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Old habits die hard (sometimes)

Can *département* heterogeneity tell us something about the French fertility decline?

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Abstract Unified growth theory suggests the fertility decline was crucial for achieving long-term growth, yet the causes behind that decline are still not entirely clear from an empirical point of view. In particular for France, the first country to experience this demographic transition in the European context, the reasons why some areas of the country had lower fertility than others are poorly understood. Using *département* level data for the last quarter of the nineteenth century, this paper exploits the French regional variation to study the correlates of fertility, estimating various fixed-effects models. The findings confirm the importance of some of the forces suggested by standard fertility choice models. Education in general, female education in particular, for example, seems to be crucial. Results also highlight the relevance of non-economic factors (such as secularisation), for which I provide new measurements. The presence of spatial dependence also suggests that diffusion of fertility played a particular role.

Keywords Economic history · Nineteenth-century France · Fertility transition

JEL Classification N33 · J13

1 Introduction

Economists have always considered the study of economic growth important, yet only recently have they given attention to how that growth became more the rule than the exception. For the major part of human history, income per capita seems to have remained at subsistence level, with improvements (if any) in the standard of living only marginal or temporary (Clark 2005, p. 507; Ashraf and Galor 2011). Barely two centuries ago this ceased to be the case, and an era of sustained growth began. Economic historians have studied this phenomenon

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with great interest over the years, and recently the topic has regained appeal in mainstream economics, mainly thanks to the development of unified growth theory (UGT). Models in this literature put into a single theoretical framework *both* pre-industrial stagnation and modern economic growth, *and* the change from one to the other (Galor 2011). In all of them, the demographic transition plays a key role. By avoiding the dilution of physical capital and land, increasing the investment in human capital, and temporarily augmenting the size of the labour force, the systematic fall in birth rates paves the way for economic growth (Galor 2011, p. 46). Yet UGT provides only one possible narrative, and many studies in fact disagree on *what* drives that decline, potential candidates ranging from biological and environmental conditions to socio-cultural factors and economic motivations (Guinnane 2011; Galor 2012). Identifying the forces that contributed to the fall in fertility, either to validate the internal logic of these models or to think further about the mechanisms at work in them, is of crucial relevance for understanding the path of Europe's economic growth. The present paper sheds light on this issue by providing a quantitative assessment of the factors that help explain differences in fertility within France during the transition.

France is arguably the most iconic case in the European fertility decline. The evolution of birth rates during the nineteenth century was rather unequal in the various corners of the continent, but even to the naked eye, distinct regional patterns are easily identifiable (Flinn 1981, pp. 30–31; Guinnane 2011, pp. 590–592). Downward trends were common, yet timing of the initial fall sometimes differed. A sense of the different experiences can be seen in Fig. 1, which depicts (smoothed) series of crude birth rates for England and Wales, France, and Sweden over the long term. The patterns of England and Wales and Sweden are representative of most regions in Europe. Fertility fluctuates around a relatively high mean in pre-industrial times, and then a decline begins at some point after the mid-nineteenth century and continues through to the interwar period. Although following the general overall pattern, the French decline arguably began 50 years earlier than in any other part of the continent.[1] Since, in contrast to other places in Northern Europe, France was relatively less urban and industrialised (see e.g., Heywood 1995), this timing has been particularly difficult to reconcile, for example, with arguments suggesting economic forces drove the fall in births.

Further, the evidence we have of fertility rates within the country also shows certain peculiarities. Figure 2 plots the widely used I_g index of marital fertility, a measure of the proportion of legitimate births with respect to the maximum biologically attainable (Coale and Watkins 1986) for all *départements* at different dates in the century.[2] In those maps it is easy to identify at least two areas of low fertility, the valley of the Seine (Bassin Parisien) and the Garonne (Bassin Aquitaine), and two 'islands' of high fertility, the region of Bretagne in the north-west and the Massif Central in the centre-south-east. Although fertility is decreasing throughout the period, the large differences across regions show certain persistence. As early as 1831 one can find *départements* such as Gironde or Eure with indices below 0.40—evidence of fertility limitation—while as late as 1901 places like Finistère or Côtes-du-Nord still had indices above 0.70—showing little or no limitation at all.

[1] Due to various technical matters, dating the beginning of the fertility decline has been a hotly debated issue. See Guinnane et al. (1994) for a discussion. Fifty years is, however, a rather conservative estimate. Most scholars agree the fertility transition in Western Europe began around the 1880s (e.g., Coale and Watkins 1986), yet the first signs in France appeared in the last decade of the XVIII century (see e.g., Weir 1983).

[2] The administrative unit of *département* was adopted during the French Revolution to replace the old 'provinces,' which showed considerable heterogeneity among them. The 83 *départements* that were created in 1790 were, in contrast, under a common central administration and had a more-or-less regular size (it was chosen so that any person within its borders could go and return from its capital by horse in two days). Over time the number increased to 87 in the period I study, and eventually to 101 today.

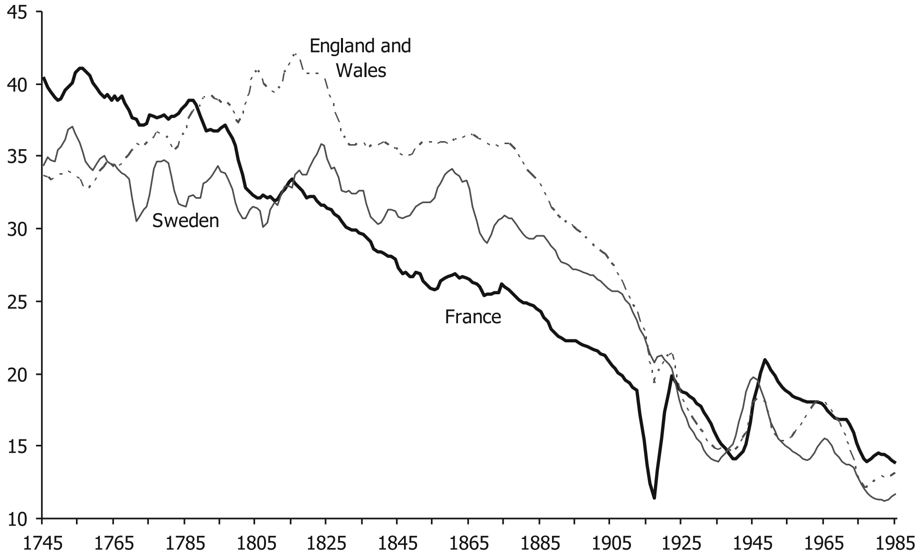

Fig. 1 Crude birth rates (births per 1,000 population) in France, England and Wales, and Sweden, 1745–1985. Sources: For France, INED (1977, pp. 332–333) and Chesnais (1992, pp. 518–541); for England and Wales, Wrigley and Schofield (1981, pp. 531–535) and Mitchell (1998, pp. 93–116); and, for Sweden, Gille (1949, p. 63) and *Statistika Centralbyrån* (Statistics Sweden, http://www.scb.se/indexeng.asp). Values are 5-year averages, centred in the year

Of course, alternative arguments to explain either feature are not lacking, but only to a limited extent have they been subject to careful empirical scrutiny. The timing of the early onset of the French decline has probably received most attention, and recent studies seem to agree that the French Revolution, or events related to it, played a central role in triggering the fall.[3] On the reasons behind the differences across regions, the evidence is less clear. Most of the components that were to shape modern theories of fertility determinants (Van de Kaa and Dirk 1996; Guinnane 2011), such as the role played by fluctuations in wealth, the value of children and the costs of rearing them, or the degree of religious faith, to mention a few, were already present in early discussions on the French decline more than 100 years ago (Spengler 1938, pp. 168–174). Despite the wealth of theoretical ideas, however, only a few have found support or rejection in sound quantitative analysis. Many of the studies on the topic have remained for some time descriptive and conjectural (Van de Walle 1974, pp. 6–7). The works of scholars like Etienne van de Walle or David Weir brought a more systematic approach to the subject,[4] and from the late 1970s to the early 1990s several refined the measurements of regional fertility (Van de Walle 1974; Bonneuil 1997) and extensively

[3] For example, Weir (1983) proposed that the institutional changes brought by the Revolution gave tools to reallocate land and labour, by making bourgeois children superfluous as labourers and costly as consumers. Cummins (2013), after studying the few individual level data available between 1750 and 1850, emphasised the key role of the Revolution in changing inequality, thus leading to the decrease in family size. González-Bailón and Murphy (2013), using an agent-based simulation to model French demographic behaviour, hint that certain socio-cultural aspects associated with the dismantlement of the Church led by the revolutionaries are at least partly to blame for the decline.

[4] It is probably fair to say that many economic historians can associate most of our understanding of the French fertility decline over the last 30 years with these two scholars. The late Etienne van de Walle was attached to the Princeton Project and researched different aspects of the French experience (Van de Walle 1974, 1976, 1980, 1992; Van de Walle and Muhsam 1995; Lesthaeghe and van de Walle 1976). David Weir,

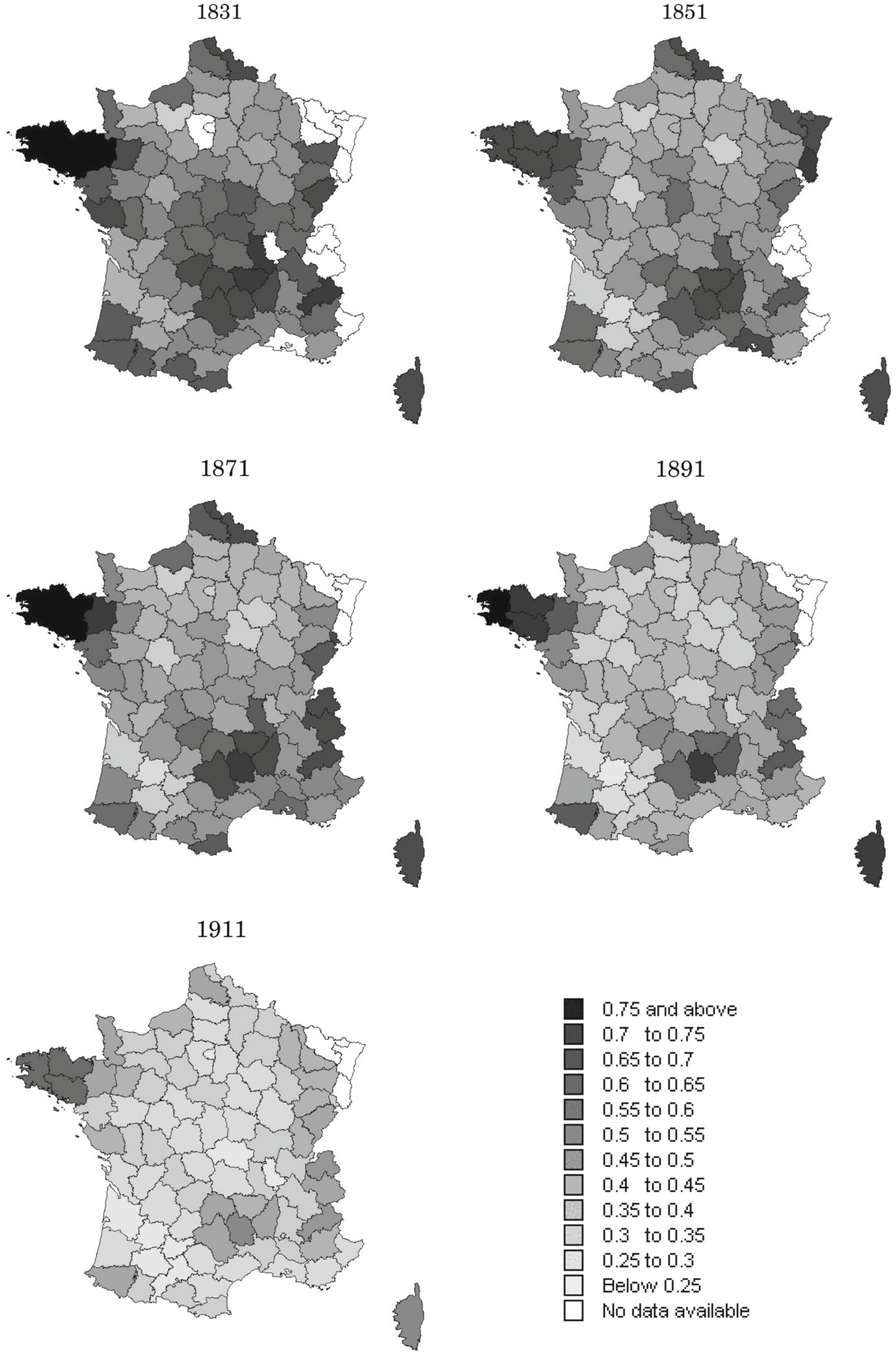

Fig. 2 Marital fertility index (I_g) in France for each *département*, 1831–1911. Sources: my own maps, constructed using data from Coale and Watkins (1986, pp. 94–107)

explored their dynamics (e.g., Van de Walle 1974; Weir 1983; Wrigley 1985a, b). A few studies did assess the relevance of some factors in explaining differences across the country (e.g., Van de Walle 1976; McQuillan 1984; Watkins 1991), but the overall picture that emerges from them is far from clear.[5] Moreover, as Brown and Guinnane (2007) have warned us as of late, many of the findings coming from these works may well be flawed. As they argued convincingly, much of the literature on fertility decline, especially that stemming from the European Fertility Project (Coale and Watkins 1986), relied upon highly aggregated data and empirical strategies that ignored relevant aspects of the time dimension, most likely leading to unreliable conclusions (Brown and Guinnane 2007, pp. 580–589). Recent research has dealt with these critiques for other regions of the continent (e.g., Galloway et al. 1994 for Prussia; Brown and Guinnane 2002 for Bavaria; Dribe 2009 for Sweden), but the French case remains poorly understood.

