourced genealogical data allows to implement three different strategies in order to identify a causal effect. To the best of my knowledge, this is the first time any of these is implemented in a historical context or with individual-level data.

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

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

[43] This is why I estimate Equation 4 with a LPM instead of logit or probit.

ables. Some *départements* could 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 it is possible that the crowdsourced data is of better quality in some period in some *départements* (since the records are kept in and uploaded online by the departemental archives), which could result in bias.[44]

Second, by extending the sample to individuals observed before dechristianization took place (until 1680), it is possible to contrast the effect of religiosity in 1791 before and after secularization, in a differences-in-differences framework with continuous treatment similar to Acemoglu, Autor and Lyle (2004). The causal effect of religiosity can be identified from the additional effect on fertility after secularization, differenced from the effect before (differences-in-differences is essentially a fixed effects estimator). The cutoff for the start of the process of secularization is estimated to be in 1760, which is also the start of the decline in fertility. Unfortunately, the exact date is an unknown parameter (although there is a consensus around the fact that it started in the mid-eighteenth century) and it is neither discontinuous or clear cut nor it is, in all likelihood, identical across space.[45] Moreover, the distribution of religiosity before secularization is unknown, although Section 4.2 suggests that regions or *département* fixed effects would account for such differences between place and that religiosity was close to 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'Haultfœuille (2017) cannot be implemented formally. Nevertheless, the fact that secularization was a smooth process would likely result in the under-estimation of the true effect, since some places were likely already treated before 1760 and the design relies on the assumption that it was not the case. Moreover, by estimating the effect of religiosity in 1791 on fertility before secularization, it is possible to further infer about whether religiosity in 1791 captures pre-existing differences or the extent of secularization.

Finally, it is possible to study the decisions of fertility 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 to separate the effect of religious beliefs and norms passed through generations from that of potentially correlated institutional characteristics. What is particularly novel in this setting is both the historical dimension and the fact that it accounts for institutional and cultural variation within country. Indeed, the traditional approach only uses migrants surveyed recently, leverages between country variation in place of origin, and assumes that there is no variation within country in either place of origin or of arrival. Here, I leverage variation in religiosity at the district of origin level, holding constant district of birth char-

[44] This issue is known, and is acknowledged for example in Henry (1972*a*,*b*, 1978); Henry and Houdaille (1973); Séguy (2001), or experienced firsthand by the author in Blanc and Wacziarg (2020).

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

acteristics. Moreover, in order to account for correlation between parents (about a third of second generation migrants have parents born in different districts from each other), I implement multi-way clustered standard errors at the parents and districts of birth of parents levels.

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

Note: This table displays the results of the causal identification individual-level regression of the log total number of children ever born on *Religiosity (1791)*. The main explanatory variable is defined as the population weighed share of refractory clergy (non-jurors) in 1791, at the district of birth level (except in (5), where it is evaluated at the district of birth of parents level and corresponds to the average level for the two parents - ensuring that individual with a missing parent are not dropped). All specifications include the full set of controls. The baseline specification corresponds to the last specification in Table 6. Two-way clustered standard errors (at the couple and district level) are reported in all specifications but the last. In (5), standard errors are four-way clustered at the district of birth of parents and parents id level (in that case, 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 (AME) are reported. This results were generated using the Stata program provided by Correia, Guimarães and Zylkin (2020). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

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

Table 7 displays the results.[46] The first specification displays the baseline results with the full set of controls at the individual, town, and district of birth level. In (2) and (3), I add, respectively, *département* of birth and *département* of birth by decade fixed effects. 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% level. In column (4), I extend the sample to all individuals observed between 1680 and 1920. Interacting religiosity in 1791 with a dummy that equals

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

one if the individual was observed after 1760, i.e. after (the start of) the bulk of the process of secularization, allows to identify the causal effect of religiosity. The point estimate is similar to that in the previous specifications and is significant at the 5% 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.[47] 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 may confound the analysis. Religiosity in the district of birth of parents in 1791 has a persistent and significant effect on fertility. These results indicate that secularization caused the early decline in fertility in eighteenth century France.

Last, but not least, it is possible to evaluate the effect of religiosity in 1791 over time, from 1680 to 1920. In what follows, I estimate the effect by 40 years periods (a higher frequency would require many more observations than available).[48] I display the results in Panel B of Appendix Figure A6.2.2. In the first period, 1680-1720, when the process of 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 in line with a smooth and heterogenous across space process of secularization, and with some places experiencing dechristianization earlier. Indeed, the process of secularization may have started before 1760 in some places, as in Provence where there is evidence of important changes in the 1730s (Vovelle, 1973) - see Section 4.2. Nevertheless, the effect is statistically not significant before 1760. After 1760, which marks the start of aggregate-level dechristianization and the decline in fertility, religiosity in 1791 has a positive and statistically significant effect. The effect slightly increases at the time of the second wave of decline in fertility, during industrialization, and then decreases, consistent with a process of diffusion (Spolaore and Wacziarg, 2019) or of interaction between cultural and economic forces as documented by Squicciarini (2020).

7 Concluding remarks

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

Using a variety of novel sources and methods, I show that religiosity in 1791 has a large effect on fertility. I leveraged novel data on religiosity over time and space to measure the process of dechristianization and to show that religiosity in 1791 does not capture pre-

[47] Appendix Figure A6.2.2, Panel A, displays the diff-in-diff result graphically.

[48] Also, unfortunately, even with the 40 years periods, statistical power is lacking to run a differences-in-differences regression over time, which adds to the limitations discussed above.

existing differences. Finally, with crowdsourced genealogies, I have been 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. In all, my results suggests that the early process of secularization accounts for most of the early demographic transition.

However, this paper is not only about the causes of the demographic transition, but also and more importantly about, broadly, the role of ideas, preferences, and culture in shaping development. The results suggest that cultural change and preferences matter in the process of development.[49] In particular, I establish that the transition from tradition to modernity played a role in the transition from stagnation to growth.[50]

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 consequences on political outcomes and democratization, in particularly during and following the French Revolution (Bois, 1960; Siegfried, 1913).

[49] 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.

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

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