Given the particular importance of France in the demographic transition debate, and its consequent relevance for the discussion on UGT, in this paper I assess quantitatively which factors contribute towards explaining differences *within* the country during the transition. Taking advantage of the persistent heterogeneity in fertility across *départements* in the nineteenth century, I study the correlates of fertility under various specifications. I assess the relationship between factors such as infant mortality, urbanisation, industrialisation, income, financial development, education, religiosity, and political participation, and the levels of fertility, introducing (departmental and time) fixed effects to control for some unobservables. In a series of estimations, I also use climatologic data to instrument infant mortality to produce 2SLS estimates that account for some of the potential endogeneity problems. I then look into spatial dependence to assess the relevance of diffusion arguments. Although a good part of the debate on fertility decline has been set-up in terms of diffusion versus adaptation hypotheses (Carlsson 1966), and the study of diffusion on fertility dynamics in a sound, quantitative manner has been used already in an historical perspective (e.g., Tolnay 1995), this has rarely been integrated into any empirical study of the European fertility decline.[6] By introducing spatial dependence along with other covariates, I can assess whether the diffusion *and* adaptation hypotheses can simultaneously contribute towards explaining fertility.

My results show that wealth was positively correlated with larger families, whereas higher literacy and the reduction of the educational gender gap (increase in female versus male literacy) were negatively correlated. Once I control for other variables, there is no indication that infant mortality, urbanisation, or industrialisation had any effect whatsoever. The level of religiosity (which I measured using two alternative proxies) is consistently relevant to explain

Footnote 4 continued
on the other hand, produced an unfortunately never fully published dissertation at Stanford (Weir 1983), and then a series of papers until the mid-1990s (Weir 1984a, b, 1992, 1993a, b, 1994, 1995; Mroz and Weir 1990).

5 Van de Walle (1976), for example, suggested that low mortality and high income played a role in decreasing fertility, while urbanisation or industrialisation did not. McQuillan (1984), however, found that different modes of production were indeed associated with family size, with areas of capitalist production having higher fertility indicators. Watkins (1991), for her part, concluded that variation across *départements* could largely be explained—as did van de Walle—by variations in disposable income, but also by migration, size of the State, and whether French was or not the main language spoken.

6 To my knowledge, the only exceptions being a working paper that expands the analysis of Galloway et al. (1994) on Prussia to incorporate spatial dependence (Goldstein and Klüsener 2014), and a recent article on the quality–quantity trade-off, also for Prussia (Becker et al. 2012). Another (preliminary) manuscript by Guillaume Daudin and co-authors (Daudin et al. 2012) also addresses the issue of diffusion in France quantitatively, yet in a different way—by estimating bilateral flows of migrations. An even more recent working paper by Spolaore and Wacziarg (2014) builds on the idea of barriers to innovation and adoption, and study how cultural and ancestral distance affected the pattern of fertility decline in Europe. I relate my results to theirs later in the paper.

fertility and has the expected (positive) sign. All these effects are present even in specifications that control for spatial dependence, which also turns out to be strongly significant, thus providing support for the diffusion hypothesis. These results give support to some of the main building blocks of the UGT. They also hint that the diffusion of cultural or other factors were partly driving fertility dynamics *along* with economic incentives, and suggest both components should be included in the theoretical models to provide a more comprehensive answer for why and how the decline occurred.

2 Understanding fertility dynamics

Economists, demographers, historians, and sociologists, each with their own analytical frameworks, jargon, and methodological techniques, have suggested hypotheses to explain the fertility transition, making the literature itself some kind of puzzle (see, e.g., Van de Kaa and Dirk 1996). Although it is by no means entirely uncontroversial, many participants in this debate agree that fertility transitions are perhaps not different from any other fertility change, so they can be interpreted in terms of a model of fertility determination. Of the many models that have been suggested, Easterlin's synthesis is arguably the one that unites most of them and provides a suitable environment in which to assess alternative hypotheses (Easterlin and Crimmins 1985, pp. 14–20). The model states that the number of children born depends upon the interaction of a set of basic determinants: the demand and supply of children, and the regulation costs of controlling fertility. In this very simple formulation, the levels of natural fertility and fertility control determine the number of births. Natural fertility (that is, the one associated with no active control) is dependent upon a range of biological and cultural variables, such as duration of marriage or the nutrition of the mother. The degree of control, typically greater than or equal to zero, depends mainly upon the motivation for contraception and the regulation costs. On the one hand, the motivation for contraception is determined by the difference between supply of children, intimately linked to natural fertility, and the demand for them, which is determined by income and tastes of the parents, as well as by the prices they face in the market. Since children consume resources (especially time and money) that could be used in alternative ways, they impose some limit on the number of offspring couples want to have. Parents, that is, face an opportunity cost of the time they need to raise children.[7] The regulation costs, on the other hand, include both market costs, such as the cost of particular contraceptives or their actual availability, and psychological costs, such as the displeasure of abstinence or the moral cost of going against religious beliefs.

Most models of fertility determination (Guinnane 2011) have a more or less straightforward interpretation in terms of this standard formulation, and the sources traditionally associated with the fall in births during the transition can be easily identified. These include the decline in infant and child mortality (which affects the supply of children), the rise in per capita income (which affects the demand for children), the rise in demand for human capital, or the decline in the gender gap (which affects the opportunity costs of parents), among others (Galor 2012). In UGT, for example, where technological change plays a crucial role, these last two channels are particularly relevant (see Galor 2011 for an extensive discussion). In one version, as the rate of technological progress increases, so does the demand for human capital, leading—via the quantity–quality trade-off—to an eventual reduction in fertility rates and population growth (e.g., Galor and Weil 1999, 2000; Becker et al. 2012). In another, the same technological progress and physical capital accumulation complements mentally

[7] The literature on this stems from the seminal contribution of Becker (1960), where, in essence, children are alternatively seen as consumption or investment goods: They can be a source of satisfaction for the parents or assets that yield some return over time (a source of future services, especially labour and old age security).

intensive tasks on which females have a comparative advantage, leading to a reduction of the gender wage gap, increasing the opportunity cost of raising children, hence inducing a decline in births (e.g., Galor and Weil 1996).

In addition to these channels, many others could potentially be relevant, so in this Sect. 1 briefly discuss some of them in terms of Easterlin's framework, in order to motivate the empirical exercise I carry out in the rest of the paper. I organise the discussion in four parts. As Ansley Coale stated in a classic paper (Coale 1973, p. 65), a fertility transition will take place if effective techniques of fertility reduction are known and available (i.e., the market costs are not infinite), if reduced fertility is perceived as advantageous (i.e., the supply of children is higher than the demand), but also if fertility falls within the calculus of conscious choice (which can well be interpreted as market or psychological costs—or both—not being infinite). The following three subsections correspond more or less to the aspects highlighted by Coale. In the last part I then provide a brief discussion of why it makes sense to also account for diffusion.

2.1 Means to control

An issue that regularly turns up in discussions about fertility behaviour in the past is that of the availability of a means to control it. That is, whether the market costs of regulating fertility were infinite or not. There is little *direct* evidence showing that the average couple knew how to control fertility, and the consensus up to 50 years ago indeed was that at least in medieval times they did not (Flandrin 1979, p. 194), but there are several facts that suggest they did know. On the one hand, most cultures across space and time have had some method to control the size of their families: abstinence, *coitus interruptus*, abortion, and infanticide, for example, were generally known. Further, in predominantly rural societies (like early modern France) the breeding of domestic animals is an essential part of daily activities and knowledge of animal reproductive behaviour must have been widely known then. Details about the peculiarities of human fertility might have been missing, but knowledge about the general dynamics of reproduction must have been common. On the other hand, anecdotal evidence suggests the use of some sort of contraceptive was widespread. Many eighteenth century writers, for example, talked about the 'art of cheating nature' (see, e.g., Ariès 1948, 1953; Bergues et al. 1960; Van de Walle and Muhsam 1995). Little information is available regarding the lower social classes and, when available, it generally refers to extra-marital relationships, but it is known that the nobility and urban bourgeoisie practised some degree of family limitation (Van de Walle and Muhsam 1995, pp. 261–265). Although abstinence and changes in the frequency of sexual intercourse might have played a role, what appears to have been frequently used at the time was *coitus interruptus*. Contrary to common belief, this simple tool is relatively efficient (Santow 1995, pp. 29–30), and most of the literature agrees that the 'sin of Onan' was fairly widespread in Europe (and France in particular) at the time and might have been the main mechanism driving the fertility decline (Le Roy Ladurie 1965; Flandrin 1979; Van de Walle and Muhsam 1995). Alternative instruments associated with different ways of having intercourse, like sodomy or intercourse without ejaculation (*amplexus reservatus*), appear to have been reserved for prostitution, but were known and perhaps occasionally used among married couples. Other, rather more expensive, contraceptives like condoms or sponges may have played only a minor role (McLaren 1990, pp. 157–158; Van de Walle and Muhsam 1995, p. 273), as probably did action after delivery (Bechtold 2001, pp. 167–168). Abortion, nevertheless, was known and increasingly practised, especially among married women (McLaren 1978; Flandrin 1979, pp. 194–195), and most likely acted as an alternative when other means did not provide the expected result.

2.2 Motivation to control

Given that accessibility and knowledge of contraceptive tools seems to have been more or less available at the time, sources of variations should be looked for elsewhere. To have a motivation to control fertility, couples must be able to have at least the family size they want. Natural fertility, and consequently the actual supply of children, is determined by several components, many of which are virtually impossible to study in a rigorous way in historical societies. The extent of breastfeeding or the regularity of sexual practices, for example, were most likely relevant factors, yet little record remains of their practices. One crucial element, though, is indeed observable: infant mortality. Even if we assume couples had some degree of control over the size of their families, infant or child mortality in the past was a factor on which they had only a marginal influence. The ways to avoid morbidity and death were poorly understood or simply difficult to deal with. When the number of children one can have is not certain because of a high risk of death at an early age (in some places in France, at the beginning of the transition as many as one child in two would die in the first 5 years of life), couples might increase their fertility only to make up for the expected loss (Brown and Guinnane 2002, p. 41). Indeed, as Fig. 3 illustrates, in the earliest stages of the transition in France (circa 1831) there seems to be a positive correlation between fertility and child mortality. This evidence is indeed suggestive, but one must take into account the possibility that causality in this case could also go in the other direction, as high fertility might be leading to high mortality. I address this issue later in the empirical implementation.

Early studies on fertility determinants suggested that increases in income would lead to a fall in fertility because the negative substitution effect on fertility would dominate the positive income effect (Becker 1960; Willis 1973). Evidence of this connection is nevertheless poor and, when available, seems to point to a *positive* link between income and fertility, a situation that had led some authors to raise a series of doubts about the validity of the assumptions underpinning these theories (Galor 2011, p. 116). It could also be the case that what it is relevant is not the income of the family, but that of the mother, as she is the one who normally devotes more time to the raising of children. Part of the literature has been devoted to this, and some theoretical discussions suggest that the reduction in the gender gap could lead to a decline in fertility (Galor and Weil 1996). Although this relationship is well established for current societies (e.g., Lagerlöf 2003, pp. 406–407), little is known about historical societies during the transition.[8]

Changes in these opportunity costs might also come from other aspects of the socio-economic environment. In rural, sometimes self-sufficient, communities children can begin to contribute to family income earlier because agricultural labour usually requires fewer skills than industrial labour, or direct access to food supplies reduces the costs of having additional children. Urbanisation should discourage fertility and, in a similar way, the size of the agricultural sector could encourage it. The evidence of this link between urbanisation or industrialisation and fertility is somewhat unclear for the French case.[9] One possibility is that

8 As is often the case, a Scandinavian country provides an exception. A study of Sweden suggests that indeed increases in the relative wages of women contributed to the fertility decline (Schultz 1985).

9 Of the five *départements* with the lowest level of marital fertility in 1831, only Gironde had a major city (10,000 inhabitants or more) in 1801. At the same time, *départements* with a considerable population in large urban centres like Bouches-du-Rhône or Loire Inférieure still had I_g indices above 0.60 as late as 1851. Assessing industrial development is more complicated. Some figures for the late eighteenth century show clusters of textile production in the Bassin Parisien, but also in Brittany and the *départements* north of Paris, whereas metallurgic activity was concentrated in the east of the country, and here the fertility behaviour was close to average (Léon 1970, pp. 228, 234, 238). The fact that areas leading the decline were located in major

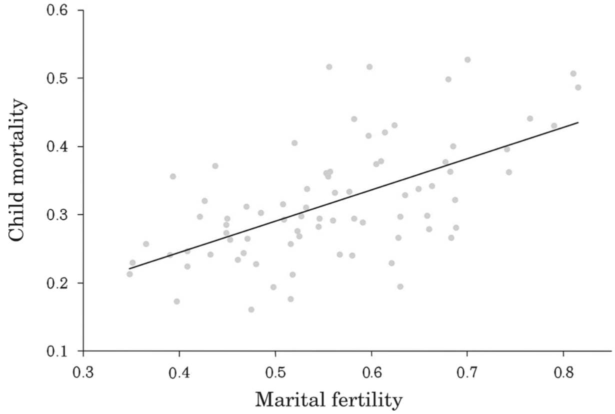

Fig. 3 Marital fertility and child mortality across *départements*, 1831. Sources: marital fertility corresponds to the I_g index for 1831 and comes from Coale and Watkins (1986, pp. 94–107). Child mortality is the 4q0 value as estimated by Bonneuil (1997)

these modernisation factors influenced fertility not directly but, as UGT suggests, through the increase in the demand for human capital (e.g., Galor and Weil 2000; Galor and Moav 2002).[10] Technological progress arguably increases the requirements of human capital. If children's quality does not come for free, one expects that at some point a substitution might come into play between quality and quantity, incentivising parents to have smaller families. The literature on this has grown considerably as of late, most findings pointing to a considerable role of this quantity–quality trade-off in the fertility transition (e.g., Becker et al. 2010, 2012; Klemp and Weisdorf 2012). Figure 4 shows suggestive evidence on this: Circa 1836 it was indeed the case in France that in those *départements* where a larger proportion of the school-age population attended schools, fertility was lower.

One additional component that sometimes features in discussions about the fertility transition is the role of financial institutions. This stems from one aspect of considering children as investment goods: Parents might spend on their offspring when they are young and healthy, expecting children to look after them in sickness and old age. This view provides at least two hypotheses connected to the fertility decline (Guinnane 2011, p. 607). One reinforces the importance of rural-urban transformation: In a context where children begin to migrate to cities, the intergenerational transfer becomes less likely and hence reduces the motivation to have children. The other is associated with the development of financial institutions and the welfare state, because the introduction of alternative ways of preparing for old-age could reduce the demand for children. The literature seems to agree that if this channel played any role, it was probably small (Guinnane 2011, pp. 607–608, Galor 2011, p. 136). Brown and Guinnane (2002), for example, failed to find any sign of this link in Bavaria. Yet Galloway et al. (1994) found for Prussia some evidence that the growth of financial institutions contributed to the decline in fertility, and this effect seems to survive even after the introduction of spatial dependence (Goldstein and Klüsener 2014).

valleys is suggestive, but it is difficult to go beyond facile interpretations when thinking about the relevance of physical geography: both areas had large rural sectors, but agricultural activity was concentrated on wheat in one and vines in the other (Rémond 1966, pp. 55–58). And while both had large rivers, integration appears to have differed considerably between those regions (Daudin 2008).

10 A connected argument is that modernisation, in fact, fostered the possibility of social mobility (see e.g., Dumont 1890; Cummins 2013), and this led to human capital accumulation as a way to climb up the social ladder, towards higher quality and lower quantity of children.

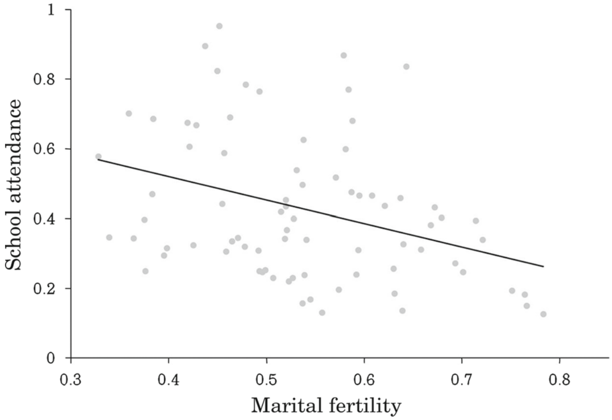

Fig. 4 Marital fertility and education across *départements*, 1836. Sources: marital fertility corresponds to the I_g index for 1836 and comes from Coale and Watkins (1986, pp. 94–107). School attendance is the ratio of students to school-aged population (5–15 years) in 1836–1837, and the data used to construct that estimation was kindly given to me by Claude Diebolt

2.3 Choice to control?

The final point highlighted by Coale (1973, p. 65) has to do with whether couples actually *consider* deciding on the size of their families. Although it is not really disputed that the transition involved the use of active contraception (see, e.g., Flandrin 1979), it is not entirely clear whether before that time contraception was conceived of as a possibility at all. For pre-transitional France there is evidence that—in a typical Malthusian fashion—the decision of *when to marry* affected fertility (Weir 1983, Chap. II), but only scarce and scattered examples of certain families or small groups actually practicing control within marriage (e.g., Livi-Bacci 1986). Demographers have traditionally suggested that the choice of when to marry *was* indeed the tool used to control procreation in pre-industrial times, via altering women's exposure to the risk of becoming pregnant. If that had been the case, changes in the dynamics of marriage might have generated a motivation for couples to engage in post-marriage fertility regulation. Arguably, the French Revolution brought some of them, as a few normative changes introduced shortly after 1789 made establishing marriage contracts easier in several ways, and some might have even promoted unions.[11] Other accounts instead point directly towards a cultural change triggered by modernisation (e.g., Lesthaeghe 1983), yet, the nature of this modernisation and how it induced the ideational shift is rarely defined in a precise way.[12]

[11] For example, revolutionary laws lowered the age before which parental consent was needed, authorised divorce, and, by making civil contracts independent of the Church, it avoided the prohibitions of marriage in certain periods such as Advent and Lent (Bergeron 1981, p. 110). Most notably, the Jourdan–Delbrel law in 1798 exempted married men from conscription, which created a clear incentive to marry, *orthogonal* to the decision of having children. Further, a recent body of literature also suggests (more as an empirical regularity than in terms of a theory) that social upheavals have a profound effect on the evolution of birth rates (Binion 2001; Caldwell 2004; Bailey 2009).

[12] According to this literature, it was the spread of new ideas—and not the change in material conditions—that accounted for the decline (Cleland and Wilson 1987, p. 27). Lesthaeghe, for example, suggests that the intellectuals of the Enlightenment provided the raw material that, in the hands of the French revolutionaries, led to the legitimisation of individual freedom of choice in different aspects of life, including fertility (Lesthaeghe 1983, p. 413).

More often than not, however, it is religion that is blamed for the lack of individual self-determination in the pre-transitional period, especially on family life. Free will enjoyed a central role in Catholicism, but in matters of procreation, as in many other areas where the mechanisms of nature were not fully understood, individuals probably felt they had only limited control. 'The Lord gave, and the Lord hath taken away', the saying usually heard at the time by grieving parents that had lost a child, conveys the idea that fertility was largely dependent on the will of God (hence independent from the will of men in general—and parents in particular). This idea was pervasive in medieval and early modern France (Flandrin 1979, p. 179; Ariès 1980, p. 646), as it is right now in many underdeveloped countries (Van de Walle 1992, p. 490–496). Some authors have then suggested that for the transition to occur, this preconception should disappear (Van de Walle 1992, p. 490).[13] As de-Christianisation was part of the *zeitgeist* of the Revolution,[14] arguments along these lines also call that event instrumental. Although the early nineteenth century saw a religious revival, the Revolution had shaken the Church to its very foundations; this might have created a window of opportunity for an ideational change, as "(t)he hiatus in clerical control consequent upon the Revolution seems to have enabled at least some French men and women to break free from old constraints" (Gibson 1989, pp. 244–245), allowing them to reach a new ideal normative equilibrium in terms of fertility behaviour.[15]

But the National Assembly interfered in the regular functioning of the Church in a more literal way, as the latter suddenly saw many of its liberties curtailed, along with its resources, and its whole apparatus shaken by the purge of its members.[16] An interesting case of this is the Ecclesiastical Oath of 1791. Towards the end of 1790 the revolutionaries imposed a clerical oath of allegiance to the new Constitution that split the clergy into jurors (*constitutionnel*) or non-jurors (*réfractaire*), fuelling confrontations within the clergy and at different levels of society. The nature and consequences of the oath are rather complex (see Tackett 1986), but some authors have suggested that the relaxation of clerical discipline in 'constitutional' regions can partly explain the rapid spread of birth control in those areas (Sutherland 2003, p. 345), where the Church was now lacking a considerable amount of raw material to sustain clerical authority and administer sacraments. This contributed to the end of a quasi-universal religious practice in France (Gibson 1989, p. 228) and, in particular, perhaps limited the potential ways in which local priests could have influenced birth control practices, facilitating the rise of 'anomalies' in sexual behaviour such as contraceptive practices, illegitimacy, and bridal pregnancies (Le Roy Ladurie 1965; Van de Walle and Muhsam 1995).[17] Or it

[13] Up to the late eighteenth century, Catholicism dominated social life (see e.g., Le Bras 1955), conveyed much of the normative framework in France, and had strong attitudes regarding family behaviour and against contraception. In particular, it condemned heavily the 'sin of Onan,' the main technique couples had to control fertility at the time (Flandrin 1979, pp. 194–196).

[14] Already during the eighteenth century there were signs of de-Christianisation. Attendance at mass became less frequent, the number of people joining the clergy diminished, and the proportion of religious books owned by those rich enough to buy them fell considerably (Gibson 1989, p. 3).

[15] This view can be connected with the recent developments regarding the role of social networks in fertility choice, which suggest that fertility could well be a coordination problem (Kohler 2001, pp. 143–144). For an extensive discussion of this argument, see González-Bailón and Murphy (2013).

[16] It is estimated that as many as 3,000 priests were killed (Tackett 2006, p. 549), more than 32,000 were forced to leave the country (Gibson 1989, p. 52), and recruitment of new priests was stopped or seriously curbed.

[17] Arguments not directly related to Catholic views on sexual behaviour are consistent with this story. Given the extent of the influence of the Church, it is likely that weakly religious areas could have been more sensitive to the institutional changes brought by the Revolution and *these* changes could have had an impact on fertility. Inheritance laws provide a clear example. Although supposedly affecting the whole nation simultaneously, it

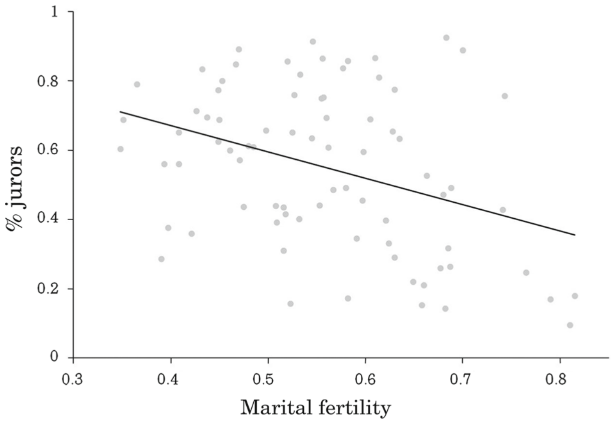

Fig. 5 Marital fertility (1831) and the Oath (1791). Sources: marital fertility corresponds to the I_g index in 1831 and comes from Coale and Watkins (1986, pp. 94–107). The proportion of jurors indicates priests taking the oath, and was estimated by me using data from Tackett (1986)

could well be that the proportion of priests swearing the Oath reflected in itself the level of secularisation of the different *départements*. Tackett himself suggested "almost everywhere laypeople exerted pressure on the clergy to accept or reject the oath, with the oath ceremony providing the occasion for a de facto referendum on the general religious and secular policies of the Revolution" (Tackett 2006, p. 546). Indeed, as we can see in Fig. 5, there is a clear negative correlation between the proportion of oath-takers (in 1791) and marital fertility a generation afterwards (in 1831).

In line with arguments of other authors (e.g., Weir 1983, p. 39; González-Bailón and Murphy 2013), the previous discussion suggests the events of 1789 were connected with the fertility decline, partly channelled through their effect on self-determination, or on French Catholicism, or on the organisation of the Church. In any case, there are reasons to believe that factors associated with the French Revolution or the vitality of Catholicism might help explain different levels of fertility.

2.4 On diffusion

One last point to discuss, somewhat connected with the discussion in the previous section, is the role of diffusion via social interaction. Both the presence of clustering and the spatial evolution of rates in Fig. 2 point towards diffusion as a way of describing what happened in France (Bocquet-Appel and Jakobi 1998, p. 190; González-Bailón and Murphy 2013). Further, a recent unpublished manuscripts finds evidence that the French decline can be linked to the transmission of fertility norms via migration (Daudin et al. 2012). Hypotheses linking social interaction with fertility can be traced back at least to the late nineteenth century,[18] but they gained special support in the 1970s with the publication of the first results of the European Fertility Project (Coale and Watkins 1986). Some of their findings, especially the fact that fertility patterns were strongly correlated with the distribution of

has been suggested these laws were unequally enforced (Brandt 1901), and that, in this, the influence of the Church (by promoting or opposing implementation) could have been instrumental.

18 Among the first ideas that appeared to explain the decline, some authors attributed the fall in French birth rates to changes in the nature of social dynamics (Dumont 1890) or in the moral order of society (Leroy-Beaulieu 1913).

various cultural traits (e.g., language), led to the conclusion that the fertility decline was mainly driven by social interactions and the diffusion of reproductive behaviour (Knodel and van de Walle 1979, p. 239). The importance of social interactions for explaining fertility has been nonetheless very controversial, in particular among economists that look at diffusion stories with scepticism because they find it hard to believe rational agents were unwilling to control fertility on moral grounds (e.g., Brown and Guinnane 2002, p. 40).

Of course, social constructs like moral norms are not necessarily outside the calculations of a rational agent (see, e.g., Iannaccone 1992, 1998). In fact, recent studies have proposed various micro-founded models where social interaction affects rational, utility-maximising couples (e.g., Durlauf and Walker 2001; Kohler 2001), which can be expanded to include the role of fertility norms (González-Bailón and Murphy 2013), and innovation and social diffusion (Spolaore and Wacziarg 2014). According to these models, fertility choices are seen as coordination problems: the benefits of choosing high or low fertility are dependent upon the fertility choices of others. There, agents assess a value function that, along with personal attributes (including tastes, environmental factors, etc.), includes as a key argument the expectations of what others are doing in terms of fertility. Couples then face a cost of deviating from the average behaviour of the other agents.[19] Whereas traditionally economic and diffusion stories have been treated as alternatives (see Carlsson 1966; Brown and Guinnane 2002, p. 40), these recent theoretical developments suggest both components should be incorporated together, hence empirical implementation should also partly control for diffusion.

3 Assessing the French experience

3.1 The data

In order to evaluate some of the hypotheses summarised above, I collected information to create more than twenty different variables and build a novel *département*-level panel dataset spanning the last quarter of the nineteenth century. The dataset is satisfactory in many senses. First, looking at *département*-level data allows me to strike a reasonable balance between availability of covariates and level of aggregation.[20] The alternative of using household-level data limits in many ways the scope of analysis,[21] while the use of higher levels of aggregation is known to lead to loss of efficiency in estimation (Brown and Guinnane 2007, p. 575). Second, the data cover all *départements* at the time, thus capturing the whole population

[19] There are various reasons for this, the most straightforward being social pressure. Another is uncertainty. The decision to reproduce is an important yet relatively infrequent choice in a lifetime; this makes people rely on the experience and judgment of others to make their own assessment, which introduces a particular form of social interaction effect by means of learning. See discussion in, e.g., Kohler (2001) or González-Bailón and Murphy (2013).

[20] Although van de Walle long ago pointed out that the use *département*-level data had been largely neglected (Van de Walle 1974, p. 8), little has been done since then, and the handful of papers that have done so used only a few covariates in a simple cross-sectional framework (e.g., McQuillan 1984; Watkins 1991, Chap. 7).

[21] At least so far the use of household-level data has proved limited. Some studies (e.g., Weir 1995; Hadeishi 2003; Cummins 2013) have used this sort of information but had to constrain themselves to relatively small, and most likely special, areas of France. Also, they could study the potential influence of only a small number of covariates that are unlikely to grow in the future. Weir took advantage of one of those rare examples where some information could be cross-referenced from other sources for a town (Weir 1995, p. 2), and recently Cummins (2013) has studied another three, but it is uncertain whether much can be done with others due to lack of records that can be potentially linked to the demographic data (Cummins 2013, p. 453).

of France rather than only a few scattered villages. Third, it comprises the years 1876, 1881, 1886, 1891, and 1896, covering the period when the divergence in fertility among *départements* was greatest. It is true that by then the fertility decline was well under way, but the persistence of high fertility in some parts of France illustrated in Fig. 2 suggests that, whatever factor was impeding its decline, that factor was probably still present. Also, the period covered by the dataset is characterised not only by great heterogeneity between *départements*, which measured by the coefficient of variation of I_g across *départements* is actually maximised in 1886, but also by a decreasing mean value of fertility level (González-Bailón and Murphy 2013, p. 141, Fig. 3), providing a unique set up for an analysis of temporal and cross-section variation. This leads us to the last, and probably most important, aspect of this dataset: that it is built specifically to be a panel. The panel structure, which is virtually impossible to obtain for historic individual data, allows me to deal with the recurrent problem of unobserved confounding factors, now well understood in the literature (see e.g., Brown and Guinnane 2007; Angrist and Pischke 2009, Chap. 5) and never addressed in previous studies of the French decline (e.g., McQuillan 1984; Watkins 1991, Chap. 7). Also, it lets me address one of the key criticisms recently made of the European Fertility Project, namely the study of fertility transition as a *change* over time (Brown and Guinnane 2007, pp. 585–589).

Table 1 lists the main variables I use, with their definitions and some descriptive statistics, for the whole country and two selected groups. Definitions are in general self-explanatory, yet some might need further explanations. First, since the main interest was in the behaviour of couples, I decided to use the I_g Princeton index to measure marital fertility. This index is less coarse than others like the crude birth rate, it is more available than the total fertility rate, and it is widely used in the demographic transition literature.[22] Second, due to the lack of data on actual income, I used direct taxes per capita as a proxy,[23] which I made more illustrative by taking the income for the whole country in the relevant years and using the proportion of national contribution to direct taxes as a weight to obtain departmental proxies for income. Lastly, I experimented with several measures of secularisation, two of which I use here. One possibility was to look at the size of the clergy, so I use the number of *desservants* (a class of parish priests who were named by the bishop without the sanction of the Government, but who could also be removed at any time by the bishop, i.e., a part of clergy over which the Church still had substantial discretion) per thousand inhabitants, which enjoyed some variability. I also constructed another variable using the proportion of students in religious schools, on the premise that in a more anticlerical region fewer parents would have sent their children to religious schools.

The first column gives the mean for all *départements* for all the years in the sample; the other two simply average the values for two selections of *départements*: one consisting of the ten with the highest fertility and another of the ten with the lowest fertility. These statistics already provide some hints about what could explain the variation. *Départements* with high fertility are net senders of migrants, have fewer urban areas and fewer people working in industry, and are poorer, less financially sophisticated (which I proxy here with the number of saving accounts per capita), and less educated. Nevertheless, they tend to be

[22] Guinnane et al. (1994) warn us to be cautious when drawing conclusions from Princeton indexes, arguing that they do not describe perfectly parity dependence/independence, especially when there is substantial cultural heterogeneity or in the early stages of the transition. Since I am not making statements about parity dependence and looking into a period when the transition is ongoing, those caveats are not particularly relevant in this case.

[23] As done by Weir (1995), and supported by the fact that those taxes were more or less equal across *départements* and did not change much over the period studied (see Willis 1895, pp. 46–48).

Table 1 Means and st. dev. of main variables, French *départements*, 1876–1896

Variable	Definition	All	High fert.	Low Fert.
Marital fertility	Princeton index of marital fertility (I_g)	0.455 (0.128)	0.700 (0.075)	0.302 (0.031)
Infant mortality	Deaths of children younger than 1 year old over births	0.163 (0.037)	0.178 (0.035)	0.163 (0.033)
Net immigr. 15/19–20/24		−0.015 (0.128)	−0.065 (0.034)	0.029 (0.093)
Net immigr. 20/24–25/29	Net immigration of women aged $(a)/(a+4)-(a+5)/(a+9)$ in the last five years	−0.027 (0.058)	−0.064 (0.034)	0.014 (0.060)
Net immigr. 25/29–30/34		−0.016 (0.051)	−0.045 (0.030)	0.006 (0.040)
Foreigners	Change in # of foreign-born per population in the last five years	0.002 (0.009)	0.0009 (0.006)	0.001 (0.004)
Income per capita	NDP weighted by direct taxes, per capita, over the price of wheat	760.0 (325)	423.6 (136)	1089 (419)
Savings per capita	Money in saving accounts, per capita, over the price of wheat	78.7 (72.2)	36.1 (29.0)	101.9 (96.5)
Urban population	People living in urban areas as a % of total population	0.282 (.162)	0.160 (0.056)	0.332 (0.236)
% Working in industry	People working in industry as a % of total population	0.101 (0.050)	0.052 (0.021)	0.126 (0.065)
% Working in agriculture	People working in agriculture as a % of total population	0.208 (0.064)	0.247 (0.053)	0.200 (0.079)
Saving books	Number of saving books per adult	0.121 (0.086)	0.051 (0.029)	0.160 (0.102)
Literacy (female)	% of women signing the marriage contract (not drawing a cross)	0.808 (0.162)	0.712 (0.208)	0.860 (0.114)
Literacy (male)	1 minus the % of conscripts that do not know how to write or read	0.899 (0.085)	0.843 (0.125)	0.925 (0.050)
Literacy gap (f/m)	Ratio of female to male literacy	0.892 (0.126)	0.830 (0.156)	0.928 (0.103)
Religion (desservants)	Number of *desservants* per 1,000 population	0.944 (0.382)	0.934 (0.442)	0.928 (0.103)
Religion (religious education)	% Primary school students attending religious institutions	0.317 (0.121)	0.387 (0.170)	0.266 (0.071)
Republican vote	% of votes received by republican parties (as opposed to monarchist parties)	0.649 (0.202)	0.611 (0.233)	0.621 (0.171)
Turnout at the polls	People turning out at the polls as a % of voters inscribed	0.745 (0.073)	0.712 (0.074)	0.782 (0.056)

Standard deviations in parenthesis. See Appendix 1 for a detailed account of sources and of how variables were constructed. *Départements* with systematic high fertility are Hautes-Alpes, Ardèche, Corsica, Côtes-du-Nord, Finistère, Ille-et-Vilaine, Lozère, Morbihan, Savoie, and Haute-Savoie; those with systematic low fertility are Aube, Eure, Gers, Gironde, Indre-et-Loire, Lot-et-Garonne, Oise, Seine, Tarn-et-Garonne, and Yonne

similar among themselves when it comes to infant mortality, and in political terms they are equally ‘republican’ and politically participative. Since the two measures of religion suggest opposite readings, its role—at this descriptive level—is not entirely clear.

3.2 Pooled OLS versus panel results

To study the contribution of these variables to fertility, it is necessary to specify a treatable econometric model that incorporates them. A general empirical counterpart of Easterlin's formulation could take the following form:

$$\mathrm{f}_i = \mathrm{fertility}_i = \alpha + \sum_{j=1}^{l} \beta_j x_{ji} + e_i \tag{1}$$

where, as usual, i indicates the individual unit (*département* in this case), e_i is a random disturbance, and the vector $\boldsymbol{x}$ includes all the variables affecting fertility.[24] The first column of Table 2 presents estimates of this initial model that I report as elasticities evaluated at the overall mean.[25] Not surprisingly, the results of these pooled-OLS estimations are not far from previous studies using only cross-sectional data. There I find evidence of marital fertility being positively correlated with infant mortality (as in Van de Walle 1976) and urbanisation (as in McQuillan 1984), yet negatively correlated with income (as in Van de Walle 1976 and Watkins 1991) and proportion of people working in agriculture. Interestingly enough, it also suggests that financial sophistication (increase in saving books per capita) also leads to smaller families. There also seems to be a small role played by migration, where net inflow of women in their mid-twenties has a negative effect on fertility.[26]

A crucial drawback of pooled-OLS to assess this aspect of fertility behaviour, however, is that it does not model change over time, something that has been shown to lead to unreliable estimates (Brown and Guinnane 2007, Sect. 3). Panel data allow us to deal with this, and part of the omitted variable problem, by introducing fixed- and period-effects. That is, recognising that a certain amount m of the components of the $\boldsymbol{x}$ vector are non-observable, and introducing the time dimension the panel-structured data allows me to exploit, model (1) can be better specified as:

$$\mathrm{f}_{it} = \alpha + \sum_{j=1}^{l-m} \beta_j x_{jit} + u_i + year_t + \varepsilon_{it} \tag{2}$$

24 That is, through the different channels discussed in the previous section. Clearly, it is sometimes difficult to determine whether a particular factor is affecting fertility through one or more of these channels. For example, women's education could be influencing natural fertility (by making healthier, more fecund mothers), children's supply (by reducing the chances of child mortality), children's demand (by increasing the mother's opportunity costs), and regulation costs (by affecting moral costs). Although it is plausible to imagine cases in which the mechanisms could be disentangled, in practice we must satisfy ourselves with assessing the overall effect of a particular variable.

25 This is to ease the assessment of each variable's impact on fertility and make them comparable to other studies (e.g., Brown and Guinnane 2002; Dribe 2009). In Appendix 2 I report the actual coefficient estimates and additional information on the regressions.

26 Other studies of the fertility decline have considered it important to incorporate migration, yet none found it to be of any relevance for explaining fertility (e.g., Brown and Guinnane 2002, p. 43; Dribe 2009, pp. 80–81). This negative effect I find of net inflow of women in their mid-twenties probably works by increasing the denominator of the I_g index, as mean age of marriage in this period for most *départements* is in the low twenties. It is difficult to draw strong conclusions based upon this outcome, but one way of reading it is that women—at least those migrating—were delaying births rather than spacing them. They could also be learning. It has been suggested lately (Daudin et al. 2012) that migrants went to *départements* with low fertility (which Table 1 above supports), where they probably adopted the social norm and eventually transmitted it back to their *départements* of origin, fostering the diffusion effect.

Table 2 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, pooled-OLS, and fixed-effects models

Dependent variable: I_g	Pooled OLS		Panel FE	
	Elast.	(t-val.)	Elast.	(t-val.)
Demographic controls				
Infant mortality	0.196***	(2.70)	−0.010	(−0.47)
Net immigration 15/19–20/24	−0.009	(−1.05)	0.002	(1.07)
Net immigration 20/24–25/29	−0.045***	(−5.17)	−0.012***	(−4.09)
Net immigration 25/29–30/34	−0.002	(−0.29)	0.005***	(3.27)
Foreigners (% change in pop)	0.002	(0.97)	0.001	(1.29)
Economic				
Income per capita	−0.179***	(−2.42)	0.055**	(2.24)
Urban population	0.080	(1.49)	0.037	(0.54)
% Working in industry	−0.010	(−0.23)	0.018	(0.65)
% Working in agriculture	−0.205***	(−4.24)	−0.018	(−1.04)
Saving books per capita	−0.068**	(−1.92)	0.031**	(1.75)
Education				
Literacy (male)	−0.311	(−1.34)	−0.154**	(−2.36)
Literacy gap (f/m)	−0.086	(−0.48)	−0.150***	(−3.63)
Modernisation				
Religion (religious education)	0.135**	(2.53)	0.086**	(2.45)
% Republican vote	−0.069	(−1.15)	0.011	(0.63)
Turnout at the polls	−0.491**	(−2.27)	−0.053	(−1.17)
Fixed effects & time dummies	No		Yes	
R^2:			0.79	
F (df, n)	32.0		34.0	

Values in this table are elasticities evaluated at the overall mean, and in brackets the t-values of the original coefficients. See Appendix 1 for a complete description of sources and Appendix 2 for the regression coefficients. All estimations included 435 observations (5 for each of the 87 *départements*). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation.
Asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %
As a robustness check, I estimated these same models taking the crude birth rate—a coarser measure of fertility—as the dependent variable. This measure seems to be more sensitive to industrialisation, which showed a positive impact on births, but all other results were virtually the same

Here t indicates time, and the inclusion of year dummies allows us to account for period effects. A crucial element of this specification is the individual term u_i, which captures the effect of some unobservables, assuming that those are associated with characteristics of each *département* and do not change much. If these are indeed constant across time, a fixed-effects model will be able to provide appropriate estimates, as coefficients are identified only by variations across periods. This method of course runs into trouble under the presence of time-invariant variables,[27] but in all variables I study there is indeed variability across time, making the model well specified in that respect.

[27] The random effects approach does not have these problems, but it assumes that individual effects are uncorrelated with the other regressors. This assumption is too strong for my model, as some of the variables

The column labelled 'Panel FE' in Table 2 shows how results change if we use this alternative, more reliable procedure. The first remarkable finding is that, in contrast to the previous results, but in line with quantitative analyses that profit from the panel structure (e.g., Brown and Guinnane 2002), infant mortality at this stage of the transition does not to contribute to explaining fertility at all, a result that holds even when experimenting with alternative measures of mortality, such as child (children up to 5 years) or perinatal mortality (not reported). The fact that the influence of infant mortality is wiped out by the introduction of fixed-effects suggests that the relationship found in the naïf-pooled OLS was probably coming from unobserved heterogeneity across *départements*,[28] and once that is controlled for, there is no additional contribution of that variable.

Another substantial change is that income seems to have a positive impact on births, an outcome that is most likely reflecting the role of wealth on fertility in a context where children are considered normal goods.[29] As the discussion earlier in the paper somewhat anticipated, urbanisation and the number of people in industry or agriculture do not seem to be correlated with fertility, and the proxy for financial development reverts its sign. The factors that turn out to be significant in this second specification are male literacy and the gender gap in literacy. As many development theories suggest (see e.g., Schultz 1997), fertility in nineteenth century France is sensitive to the level of education but, crucially, to the relative education of females with respect to males. This is in line with the idea that the opportunity cost faced by mothers matters at the moment of deciding the size of the family, and that the reduction in the (in this case educational) gender gap can lead to a decline in fertility, as suggested by UGT (Galor and Weil 1996).

Although not all 'economic' factors appear to have had an impact on fertility, the results so far support the hypothesis that some economic motives did matter. What about cultural and social variables? If factors directly associated with the democratic values fostered by the French Revolution were ever important for explaining births, they were certainly not relevant in the middle of the transition. Neither republicanism (i.e., the proportion of people voting for parties that were not monarchist) nor political participation seem to be connected with fertility. Religiosity, however, does show significant effects with the expected sign. This confirms one of the clearest results of the Princeton project (Knodel and van de Walle 1979; Lesthaeghe and Wilson 1986) and subsequently, more sophisticated studies (e.g., Weir 1983; Galloway et al. 1994; Brown and Guinnane 2002): Regions (in this case, *départements*) that are more religious, in this case in the sense of being more Catholic, had higher fertility.

Footnote 27 continued
we are unable to observe are likely correlated with those we do observe. This can generate inconsistent estimates due to omitted-variable bias, so in this context, fixed effects are generally preferred.

28 Many potential elements could be the source of this. For example, one plausible story is that the result is partly driven by differences in breastfeeding practices. Those were largely unobserved, likely time invariant, probably showed a certain degree of variation across *départements*, and could affect both infant mortality and fertility.

29 Murtin (2013), using a panel of countries in the long run (1870–2000), and controlling for mortality and education, finds the same positive effect of income on fertility. Other works that have looked into income-related measures have instead relied upon wage data, which arguably are closely connected to the idea of opportunity cost of time rather than that of wealth and, as expected, they suggest either a negative correlation with fertility (Brown and Guinnane 2002, p. 44; Dribe 2009, p. 85) or no correlation at all (Galloway et al. 1994, p. 152).

3.3 Potential endogeneity of infant mortality and 2SLS estimates

Earlier, in Sect. 2.2, I pointed out that infant mortality is likely to be endogenous, which could be creating a bias in our estimates. It may be that not only infant mortality and fertility are simultaneously determined; unobserved factors might affect both, generating spurious correlation (Schultz 1997, p. 339). One way of dealing with that is to use instrumental variables estimation. Finding a suitable instrument is not always easy, but for this particular case climate data is at least promising. By its very nature, climate is indeed exogenous. Also, hot summers are likely to affect child mortality, but not fertility, making it a potentially good instrument.[30] The literature on nineteenth century child mortality suggests there are clear seasonal patterns in which particularly hot summers increased the risk of death, especially via diarrheal mortality (e.g., Cheney 1984; Woods et al. 1988, p. 362).[31] Exploiting the climatologic data in Luterbacher et al. (2004), I computed the deviations of the mean summer temperature over the 50-year average for each *département* and each year in the panel (see Appendix 1 for details), which I then use to instrument infant mortality. In Table 3 below I report the results of a series of models that use this information to generate 2SLS estimates of various versions of the regression equation (2).[32] In all cases the F-tests of the excluded instruments in the first-stage regression (reported at the bottom of the table) rejected the hypothesis of their being zero.

Column (i) in Table 3 reports the baseline estimation, while the other columns provide a series of robustness checks. Column (ii) uses deviations from July's (instead of summer's) temperature as an instrument. Column (iii) assesses the same model, but with child mortality (i.e., children under five) in place of infant mortality. All three columns suggest the same general outcome, and this does not alter the assessment made using the fixed-effects model. One possible concern could be that people take time to adjust to mortality changes, so instead of looking at current mortality we should use lagged values. In column (iv) I explore this possibility by including as an additional explanatory variable the level of infant mortality five years before, and the main results remain.[33]

3.4 The role of education

An important issue concerns the potential endogeneity of education, as some aspects of education are arguably jointly determined with fertility. Investment in human capital, for example, is one of them. As the quantity–quality debate clearly illustrates (e.g., Becker et al. 2010), the perspective of higher school enrolment may indeed reduce fertility, but lower birth rates could also release resources that facilitate children's access to schools. Because

[30] Of course, the instrument not only needs to be exogenous in the sense of being stochastically determined, but also to affect fertility only through its effect on child mortality. It is indeed plausible to think that shocks to temperature could, for example, affect agricultural output, indirectly affecting fertility. Since I am including as a regressor the proportion of people working on agriculture, this mechanism is at least partly taken into account. It is also reasonable to think that temperature in itself could affect human reproduction. There is in fact some suggestion in the biological literature that high temperatures have a negative impact on fertility in tropical places, but there seems to be nothing conclusive for more temperate regions like France (Bronson 1995). In fact, in within the dataset I am using, there is no correlation whatsoever between fertility and deviations in summer temperatures in the current or previous year.

[31] Although the peak varies from year to year and place to place (Cheney 1984, p. 563), the effect seems to concentrate in July, so in the estimations I use this as a robustness check.

[32] Appendix 2 includes details on the first stage corresponding to each of the models.

[33] Using lagged mortality *instead* of current mortality (not reported) does not change these results.

Table 3 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS

Dependent variable: I_g	(i)		(ii)		(iii)		(iv)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
Demographic controls								
Infant mortality	−0.034	(−0.65)	−0.054	(−0.78)			−0.046	(−0.82)
Infant mort., t—5 years							−0.022	(−1.02)
Child mortality					−0.039	(−0.63)		
Net immigr. 15/19–20/24	0.002	(0.95)	0.001	(0.88)	0.001	(0.90)	0.001	(0.92)
Net immigr. 20/24–25/29	−0.012***	(−4.17)	−0.012***	(−4.22)	−0.012***	(−4.21)	−0.012***	(−4.25)
Net immigr. 25/29–30/34	0.005***	(3.17)	0.005***	(3.10)	0.005***	(3.21)	0.005***	(3.04)
Foreigners (% ch. in pop)	0.001	(1.30)	0.001	(1.32)	0.001	(1.31)	0.001	(1.29)
Economic								
Income per capita	0.054**	(2.11)	0.053**	(2.04)	0.053**	(2.06)	0.054**	(2.11)
Urban population	0.039	(0.59)	0.042	(0.63)	0.043	(0.64)	0.038	(0.58)
% Working in industry	0.018	(0.67)	0.019	(0.68)	0.017	(0.63)	0.020	(0.74)
% Working in agriculture	−0.015	(−0.80)	−0.013	(−0.63)	−0.017	(−0.91)	−0.011	(−0.57)
Saving books per capita	0.029**	(1.74)	0.028**	(1.73)	0.030**	(1.76)	0.029**	(1.69)
Education								
Literacy (male)	−0.156**	(−2.34)	−0.158**	(−2.37)	−0.157**	(−2.32)	−0.163**	(−2.48)
Literacy gap (f/m)	−0.149***	(−3.58)	−0.148***	(−3.53)	−0.151***	(−3.57)	−0.153***	(−3.66)
Modernisation								
Religion (relig. education)	0.089**	(2.55)	0.092***	(2.64)	0.090**	(2.52)	0.088**	(2.52)

Table 3 continued

Dependent variable: I_g	(i)		(ii)		(iii)		(iv)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
% Republican vote	0.012	(0.66)	0.013	(0.72)	0.012	(0.65)	0.013	(0.68)
Turnout at the polls	−0.053	(−1.17)	−0.052	(−1.16)	−0.050	(−1.11)	−0.049	(−1.14)
Instrument								
Dev. summer temp.	X				X		X	
Deviation July temp.			X					
F test excl. instruments	24.6		16.8		18.5		24.3	
R^2	0.79		0.78		0.78		0.79	
F (df, n)	33.3		33.1		32.4		30.8	

Values in this table are elasticities evaluated at the overall mean. See Appendix 1 for a complete description of sources and Appendix 2 for the regression coefficients. All estimations included 435 observations (5 for each of the 87 *départements*), fixed effects, and time dummies. Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation.
Asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

no valid instruments were available to deal with this problem,[34] in the regressions discussed in the previous Sect. 1 did not include any variable associated with current educational investment that could lead to biased estimators. Column (v) in Table 4 shows that including such covariate (without instrumenting for it) does not really alter the estimates. Dividing the number of children attending school by the school-aged population I constructed the variable 'enrolment' and its square, which proxies for educational attainment.[35] This sort of measure faces clear limitations (see Becker et al. 2010, p. 182), but it is the only one available to address this aspect of education at *département* level. As can be seen, enrolment turns out to be significant and with the expected sign. Though potentially endogenous, its inclusion does not really alter the previous results, giving some confidence that at least these other estimates are reliable. Data availability imposes serious limitations here, but further research might be able to fully disentangle the effect of educational attainment on French fertility in this period.

Since the other measures of education I use (literacy of conscripts and women getting married) correspond to educational investment *in the past*, the potential problem, though not entirely eliminated (because the investment back then could have been triggered by fertility changes), is perhaps weakened. Following this logic, assessing the impact on current fertility of education levels further back in time could provide more reliable results. This is what columns (vi) and (vii) reflect. I collected additional information on male and female literacy since 1856, which allowed me to construct a variable that corresponds to the level of fertility 20 years before each year of the panel, and I use those as regressors. Although these estimates should be taken with caution and await confirmation from eventual studies that can deal properly with the endogeneity issues raised above, they preliminarily suggest the impact of education and the educational gender gap are strong and persistent. In fact, when both current and past values are included, *past* education but *current* gap seem to matter the most. This is at least consistent with the quantity—quality debate that has gained considerable support in the recent empirical literature (e.g., Becker et al. 2010; Klemp and Weisdorf 2012). Further, these results allow us to offer the hypothesis that the efforts made by the French state during the nineteenth century to organise and enforce primary education—such as with the Guizot law of 1833, which required every commune in France to maintain an elementary school, provide a minimum wage to teachers, facilitate free education to families that could not afford the *contribution scolaire*, and eventually extend it to all boys and, most importantly, girls—probably had a reinforcing effect on fertility dynamics.

3.5 Further robustness checks

As I show in this section, the findings presented so far stand even after a series of additional robustness checks, which are evaluated in Table 5. For example, it might be the case that, fertility being highly persistent over time, estimations suffer from serial autocorrelation. To ameliorate this effect, one could estimate the same model with a longer space between periods. In column (viii) I do so, and report the (largely unchanged) estimates obtained

[34] Becker et al. (2010, 2012), following Galor and Moav (2009), have suggested landownership inequality is a reasonable instrument in this context (see e.g., Becker et al. 2010, p. 186) but no such a variable exists for France during the period of study for the five years of the panel. Avenel (1894) does report certain cross-sectional estimates on the size of land plots, which under certain assumptions could be connected to landownership, but when I assessed the association with educational investment (different measures of enrolment), none was found.

[35] Enrolment rates such defined refer really to gross enrolment, and particularly high values can indicate *low* educational attainment (e.g. associated with repetition). Since data availability impedes the estimation of net enrolment rates, by introducing the square of the variable I can account for the implied non-linearity.

Table 4 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS, robustness checks on education

Dependent variable: I_g	(v)		(vi)		(vii)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
Demographic controls						
Infant mortality	−0.021	(−0.40)	−0.046	(−0.90)	−0.055	(−1.08)
Net immigr. 15/19–20/24	0.001	(0.78)	0.002	(1.20)	0.002	(1.28)
Net immigr. 20/24–25/29	−0.012***	(−3.95)	−0.012***	(−4.10)	−0.013***	(−4.43)
Net immigr. 25/29–30/34	0.005***	(3.26)	0.005***	(3.00)	0.005***	(2.94)
Foreigners (% ch. in pop)	0.001	(1.17)	0.001	(1.54)	0.001	(1.52)
Economic						
Income per capita	0.053**	(2.17)	0.051**	(2.01)	0.044**	(1.73)
Urban population	0.028	(0.42)	0.033	(0.49)	0.016	(0.25)
% Working in industry	0.019	(0.68)	0.021	(0.80)	0.019	(0.74)
% Working in agriculture	−0.016	(−0.83)	−0.009	(−0.51)	−0.010	(−0.57)
Saving books per capita	0.033**	(1.84)	0.028	(1.62)	0.022	(1.26)
Education						
Literacy (male)	−0.131**	(−2.00)			−0.103	(−1.37)
Literacy gap (f/m)	−0.147***	(−3.57)			−0.116***	(−3.08)
Literacy (male), t—20 years			−0.208***	(−3.18)	−0.125**	(−1.85)
Lit. gen. rat. (f/m), t—20 years			−0.064**	(−2.17)	−0.057**	(−1.99)
Enrolment	−0.206**	(−1.85)				
Enrolment (squared)	0.104**	(−1.85)				
Modernisation						
Religion (relig. education)	0.081**	(2.27)	0.096***	(2.57)	0.093***	(2.66)
% Republican vote	0.013	(0.71)	0.012	(0.63)	0.016	(0.86)
Turnout at the polls	−0.055	(−1.22)	−0.056	(−1.19)	−0.052	(−1.12)
F test excluded instruments	25.8		25.4		25.8	
Observations	435		435		435	
R^2	0.78		0.78		0.79	
F (df, n)	31.1		30.1		30.6	

Values in this table are elasticities evaluated at the overall mean. See Appendix 1 for a complete description of sources and Appendix 2 for the regression coefficients. All estimations included observations for 87 *départements* per year, fixed effects, and time dummies. Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation.
Asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

from dropping years 1881 and 1891, hence having a panel of 3 periods, spaced every 10 years.[36]

Also, another potential problem could be the reliability of the income measure. Since I relied upon a proxy (constructed based upon direct taxes), I experimented here with another proxy: the amount of savings per capita, which is also likely to be correlated with income.

[36] Moreover, I evaluated the alternative of also dropping 1886, but the results did not change substantially.

Table 5 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS, various robustness checks

Dependent variable: I_g	(viii)		(ix)		(x)		(xi)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
Demographic controls								
Infant mortality	−0.001	(−0.01)	−0.052	(−0.97)	−0.057	(−1.08)	−0.015	(−0.29)
Net immigr. 15/19–20/24	0.002	(1.17)	0.003**	(1.84)	0.002	(1.49)	0.002	(0.81)
Net immigr. 20/24–25/29	−0.013***	(−3.29)	−0.012***	(−4.16)	−0.012***	(−4.32)	−0.011***	(−3.92)
Net immigr. 25/29−30/34	0.006**	(2.12)	0.005***	(3.15)	0.004***	(2.93)	0.004***	(2.69)
Foreigners (*% ch. in pop)*	0.001	(0.79)	0.001	(1.52)	0.001	(1.48)	0.001	(1.44)
Economic								
Income per capita	0.067**	(1.70)			0.040	(1.57)	0.065**	(2.48)
Savings per capita			0.040***	(2.97)	0.035**	(2.47)		
Urban population	−0.028	(−0.34)	0.018	(0.28)	0.020	(0.30)	0.058	(0.84)
% Working in industry	0.008	(0.26)	0.009	(0.32)	0.013	(0.45)	0.020	(0.74)
% Working in agriculture	−0.024	(−0.80)	−0.009	(−0.47)	−0.007	(−0.36)	−0.013	(−0.70)
Saving books per capita	0.032**	(1.73)	−0.034	(−1.24)	−0.028	(−1.01)	0.028	(1.58)
Education								
Literacy (male)	−0.190***	(−2.60)	−0.144**	(−2.10)	−0.141**	(−2.10)	−0.158**	(−2.36)
Literacy gap (f/m)	−0.146**	(−2.46)	−0.147***	(−3.38)	−0.138***	(−3.28)	−0.144***	(−3.80)
Modernisation								
Religion (relig. education)	0.093***	(2.65)	0.075**	(1.94)	0.073**	(1.91)		
Religion (desservant)							0.083**	(2.40)
% Republican vote	0.018	(0.70)	0.015	(0.79)	0.015	(0.81)	0.012	(0.62)
Turnout at the polls	−0.017	(−0.20)	−0.042	(−0.94)	−0.046	(−1.04)	−0.051	(−1.08)

Table 5 continued

Dependent variable: I_g	(viii)		(ix)		(x)		(xi)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
F-test excluded instruments	8.3		26.1		25.0		24.6	
Observations	261		435		435		435	
R^2	0.80		0.79		0.79		0.78	
F (df, n)	38.0		32.2		32.0		34.4	

Values in this table are elasticities evaluated at the overall mean. See Appendix 1 for a complete description of sources and Appendix 2 for the regression coefficients. All estimations included observations for 87 *départements* per year, fixed effects, and time dummies. Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation.
Asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

The impact we can see in column (ix) is somewhat smaller yet equivalent and, interestingly enough, when we make the two proxies ‘compete’ in column (x) it is savings per capita—arguably less noisy—that dominates, but without affecting the other coefficients much.

The last robustness check I consider is in column (xi), where I try an alternative measure of religiosity: the proportion of *desservants* in the population. Again, although this measure is completely independently constructed, the results persist. Interestingly, as with education, this aspect also highlights the potential relevant role of the State. If, as suggested in the discussion in Sect. 2.3, the revolutionary government indeed contributed to debilitating the quasi-universal religious practice in France (Gibson 1989), it might have been instrumental in fostering the subsequent fertility decline.[37]

3.6 Accounting for spatial dependence

Yet another aspect to consider is the role of diffusion. As I pointed out earlier, a good part of the debate on fertility decline has been set up in terms of diffusion versus adaptation hypotheses (Carlsson 1966) without any systematic attempt to assess whether diffusion explains anything *once we account for other covariates*. One way to address this issue is by introducing a spatially lagged component:

$$\mathrm{f}_{it} = \alpha + \sum_{j=1}^{l-m} \beta_j x_{jit} + \rho \sum_{k \neq 1} w_{ik} \mathrm{f}_{kt} + u_i + year_t + \xi_{it} \tag{3}$$

In essence, this is a standard spatial specification (Upton and Fingleton 1985; Anselin et al. 2008), and similar ones have already been used to study diffusion of fertility (e.g., Casterline 2001, pp. 18–19), including in an historical perspective (e.g., Tolnay 1995), although in general they did not have the panel structure I am exploiting here, which has only been explored recently in the theoretical econometric literature (Elhorst 2010, 2012). Each w_{ik} is the element of a pre-specified weighting square matrix W that establishes the spatial arrangement of units in the sample (in this case, *départements*), typically a standard distance matrix like the one I use here.[38] The spatial autoregressive parameter ρ perceives the spatial effect, and (3) is typically considered as the formal specification to describe social interaction (Anselin et al. 2008, p. 630). This ‘spatial lag’ model then describes some sort of diffusion process whereby fertility in *département i* is jointly determined with the fertility in all *k* neighbouring *départements*, depending on how close they are. The term ξ indicates, as usual, the independent, identically distributed error terms. In a common alternative spatial specification, the ‘spatial error’ model, the dependent variable depends only upon local characteristics (that is, $\rho = 0$), but this error is assumed correlated across space:

$$\xi_{it} = v_{it} + \lambda \sum_{k \neq i} w_{ik} \xi_{kt} \tag{4}$$

[37] If this reading is indeed correct, an interesting political economy corollary stems from this argument. Since the revolutionary government had the typical pro-natalistic interest of modern states (they need people to pay taxes and fight wars), its success in dismantling (at least partly) the Church’s structure might have been Pyrrhic, as it hampered the institution that was helping to sustain high levels of fertility.

[38] The choice of W is indeed arbitrary, but not more arbitrary than assuming no spatial dependence (i.e., a matrix of zeros), as is normally done. Of the many different matrices that can be chosen, the distance matrix (which has as elements the inverse of the distance between the centroid of each unit, in this case, *département*) is among the most typical. I explored using another common choice, the neighbouring matrix (that is, one that assigns the value of 1 to adjacent *départements* and 0 to the rest), but the results did not change.

Table 6 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, spatial dependence

Dependent variable: I_g	(xii)		(xiii)		(xiv)	
	Elast.	(t-val.)	Elast.	(t-val.)	Elast.	(t-val.)
Demographic controls						
Infant mortality	−0.011	(−0.39)	−0.012	(−0.54)	−0.013	(−0.53)
Net immigr. 15/19–20/24	0.003	(1.52)	0.002	(1.39)	0.002	(1.48)
Net immigr. 20/24–25/29	−0.009**	(−2.23)	−0.011***	(−3.69)	−0.012***	(−3.71)
Net immigr. 25/29–30/34	0.006***	(3.38)	0.005***	(3.07)	0.005***	(3.06)
Foreigners (*% ch. in pop)*	0.001**	(1.78)	0.001	(1.49)	0.001	(1.54)
Economic						
Income per capita	0.033	(1.06)	0.047**	(1.92)	0.048**	(1.75)
Urban population	0.035	(0.41)	0.039	(0.56)	0.039	(0.51)
% Working in industry	0.017	(0.54)	0.010	(0.38)	0.010	(0.33)
% Working in agriculture	−0.014	(−0.68)	−0.013	(−0.70)	−0.012	(−0.56)
Saving books per capita	0.033	(1.63)	0.032**	(1.93)	0.036**	(2.01)
Education						
Literacy (male)	−0.209**	(−2.42)	−0.175***	(−2.74)	−0.204***	(−2.94)
Literacy gap (f/m)	−0.124**	(−2.20)	−0.127***	(−3.03)	−0.134***	(−2.89)
Modernisation						
Religion (relig. education)	0.080**	(1.77)	0.082**	(2.40)	0.088**	(2.31)
% Republican vote	0.024	(1.08)	0.020	(1.21)	0.024	(1.30)
Turnout at the polls	−0.043	(−0.66)	−0.051	(−1.05)	−0.052	(−0.94)
Spatial coefficients						
ρ	0.252***	(22.21)			0.103***	(419.2)
λ			0.103***	(808.3)	0.102***	(1032)

Values in this table are elasticities evaluated at the overall mean. See Appendix 1 for a complete description of sources and Appendix 2 for the regression coefficients. All estimations included 435 observations (5 for each of the 87 *départements*), fixed effects, and time dummies. Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation.
Asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Here λ is the spatial autocorrelation coefficient, the assumption being that fertility is affected by common unobserved factors in neighbouring *départements*, that is, omitted variables difficult to quantify that might have a distinct spatial footprint.

Estimation of these sorts of spatial panel models imposes a series of computation challenges (see, e.g., Anselin et al. 2008; Elhorst 2010, 2012), making it difficult to account for both endogenous dependent variables and spatial dependence. Given that the results I obtain from my original fixed-effects specification and the subsequent IV estimates are not substantially different, here I go back to the model without IV and apply the spatial dependence. Table 6 below shows the results of this analysis, where I compare the results of three alternative models: a spatial lag model ($\rho \neq 0, \lambda = 0$), a spatial error model ($\rho = 0, \lambda \neq 0$), and a combination of them ($\rho \neq 0, \lambda \neq 0$).[39]

[39] Regressions were performed using the recently developed xsmle command for STATA, which estimates the parameters by maximum likelihood as suggested by the theoretical literature (e.g., Anselin et al. 2008; Elhorst 2010, 2012).

The first important thing to notice is that the results I obtained in my previous analysis hold, again, even when controlling for spatial dependence in these various forms. The coefficient corresponding to the income measure I use weakens under the spatial lag model, but perhaps because it is a particularly noisy variable, as discussed in the previous section. In all other specifications, results are comparable with my previous analysis. Second, after controlling for all those covariates, there is *still* a residual effect for diffusion, as recently found for Prussia as well (Goldstein and Klüsener 2014; Becker et al. 2012). Of particular interest is column (xiv), which includes both spatial–lag and spatial–error components, and both turn out to be relevant. This suggests that, indeed, neighbouring fertility affected local fertility, even when there seems to be additional common unobserved factors spatially correlated that matter.

To my knowledge, these are the first pieces of quantitative evidence that give support to theories that emphasise the role of social interactions in fertility choice (e.g., Durlauf and Walker 2001; Kohler 2001) in the context of the demographic transition. It is hard, however, to say much about the actual mechanisms behind this diffusion from the analysis presented here, and further work is needed in this area (see González-Bailón and Murphy 2013). As some of the literature argues (e.g., Kohler 2001), it is plausible that this had to do with the role of social networks. Indeed, as suggested by Daudin et al. (2012), and supported by some of my results, social networks and migration flows partly explain the fertility patterns we see in France during the nineteenth century. Also, this was perhaps facilitated by an increasingly common language, which might, to a degree, explain why low fertility was achieved earlier in places where French was more widespread (see, e.g., Weber 1976, pp. 498–501, or Watkins 1991). Here we have yet another argument suggesting that the French State after the Revolution may have played a role in the fertility decline, this time by imposing a common language throughout the country that facilitated social interaction.

These estimations provide results that are consistent with the original model I discussed in the previous sections. A general reading of these findings is that, in the case of France, it is a combination of economic factors and cultural elements that contribute to explaining different levels of fertility, to some degree mediated by a diffusion process and—at least arguably—reinforced by the particular policies taken by the State following the Revolution in its attempt to build a secular French nation.

4 Conclusion

In this paper I examined the potential factors driving the fertility decline within France during the fertility transition. The econometric analysis I perform using fixed-effects panel models finds evidence that confirms the key roles played by *both* economic *and* cultural factors in explaining fertility. Most notably, income is positively correlated with larger families, whereas more education is negatively correlated with it. These two features make the French story somewhat difficult to reconcile with the traditional account of an income-driven substitution effect leading to fertility decline (Becker 1960). Yet, they are still consistent with UGT, where the demand in education comes from complementarities associated with technological change (e.g., Galor 2011). The systematic negative effect of the literacy gender gap also resonates with UGT, which puts a special emphasis on the narrowing of the gap for driving fertility decline (Galor and Weil 1996). As I pointed out in the discussion above, due to the potential issue of endogeneity that this paper is not able to address properly, these findings regarding education have to be taken with caution, but they are indeed suggestive. In my results, there is no clear indication that infant mortality, urbanisation, or industrialisation had any direct effect whatsoever. Religiosity, measured in two different ways, is consistently relevant for explaining fertility. All these effects are present despite the fact that I introduced spatially lagged fertility, which also turns out to be strongly significant, thus providing support for the diffusion hypothesis. One possible way to read these results points towards the idea that cultural factors were partly driving fertility dynamics by preventing or allowing the adjustment to economic incentives. This suggests that both components should be included in UGT and related theoretical models to provide a more comprehensive answer for why the decline occurred (and eventually induced Western Europe to achieve modern economic growth). The analysis developed here allows us to more confidently establish the link between some cultural traits, economics, and fertility, though it is still rough in determining the precise way in which this took place. As pointed out by many researchers, probably most emphatically by Weir (1983, p. 281), the connection cannot be taken lightly, and more research should be put into the mechanism behind this.

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Appendix 1: Details on data sources

Official French statistics and demographic data

The major part of the dataset was constructed using official statistics from the *Service de la Statistique Général de la France* between 1878 and 1903, and Table 7 details the references for most of the variables collected. The proportions of people in different economic activities were calculated by adding up the number of individuals working as *chefs*, *patrons*, *employes*, *commis*, *ouvriers*, or *journaliers* in the diverse sectors within either industry or agriculture, and dividing them by the total population. These figures were extracted from various series of the 1876, 1881, 1886, and 1891 *recensements* (ACRH 2011b),[40] and from the 1896 *statistique industrielle* (ACRH 2011a).[41] Number of school-aged children (4–12 years old) used to compute school attendance also comes from the *recensements* (ACRH 2011b).[42]

[40] For 1876, series V33 to V40 from REC_T28, and V197 to V204, V212 to V219, V227 to V234, and V242 to V249 from REC_T30. For 1881, series V149 to V154, V164 to V169, V179 to V184, V194 to V199, V209 to V214, and V224 to V229 from REC_T41, and V7 to V12 from REC_T42. For 1886, series V177 to V182, V190 to V195, V203 to V208, V216 to V221 from REC_T46, and V215 to V220 from REC_T47_II. For 1891, V289 from REC_T63_II, V18, V30, V102, and V126 from REC_T64_I.

[41] Series V70 to V73, V99 to V102 and V128 to V131.

[42] For 1876, series V11 to V18 from REC_T28, and V55 to V63 from REC_T30. For 1881, series V229 to V237 from REC_T30, and V233 to V241 from REC_T40. For 1886, series V188 to V196 from REC_T44, and V106 to V114 from REC_T45. For 1891, series V220 to V230 from REC_T61, and V169 to V179 from REC_T62_I. For 1896, series V69 to V79 from REC_T71_I, and V255 to V265 from REC_T71_II.

The retrospective data on literacy I use to run robustness checks in Section 3.4 come from the *Statistique de l'enseignement Primaire, 1829–1877* (ACRH 2011c),[43] and infant mortality rates corresponding to 1871 (used to create the 5-year lag in Section 3.3) were built from the 1972 figures of the *Mouvement de la Population* (ACRH 2011d).[44] Fertility data were available from studies that are part of the European Fertility Project. In particular, marital fertility (I_g) was obtained from the main publication of the project (Coale and Watkins 1986, pp. 94–107). Migration came from Bonneuil (1997).

Information on elections

Political variables were obtained from different sources. Frédéric Salmon kindly shared with me his estimations of turnout at the polls for all legislative elections between 1876 and 1898, as well as the votes received by different parties in 1877, 1885, and 1898, which I used to estimate the proportion of votes received by republican groups (as opposed to monarchist parties).[45] I constructed this latter measure for 1889 in the same way using the data estimated by Rudelle (1982, pp. 264–267), and for the three other elections (1876, 1881, and 1893) I relied upon (Avenel, 1894, p. 65). For the purpose of the panel I applied the elections of 1876, 1881, 1885, 1889, and 1893 for 1876, 1881, 1886, 1891, and 1996 respectively.[46]

Temperature data

Climatologic data was kindly given by a group of researchers at the University of Bern, who calculated a monthly series spanning five centuries of European climatologic data (Luterbacher et al. 2004).[47] They reconstructed the climatic history of Europe using a large number of homogenised instrumental data series, as well as additional information coming from sea-ice, tree rings, and documentary records (Luterbacher et al. 2004, p. 1500), thus obtaining a grid with a resolution of $0.5° \times 0.5°$ (which in the case of France is equivalent to having a measure each 38 km in the east–west spectrum, and approximately 55 km in north–south direction) where the value at each point represents the monthly average temperature in the 0.5° radius. About 250 of these data-points lay on French territory. To obtain estimates of the temperature in each *département*, I averaged the values corresponding to the points laying on that department. Following this procedure, I calculated for the years of the panel the deviations of summer temperature (July to September) from the corresponding 1850–1900 mean.

43 Series V77, V79, V80, V82, V83, V85, V86, V88, V89, V91, V92, V112, V113, V115, V116, V118, V119, V121, V122, V124, V125, V127, and V128 from ENSP_T38.

44 Series V21, V187 and V210 from MVTPOP_T126_II.

45 Frédéric Salmon has worked extensively on electoral statistics in France. See, for example, Salmon (2001) and http://geoelections.free.fr.

46 I also explored the possibility of using the plausible alternative of linking the average of 1889 and 1893 to 1891, and the one of 1893 and 1898 to 1896 instead, but the general results were largely unchanged.

47 I have to thank Roman Studer here for letting me know about this study and putting me in contact with the researchers in charge of it.

Table 7 Variables obtained from official French statistics

Variable	Reported year PUBLICATION (publication year: pages)				
Population					
Total	1876 ASF (1879: 14–17)	1881 ASF (1884: 12–15)	1886 ASF (1888: 4–5)	1891 ASF (1903: 8–11)	1896 ASF (1903: 8–11)
Women	1876 ASF (1879: 34–37)	1881 ASF (1883: 20–23)	1886 DEN (1888: 84–85)	1891 ASF (1892/4: 24–25)	1896 ASF (1899: 2–5)
By age (<5 years old)	1876 DEN (1878: 96–99, 120–123)	1881 DEN (1883: 136–139, 160–163)	1886 DEN (1888: 152–155)	1891 DEN (1894: 605–607)	1896 DEN (1899: 356–359)
Births, stillbirths, and number of natural children born	1876 ASF (1879: 44–47)	1881 ASF (1884: 26–29)	1886 ASF (1889: 14–17)	1891 ASF (1899: 2–5)	1896 ASF (1902: 16–19)
Deaths (<5 years old)	1876 ASF (1879: 54–61)	1881 ASF (1884: 36–43)	1886 SGF (1889: 64–71)	1891 SGF (1892: 56–73)	1896 SGF (1898: 80–87)
Foreigners[a]	1876 DEN (1878: 88–91)	1881 DEN (1883: 116–119)	1886 DEN (1888: 96–97)	1891 DEN (1894: 506–509)	1896 DEN (1899: 258–261)
Urban	1876 ASF (1879: 14–17)	1881 ASF (1884: 12–15)	1886 ASF (1888: 4–5)	1891 ASF (1892/4: 12)	1896 ASF (1903: 24–27)
Literacy and education					
Women being able to sign their marriage certificate	1876 ASF (1879: 18–21)	1881 ASF (1884: 31, 33)	1886 ASF (1889: 18–19)	1892 ASF (1892/4: 50–51)	2011c ACRH (1895: v224)
Number of conscripts and their literacy level[b]	1876 ASF (1879: 474–477)	1881 ASF (1884: 524–527)	1887 ASF (1888: 414–417)	1893 ASF (1892/4: 684–5)	1897 ASF (1898: 628–629)

Table 7 continued

Variable	Reported year PUBLICATION (publication year: pages)				
Students in lay and congregational primary schools[c]	1875–1876 ASF (1878: 240–243)	1880–1881 ASF (1883: 246–249)	1885–1886 ASF (1888: 184–187)	1892–1893 ASF (1892/4: 282–5)	1895–1896 ASF (1897: 442–446)
Others					
Taxes: direct contributions (in francs)[d]	1876 ASF (1881: 520–523)	1880 ASF (1885: 546–549)	1886 ASF (1889: 384–387)	1892 ASF (1892/4: 572–75)	1896 ASF (1897: 485)
Number of saving books and amount of francs in them[e]	1876 ASF (1879: 218–221)	1881 ASF (1884: 232–235)	1886 ASF (1886: 158–159)	1892 ASF (1892/4: 200)	1896 ASF (1898: 68–71)
Wheat prices	1876 ASF (1879: 14–17)	1881 ASF (1884: 314–316)	1886 ASF (1888: 216–218)	1893 ASF (1892/4: 308–310)	1896 ASF (1898: 94–97)
Number of Desservants	1876 ASF (1879: 68–71)	1881 ASF (1884: 60–63)	1886 ASF (1889: 26–29)	1991 ASF (1891: 34–35)	1996 ASF (1897: 485)

All these figures came from publications of the Service de la Statistique Général de la France, either the Annuaire Statistique de la France (ASF 1878–1903), the Statistique Générale de la France-Statistique Annuelle (SGF 1889, 1892, 1898), the Résultats Statistiques du Dénombrement (DEN 1873, 1878, 1883, 1888, 1894, 1899), or the recent online publication Atelier du Centre de recherches historiques (ACRH 2011a, b, c, d)

[a] Residents that are not French nationals. Change from 1871 estimated using data for 1872 (DEN 1873, pp. 44–47), as the former was not available

[b] Information corresponding to the original list of conscript, not to those admitted to the army. Cases where the level of education was not known were extracted from the total to get literacy rates

[c] Includes all primary schools, free and public

[d] Includes mainly taxes on land (*foncière*), personal property (*personnel et mobilière*), houses (*des portes et fenètres*), and licenses (*des patentes*). Income estimates built applying the proportions implied by these taxes to the domestic product in Toutain (1987), deflated by the price of wheat

[e] Accounts held in national *Caisses d'epargne*

Table 8 Modelling marital fertility in France (1876–1896) using *départements* data, pooled-OLS, and fixed-effects

Dependent variable: I_g	Pooled OLS		Panel FE	
	β	(s.e.)	β	(s.e.)
Demographic controls				
Infant mortality	0.546***	(0.202)	−0.027	(0.057)
Net immigration 15/19–20/24	−0.266	(0.253)	0.049	(0.046)
Net immigration 20/24–25/29	−0.772***	(0.149)	−0.205***	(0.050)
Net immigration 25/29–30/34	−0.045	(0.155)	0.142***	(0.043)
Foreigners (% change in pop)	0.403	(0.414)	0.215	(0.166)
Economic				
Income per capita (in '000s)	−0.107***	(0.044)	0.033**	(0.013)
Urban population	0.129	(0.087)	0.059	(0.110)
% Working in industry	−0.044	(0.189)	0.079	(0.122)
% Working in agriculture	−0.449***	(0.106)	−0.039	(0.037)
Saving books per capita	−0.253**	(0.132)	0.115**	(0.066)
Education				
Literacy (male)	−0.158	(0.118)	−0.078**	(0.033)
Literacy gap (f/m)	−0.044	(0.092)	−0.076***	(0.021)
Modernisation				
Religion (religious education)	0.194**	(0.077)	0.124**	(0.051)
% Republican vote	−0.048	(0.042)	0.008	(0.012)
Turnout at the polls	−0.300**	(0.132)	−0.032	(0.028)
Fixed effects & time dummies	No		Yes	
R^2:	0.53		0.79	
F (df, n)	32.0		34.0	

All estimations included 435 observations (5 for each of the 87 *départements*). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Appendix 2: Additional econometric output

The tables below detail the econometric output used to construct the elasticity estimates given in the text. Table 8 shows the results of the pooled-OLS and fixed-effects regressions that appear in Table 2. Tables 9 and 10 present the estimates of the first and second stages in the 2SLS regressions corresponding to Table 3 in the text, Tables 11 and 12 those corresponding to Table 4, and Tables 13 and 14 those of Table 5. Table 15 gives the estimates of the spatial regressions discussed in Sect. 3.6.

Table 9 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS, first stage

Dependent variable:	(i) Infant mort.		(ii) Infant mort.		(iii) Child mort.		(iv) Infant mort.	
	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Instrument								
Deviation summer temp.	0.023***	(0.005)			0.029***	(0.007)	0.022***	(0.005)
Deviation July temp.			0.017***	(0.004)				
Demographic controls								
Infant mort., t—5 years							−0.034	(0.049)
Net immigr. 15/19–20/24	−0.057	(0.041)	−0.078**	(0.045)	−0.092	(0.064)	−0.058	(0.042)
Net immigr. 20/24–25/29	0.013	(0.029)	0.022	(0.029)	−0.015	(0.047)	0.012	(0.029)
Net immigr. 25/29-30/34	−0.062**	(0.035)	−0.047	(0.031)	−0.067	(0.055)	−0.064**	(0.035)
Foreigners (% ch. in pop)	0.131	(0.131)	0.088	(0.154)	0.282	(0.195)	0.127	(0.133)
Economic								
Income per capita (in ‘000s)	−0.013	(0.015)	−0.005	(0.015)	−0.022	(0.017)	−0.013	(0.015)
Urban population	0.004	(0.070)	0.041	(0.072)	0.086	(0.098)	0.002	(0.070)
% Working in industry	0.069	(0.064)	0.104	(0.067)	0.035	(0.081)	0.073	(0.066)
% Working in agriculture	0.085***	(0.027)	0.102***	(0.026)	0.062**	(0.032)	0.088***	(0.027)
Saving books per capita	−0.065	(0.055)	−0.050	(0.053)	−0.046	(0.070)	−0.064	(0.057)
Education								
Literacy (male)	−0.010	(0.025)	−0.015	(0.026)	−0.022	(0.041)	−0.012	(0.026)
Literacy gap (f/m)	0.016	(0.016)	0.010	(0.017)	0.004	(0.019)	0.014	(0.016)
Modernisation								
Religion (relig. education)	0.049	(0.043)	0.057	(0.043)	0.084	(0.072)	0.047	(0.043)
% Republican vote	0.007	(0.009)	0.007	(0.009)	0.009	(0.012)	0.007	(0.009)
Turnout at the polls	0.011	(0.020)	0.016	(0.021)	0.034	(0.029)	0.012	(0.020)
R^2	0.34		0.32		0.48		0.34	
F (df, n)	11.4		9.9		28.3		10.5	
F-test exc. instruments	2.64		16.8		18.5		24.3	

Dependent variable of the first stage regression stated at the top of each column in the table. All estimations included 435 observations (5 for each of the 87 *départements*), fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 10 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS, second stage

Dependent variable: I_g	(i) Infant mort.		(ii) Infant mort.		(iii) Infant mort.		(iv) Infant mort.	
	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Demographic controls								
Infant mortality	−0.095	(0.147)	−0.151	(0.194)			−0.127	(0.156)
Infant mort., t—5 years							−0.061	(0.060)
Child mortality					−0.074	(0.116)		
Net immigr. 15/19–20/24	0.046	(0.048)	0.043	(0.048)	0.044	(0.049)	0.043	(0.047)
Net immigr. 20/24–25/29	−0.204***	(0.049)	−0.204***	(0.048)	−0.207***	(0.049)	−0.205***	(0.048)
Net immigr. 25/29–30/34	0.140***	(0.044)	0.138***	(0.044)	0.141***	(0.044)	0.134***	(0.044)
Foreigners (% ch. in pop)	0.232	(0.179)	0.246	(0.187)	0.241	(0.184)	0.229	(0.177)
Economic								
Income per capita (in ‘000s)	0.032**	(0.015)	0.032**	(0.016)	0.032**	(0.016)	0.032**	(0.015)
Urban population	0.064	(0.108)	0.067	(0.107)	0.070	(0.109)	0.061	(0.106)
% Working in industry	0.082	(0.123)	0.084	(0.123)	0.078	(0.124)	0.091	(0.122)
% Working in agriculture	−0.033	(0.041)	−0.028	(0.045)	−0.036	(0.040)	−0.024	(0.043)
Saving books per capita	0.110**	(0.063)	0.107**	(0.062)	0.113**	(0.064)	0.109**	(0.065)
Education								
Literacy (male)	−0.079**	(0.034)	−0.080**	(0.034)	−0.080**	(0.034)	−0.083**	(0.033)
Literacy gap (f/m)	−0.076***	(0.021)	−0.076***	(0.021)	−0.077***	(0.022)	−0.078***	(0.021)
Modernisation								

Table 10 continued

Dependent variable: I_g	(i) Infant mort.		(ii) Infant mort.		(iii) Infant mort.		(iv) Infant mort.	
	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Religion (relig. education)	0.128**	(0.050)	0.131***	(0.050)	0.130**	(0.051)	0.126**	(0.050)
% Republican vote	0.009	(0.013)	0.009	(0.013)	0.009	(0.013)	0.009	(0.013)
Turnout at the polls	−0.032	(0.027)	−0.032	(0.027)	−0.031	(0.028)	−0.030	(0.026)
R^2	0.79		0.78		0.78		0.79	
F (df, n)	33.3		33.1		32.4		30.8	

All estimations included 435 observations (5 for each of the 87 *départements*), fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 11 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS with fixed effects, first stage

Dependent variable: Infant mortality	(v)		(vi)		(vii)	
	β	(s.e.)	β	(s.e.)	β	(s.e.)
Instrument						
Deviation summer temp.	0.023***	(0.004)	0.023***	(0.005)	0.023***	(0.005)
Demographic controls						
Net immigr. 15/19–20/24	−0.048	(0.041)	−0.061	(0.041)	−0.063	(0.042)
Net immigr. 20/24–25/29	0.004	(0.028)	0.022	(0.029)	0.023	(0.029)
Net immigr. 25/29–30/34	−0.070**	(0.032)	−0.057	(0.036)	−0.063**	(0.036)
Foreigners (% ch. in pop)	0.111	(0.133)	0.082	(0.123)	0.090	(0.124)
Economic						
Income per capita (in '000s)	−0.013	(0.015)	−0.012	(0.015)	−0.012	(0.015)
Urban population	0.003	(0.068)	0.021	(0.066)	0.003	(0.068)
% Working in industry	0.076	(0.065)	0.073	(0.064)	0.073	(0.063)
% Working in agriculture	0.086***	(0.026)	0.080***	(0.027)	0.084***	(0.027)
Saving books per capita	−0.079	(0.055)	−0.041	(0.055)	−0.049	(0.055)
Education						
Literacy (male)	0.003	(0.027)			−0.056**	(0.025)
Literacy gap (f/m)	0.017	(0.016)			−0.003	(0.018)
Literacy (male), t—20 years			0.060**	(0.026)	0.082***	(0.028)
Lit. gen. rat. (f/m), t—20 years			−0.002	(0.016)	−0.004	(0.016)
Enrolment	−0.040	(0.083)				
Enrolment (squared)	0.004	(0.043)				
Modernisation						
Religion (relig. education)	0.046	(0.044)	0.062	(0.042)	0.053	(0.042)
% Republican vote	0.007	(0.009)	0.009	(0.009)	0.009	(0.009)
Turnout at the polls	0.010	(0.020)	0.009	(0.020)	0.010	(0.020)
Observations	435		435		435	
R^2	0.34		0.35		0.35	
F (df, n)	11.4		12.9		12.1	
F-test excluded instruments	25.8		25.4		25.8	

All estimations included observations for 87 *départements* per year, fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 12 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS with fixed effects, second stage

Dependent variable: I_g	(v)		(vi)		(vii)	
	β	(s.e.)	β	(s.e.)	β	(s.e.)
Demographic controls						
Infant mortality	−0.058	(0.146)	−0.128	(0.143)	−0.155	(0.143)
Net immigr. 15/19–20/24	0.037	(0.048)	0.057	(0.048)	0.060	(0.047)
Net immigr. 20/24–25/29	−0.199***	(0.050)	−0.205***	(0.050)	−0.213***	(0.048)
Net immigr. 25/29–30/34	0.141***	(0.043)	0.138***	(0.046)	0.134***	(0.045)
Foreigners (% ch. in pop)	0.210	(0.179)	0.278	(0.181)	0.274	(0.180)
Economic						
Income per capita (in ‘000s)	0.032**	(0.015)	0.031**	(0.015)	0.027**	(0.015)
Urban population	0.045	(0.109)	0.054	(0.110)	0.026	(0.106)
% Working in industry	0.083	(0.122)	0.095	(0.120)	0.087	(0.118)
% Working in agriculture	−0.034	(0.041)	−0.020	(0.040)	−0.023	(0.040)
Saving books per capita	0.122**	(0.066)	0.107	(0.066)	0.083	(0.066)
Education						
Literacy (male)	−0.067**	(0.033)			−0.052	(0.038)
Literacy gap (f/m)	−0.075***	(0.021)			−0.059***	(0.019)
Literacy (male), t—20 years			−0.122***	(0.038)	−0.073**	(0.040)
Lit. gen. rat. (f/m), t—20 years			−0.039**	(0.018)	−0.034**	(0.017)
Enrolment	−0.103**	(0.056)				
Enrolment (squared)	0.056**	(0.030)				
Modernisation						
Religion (relig. education)	0.116**	(0.051)	0.138***	(0.054)	0.134***	(0.050)
% Republican vote	0.009	(0.013)	0.009	(0.014)	0.011	(0.013)
Turnout at the polls	−0.034	(0.027)	−0.034	(0.029)	−0.032	(0.028)
Observations	435		435		435	
R^2	0.78		0.78		0.79	
F (df, n)	31.1		30.1		30.6	

All estimations included observations for 87 *départements* per year, fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 13 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS with fixed effects, first stage

Dependent variable: Infant mortality	(viii)		(ix)		(x)		(xi)	
	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Instrument								
Deviation summer temp.	0.028***	(0.010)	0.023***	(0.004)	0.023***	(0.005)	0.023***	(0.005)
Demographic controls								
Net immigr. 15/19–20/24	−0.016	(0.049)	−0.072**	(0.042)	−0.063	(0.045)	−0.079**	(0.043)
Net immigr. 20/24–25/29	−0.074	(0.054)	0.014	(0.029)	0.013	(0.029)	0.014	(0.028)
Net immigr. 25/29–30/34	−0.111**	(0.047)	−0.062**	(0.035)	−0.060**	(0.035)	−0.063**	(0.035)
Foreigners (% ch. in pop)	0.445	(0.381)	0.121	(0.137)	0.124	(0.134)	0.091	(0.138)
Economic								
Income per cap. (in ‘000s)	−0.005	(0.021)			−0.012	(0.016)	−0.013	(0.016)
Savings per cap. (in ‘000s)			−0.050	(0.061)	−0.034	(0.063)		
Urban population	0.040	(0.097)	0.010	(0.070)	0.009	(0.069)	−0.030	(0.068)
% Working in industry	0.134	(0.082)	0.082	(0.068)	0.074	(0.064)	0.054	(0.062)
% Working in agriculture	0.123***	(0.035)	0.084***	(0.027)	0.083***	(0.027)	0.087***	(0.027)
Saving books per capita	0.021	(0.059)	−0.018	(0.079)	−0.029	(0.083)	−0.056	(0.052)
Education								
Literacy (male)	0.008	(0.032)	−0.011	(0.025)	−0.012	(0.025)	−0.027	(0.027)
Literacy gap (f/m)	0.040**	(0.023)	0.017	(0.016)	0.015	(0.017)	0.012	(0.017)
Modernisation								
Religion (relig. education)	0.014	(0.053)	0.051	(0.046)	0.053	(0.046)		
Religion (desservant)							−0.020	(0.013)
% Republican vote	0.007	(0.014)	0.006	(0.009)	0.006	(0.009)	0.007	(0.009)
Turnout at the polls	0.050	(0.035)	0.009	(0.021)	0.010	(0.021)	0.018	(0.020)
Observations	261		435		435		435	
R^2	0.44		0.34		0.44		0.34	
F (df, n)	8.5		10.6		8.5		11.7	
F-test excluded instruments	8.3		26.1		25.0		24.6	

All estimations included observations for 87 *départements* per year, fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 14 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, 2SLS with fixed effects, second stage

Dependent variable: I_g	(viii)		(ix)		(x)		(xi)	
	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Demographic controls								
Infant mortality	−0.004	(0.283)	−0.146	(0.151)	−0.160	(0.148)	−0.042	(0.142)
Net immigr. 15/19–20/24	0.071	(0.061)	0.094**	(0.051)	0.075	(0.050)	0.046	(0.056)
Net immigr. 20/24–25/29	−0.224***	(0.068)	−0.206***	(0.050)	−0.204***	(0.047)	−0.193***	(0.049)
Net immigr. 25/29–30/34	0.174**	(0.082)	0.130***	(0.041)	0.126***	(0.043)	0.121***	(0.045)
Foreigners (% ch. in pop)	0.300	(0.381)	0.287	(0.189)	0.283	(0.191)	0.270	(0.187)
Economic								
Income per cap. (in ‘000s)	0.040**	(0.024)			0.024	(0.015)	0.027**	(0.015)
Savings per cap. (in ‘000s)			0.232***	(0.078)	0.201**	(0.081)		
Urban population	−0.044	(0.131)	0.030	(0.105)	0.032	(0.107)	0.093	(0.110)
% Working in industry	0.037	(0.140)	0.041	(0.125)	0.056	(0.124)	0.089	(0.120)
% Working in agriculture	−0.053	(0.067)	−0.019	(0.041)	−0.015	(0.041)	−0.028	(0.040)
Saving books per capita	0.118**	(0.068)	−0.126	(0.102)	−0.106	(0.105)	0.104	(0.066)
Education								
Literacy (male)	−0.096***	(0.037)	−0.073**	(0.035)	−0.071**	(0.034)	−0.080**	(0.034)
Literacy gap (f/m)	−0.075**	(0.030)	−0.075***	(0.022)	−0.070***	(0.021)	−0.073***	(0.019)
Modernisation								
Religion (relig. education)	0.134***	(0.051)	0.107**	(0.055)	0.105**	(0.055)		
Religion (desservant)							0.040**	(0.017)
% Republican vote	0.013	(0.018)	0.011	(0.013)	0.011	(0.013)	0.008	(0.013)
Turnout at the polls	−0.010	(0.051)	−0.026	(0.028)	−0.028	(0.027)	−0.031	(0.029)
Observations	261		435		435		435	
R^2	0.80		0.79		0.79		0.78	
F (df, n)	38.0		32.2		32.0		34.4	

Notes: All estimations included observations for 87 *départements* per year, fixed effects, and time dummies, and were performed with the routine xtivreg2 for Stata (Schaffer 2010). Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

Table 15 Modelling marital fertility (I_g) in France (1876–1896) using *départements* data, spatial dependence

Dependent variable: I_g	(xii)		(xiii)		(xiv)	
	β	(s.e.)	β	(s.e.)	β	(s.e.)
Demographic controls						
Infant mortality	−0.031	(0.077)	−0.032	(0.060)	−0.036	(0.068)
Net immigr. 15/19–20/24	0.080	(0.053)	0.059	(0.042)	0.067	(0.045)
Net immigr. 20/24–25/29	−0.152**	(0.068)	−0.191***	(0.052)	−0.207***	(0.056)
Net immigr. 25/29–30/34	0.182***	(0.054)	0.139***	(0.045)	0.154***	(0.050)
Foreigners (% ch. in pop)	0.351**	(0.197)	0.230	(0.154)	0.266	(0.173)
Economic						
Income per capita (in ‘000s)	0.020	(0.019)	0.028**	(0.015)	0.029**	(0.017)
Urban population	0.056	(0.136)	0.062	(0.111)	0.063	(0.124)
% Working in industry	0.075	(0.137)	0.045	(0.118)	0.043	(0.130)
% Working in agriculture	−0.030	(0.045)	−0.027	(0.039)	−0.025	(0.045)
Saving books per capita	0.124	(0.076)	0.119**	(0.062)	0.136**	(0.068)
Education						
Literacy (male)	−0.106**	(0.044)	−0.089***	(0.032)	−0.103***	(0.035)
Literacy gap (f/m)	−0.063**	(0.029)	−0.065***	(0.021)	−0.068***	(0.024)
Modernisation						
Religion (relig. education)	0.115**	(0.065)	0.118**	(0.049)	0.126**	(0.055)
% Republican vote	0.017	(0.015)	0.014	(0.012)	0.017	(0.013)
Turnout at the polls	−0.026	(0.040)	−0.031	(0.030)	−0.032	(0.034)
Spatial coefficients						
ρ	0.252***	(0.011)			0.103***	(0.0002)
λ			0.103***	(0.0001)	0.102***	(0.0001)

All estimations included 435 observations (5 for each of the 87 *départements*), fixed effects, and time dummies, and were performed with the xsmle command for Stata. Estimates are heteroskedasticity robust, and clustered by *département* as suggested by Bertrand et al. (2004, pp. 270–272) to correct the potential risks of serial correlation. Standard errors are reported in parenthesis and asterisks indicate significance levels: * 10 %, ** 5 %, and *** 1 %

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